National Aeronautics and Space Administration

Joint Robotic Precursor Activity: Providing Strategic Knowledge to Inform Future Exploration

Presentation to the

NASA Planetary Protection Subcommittee

20 December 2012

Victoria P. Friedensen,

JRPA Manager

Joint Robotic Precursor Activity (JRPA) Overview

Goal: Inform the selection of future destinations, support the development of exploration systems, and reduce the risk associated with human exploration while maximizing the mutual benefit to both science and exploration

- **To meet this goal, NASA will jointly fund and conduct Robotic Precursor Activities**
  - These activities will provide the strategic knowledge required to inform human spaceflight (HSF) planning. By developing an integrated set of priorities NASA will leverage mission opportunities, data, and the talents of both the exploration and science communities to enable human missions to near-Earth Asteroids (NEAs), the Moon, and ultimately Mars.
- **Such activities will include**
  - Fund development of instruments for NASA and non-NASA missions to destinations relevant to human exploration beyond low-Earth orbit to gather needed information
  - Fund Research and Analysis efforts to generate strategic knowledge in support of human spaceflight planning and systems development
  - Perform strategic studies and hold joint workshops to further inform and leverage community participation
  - Lay the groundwork for future precursor missions, should funding improve
- **Total budget target is $30M ($20M/HEO-AES and $10M/SMD-PSD) formally starting in FY13. HEO-AES devoted $18M in FY12 funding to start these activities**

From the FY11 NASA Strategic Plan

- **Exploration Strategic Goal 1: Extend and sustain human activities across the solar system.**
  - **Outcome 1.3:** Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit.
    - **Objective 1.3.3: Identify hazards, opportunities, and potential destinations, to support future safe and successful human space exploration missions.**

- **Science Strategic Goal 2: Expand scientific understanding of the Earth and the universe in which we live.**
  - **Outcome 2.3:** Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.
    - **Objective 2.3.1:** Inventory solar system objects and identify the processes active in and among them.
    - **Objective 2.3.2:** Improve understanding of how the Sun's family of planets, satellites, and minor bodies originated and evolved.
    - **Objective 2.3.3:** Improve understanding of the processes that determine the history and future of habitability of environments on Mars and other solar system bodies.
    - **Objective 2.3.5: Identify and characterize small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources.**

Acronym List in Backup

Performance Goals (FY12)

Human Exploration and Operations Mission Directorate (HEOMD)

- **Performance Goal 1.3.3.1:** Identify hazards, opportunities and potential destinations, to support future safe and successful human space exploration missions
  - **APG 1.3.3.1: ERD-12-7:** In collaboration with the Planetary Science Division, develop a plan to return data that will support the selection of destinations and reduce risk for future human space exploration missions

Science Mission Directorate (SMD)

- **Performance Goal 2.3.5.1:** Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.
  - **APG 2.3.5.1: PS-12-12:** Demonstrate planning progress in identifying and characterizing small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources…

- **Performance Goal 2.3.5.2:** Return data for selection of destinations in order to lower risk for human space exploration beyond low Earth orbit
  - **APG 2.3.5.2: PS-12-13:** Demonstrate planned progress in characterizing potentially hazardous objects that are possible destinations for future human space exploration

Acronym List in Backup

JRPA FY12 Planning Activities

- **Work focused on:**
  - Defining, Refining, and Prioritizing Strategic Knowledge Gaps (SKGs)
    - NAC's Analysis Groups vetted and refined draft SKG sets for Moon, NEAs, Mars, and Mars' moons
    - Worked with the International Space Exploration Coordination Group (ISECG) (via the Strategic Knowledge Gap Assessment Team, chaired by the Chief Exploration Scientist) and began coordination with international space agencies to identify and prioritize an international set of SKGs
  - Providing background and input to the Mars Program Planning Group and the HEOMD Human Spaceflight Planning Team
  - Identifying near-term opportunities
    - Prioritized by destination and timeline
    - Destination-specific versus advancing state of knowledge
    - Building up to a Mission of Opportunity or other flight opportunity
  - Writing a Memorandum of Agreement

Ground Rules (as articulated in the MOA)

- **TheFY13 PBR called for a joint program office funded by Science and Exploration, renamed the Joint Robotic Precursor Activities (JRPA) and managed out of HQ**
- **Flat $30M (RY$, full cost) starting in FY13**
  - $10M from SMD; $20M from HEOMD
  - CS/Procurement to be determined by portfolio
- **Delegated Management/Separate Funding**
  - One office/manager (the JRPA Manager) accountable to both mission directorates
  - HEOMD/AES/JRPA will manage the overall portfolio and keep track of the funding and reporting with concurrence from PSD
- **HEOMD and SMD will, via the JRPA Team**
  - Jointly identify needs and opportunities
  - Collaboratively determine the best approach for specific elements
  - Develop a clear set of implementation guidelines
  - Seek a balanced but incentivizing approach to implementation
- **Steering Committee will:**
  - Concur on plans and funding allocation
  - Recommend portfolio to mission directorates as appropriate
- **Document management decisions in Memorandum of Agreement (MOA), project plans, etc.**
  - Rigorously track progress, actions, and products through application of best-of-practice project management approaches
- **Exploration and Science will hold JRPA commitments as a protected priority the greatest extent possible**

Guidelines

- **Recognize the Planetary Science Decadal Survey guidance: "…vital to maintain the science focus of such peer-reviewed missions and not to incorporate human exploration requirements after the mission has been selected and development has begun."**
  - JRPA objectives will not undermine SMD processes for competition
  - There are some missions for which it is too late to add an instrument, however, augmenting or supporting an existing instrument may be an option (e.g., OSIRIS-REx)
  - There are some measurements or experiments that, while revolutionary, will not provide the kinds of information that will support human mission planning
- **Recognize that HEOMD has obligations to employ and train NASA civil servants, to the fullest extent possible**
  - It will sometimes be in HEOMD's best interest to partially or completely direct work to NASA Centers
- **The Chief Exploration Scientist, an integral part of the JRPA team, will be key to maintaining a balance between these two obligations**
- **A Steering Committee is intended to provide advice and guidance, and to assist in decisionmaking where there may be competing priorities**
  - The individual DPMCs for both mission directorates, along with the MDAAs, provide formal approvals
- **JRPA is not a technology development activity: that responsibility lies with the Advanced Exploration Systems Division in HEOMD.**

Determining Priorities

- **Criteria**
  - Relevance to Human Space Flight's Strategic Knowledge Gaps (SKGs) for potential human destinations, including the Moon, Near-Earth Asteroids, and Mars
  - The Strategic Knowledge Gaps translate to sets of measurements and other activities that will be used to guide instrument/mission/R&A investments and potential collaborations with international partners
- **Processes**
  - JRPA team collaboratively develops prioritized proposals for funding specific activities
  - The Steering Committee will comment and concur on the proposed plans and funding allocation
  - The scope assignments and associated cost estimates will be documented per MOA signed at the Division level (as appropriate)
  - Once scope is assigned, each directorate is responsible for that scope irrespective of cost

Informing Exploration: Strategic Knowledge Gaps

- **To inform mission/system planning and design and near-term Agency investments**
  - Human Spaceflight Architecture Team (HAT) Destination Leads were asked to identify the data or information needed that would reduce risk, increase effectiveness, and aid in planning and design
  - The data can be obtained on Earth, in space, by analog, experimentation, or direct measurement
- **For some destinations, the needed knowledge is well identified**
  - Analysis Groups (LEAG and MEPAG) have identified pertinent measurements to gain the needed knowledge regarding the Moon and Mars
  - Significant advances in filling the knowledge gaps have been made (examples: LRO and MRO, and soon, MSL)
- **The Strategic Knowledge Gaps (SKGs) identified here will:**
  - Provide NASA's foundation for achieving an internationally developed and accepted set of integrated and prioritized SKGs through ISECG's Strategic Knowledge Assessment Team
  - Form the basis for near-term Agency investments in robotic precursor missions and activities through competed and/or directed activities. A few examples include:
    - NASA Lunar Science Institute Cooperative Agreement Notice
    - LASER (Lunar Advanced Science and Exploration Research, or equivalent) and SALMON (Stand Alone Missions of Opportunity Notice) calls
    - Development of early flight opportunities

SKGs: Common Themes and Some Observations

- **There are common themes across destinations (not in priority order)**
  - The three R's for enabling human missions
    - Radiation
    - Regolith
    - Reliability
  - Geotechnical properties (Moon, NEAs, Mars)
  - Volatiles (i.e., for science, resources, and safety) (Moon, NEAs, Mars)
  - Propulsion-induced ejecta (Moon, NEAs, Mars)
  - In-Situ Resource Utilization (ISRU)/Prospecting (Moon, NEAs, Mars)
  - Operations/Operability (all destinations, including transit)
  - Plasma Environment (Moon, NEAs)
  - Human health and performance (all destinations, including transit)
- **Some Observations**
  - The required information is measurable and attainable
  - These measurements do not require "exquisite science" instruments but could be obtained from them
  - Filling the SKGs requires a well-balanced research portfolio
    - Remote sensing measurements, in-situ measurements, ground-based assets, and research & analysis (R&A)
    - Includes science, technology, and operational experience

Status and Way Forward

- **Prioritizing SKGs:**
  - NASA engaged the external Science and Exploration communities to vet and refine the draft SKGs.
    - Lunar Exploration Analysis Group (Specific Action Team phase 2 results complete; report available on LEAG website, phase 3 [measurements/instruments] in development)
    - Mars Exploration Program Analysis Group (Precursor Strategy Analysis Group, P-SAG, final report available on MEPAG web site)
    - Small Bodies Assessment Group (SKG-SAT in progress; final report on SBAG website)
  - NASA will establish traceability of the SKGs to its currently planned robotic missions, utilization of ISS, and known opportunities for Research and Analysis efforts, and exploitation of existing ground based assets. (In process)
- **Next Steps:**
  - Vet through International Space Exploration Coordination Group
  - Prioritize across the various destinations to determine critical investment areas
- **Schedule:**
  - To be completed March 2013

The full SKG reports can be found on the web at:
Moon: http://www.lpi.usra.edu/leag/reports.shtml
Mars: http://mepag.nasa.gov/reports/index.html
Small Bodies: http://www.lpi.usra.edu/sbag/documents/

Proposed Initial JRPA Portfolio

- **FY12 was a voluntary start by HEOMD**
- **FY 13-14 activities currently include pre-existing/new projects**
  - As a result of the ESMD/SOMD reorganization (2011) these pre-existing projects were re-aligned to fit new budget lines
    - Lunar Mapping and Modeling Project (LMMP) including development of new education applications and expanding available lunar data products
    - RAD on the Mars Science Lab (MSL) has its own separate budget line in AES
    - The NASA Lunar Science Institute (NLSI) is funded by SMD and HEOMD
      - The Institute will expand to other potential human destinations in FY13 via a Cooperative Agreement Notice (release before 1 January)
  - Two HEO-funded AES projects aligned well with the JRPA objectives
    - 4x improvement to the Goldstone radar capability to image NEAs
    - Lunar ice prospecting payload project (RESOLVE)
      - Note: AES projects are funded for 3 years (FY12-14), with yearly decision reviews that determine whether the project should be funded for an additional year
  - Other investments include:
    - Lunar lander development and concept refinement
    - RFI for NEA-detector concepts
    - Strategic studies in support of Mars 2020 mission
  - R&A would include participating scientists on robotic missions, competitive calls, and other means to improve our working knowledge of all human destinations

JRPA and Planetary Protection

The Subcommittee's request:

- **Discuss how JRPA fits in to NASA's broader technology effort**
  - As noted, JRPA is not a 'technology development effort', but filling Strategic Knowledge Gaps will inform aspects of Planetary Protection plans for future human missions
- **Discuss technologies that can support NASA's ability to meet its planetary protection requirements**
  - This is more a question for HEOMD or AES to address. While there is no specific mandate for JRPA to address Planetary Protection, any JRPA-funded flight instrument or mission would certainly comply
- **Discuss how JRPA's work/mandate/budget could serve planetary protection requirements**
  - SKGs (see the websites for the entire set) are a mechanism for understanding the environments that humans will explore
  - SKG-derived knowledge is envisioned as informing mission planning and may be a factor in determining Planetary Protection requirements