Lunar Prospector: Managing a Very Low Cost Mission

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NASA Manager of LP from 1995-1998

The PI-Team Masters Forum - 2
April 27, 2010
Mission and Program Goals

• Understand the origin, evolution and resources of the Moon

• Demonstrate “Faster, Better, Cheaper” goals of Discovery Missions
  – LP was the first competitively selected Discovery Mission

• Catalyze planetary exploration via education and outreach programs
Back to the Moon with Lunar Prospector

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Back to the Moon with Lunar Prospector
Mission and Metrics Overview

• $62.8M Total Mission Cost (FY96)
  – Phase B study: $2M
  – 5 Instruments/6 experiments: $3.6M
  – Spacecraft and mission analysis: $22.6
  – ELV, translunar stage and adapter: $26M
  – Operations: $4.2M
  – Maximum award fee: $4.4M

• Education and Outreach (example)
  – Innovative Web activities using ARC information technology

• 22 Month development

• 1 year primary mission at 100km circular polar orbit

• 6 month extended mission at 10-30 km polar orbit
Trajectory
Development Approach

• Spacecraft:
  – Simple, spin-stabilized, reliable
  – High heritage instruments, components & subsystems
  – Mix of subsystem and operational redundancy

• Test
  – Rigorous test-as-you-fly program
  – Addressed all spacecraft functions and risk areas
  – No normal project steps were skipped
Mission Operations Approach

• Operations:
  – Operational simplicity combined with planning, staffing and training of all aspects of operations
  – Extensive off-nominal system and mission analysis, contingency procedures development and team training

• ELV:
  – Athena II launch vehicle with commercial ship & shoot processes
  – Rigorous mission success qualification process
Management Challenges

• Manage to cost, yet maximize mission success on a short schedule

• Balance teamwork with NASA accountability

• Develop new management tools without sacrificing prudent process

• Accommodate new roles of PI and Project Manager
LP Management Philosophy

• Freeze project design and develop without deviation
• Minimize staff; place responsibility and accountability on front-line personnel (but maintain a mix of senior and junior staff)
• Maximize science per dollar via clear, firm objectives and metrics
  – Well-defined data return (e.g., global H maps to 50 ppm)
  – < 2 year development
  – $62.8M Total Mission Cost
  – New Education and Outreach mechanisms
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Management Organization

Ames Research Ctr: Lunar Prospector Mission
Mission Manager: Scott Hubbard
Deputy Mission Manager: Sylvia Cox

Lockheed/Martin: Lunar Prospector Project
PI: Alan Binder*
Project Manager: Tom Dougherty

Cost Plus Award Fee type contract

Co-Investigators and Instruments

Spacecraft Development at LMMS

Ames LP Team
-Mission/Trajectory Analysis
-Operations/Tracking Support

Launch Vehicle Development at LMA

* Now at Lunar Research Institute

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Management Tools

• Balance programmatic oversight with technical insight
  – Simplified reporting and monitoring systems
  – Modified SR & QA surveillance

• Use performance based award fee contract with cost and science incentives
  – Maximum award fee available (15%)
  – 1/2 award fee on Cost; fee reduced dollar for dollar by overruns
  – 1/2 on Science data, but if no science data, all award fee lost

• Fixed price subcontracts

• Rapid movement of LMCO staff on and off project
Insight vs Oversight

• Oversight/ Direct Involvement
  – Proposed Science
  – Top level schedule
  – Total Mission Cost (TMC)
  – Major Reviews (IRR)
  – Athena II first use
  – Tracking/DSN Ops
  – SR & QA plan approval

• Insight/ Vigilance
  – Spacecraft Design Details (e.g.)
    > Spacecraft moment of inertia
    > C&DH breadboard FPGAs
    > Solar cell selection
    > Mast deployment
    > GRS Thermal performance*
  – Subcontract Selection and management
  – Instrument Development
  – SR & QA process monitoring

*Example of parallel analysis

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LP Management Approach

- Exploit proximity of PI/Contractor-NASA management to streamline all processes
- Minimize NASA team size but maintain continuity; restrict parallel analysis
- Combine in-depth Independent Readiness Reviews (IRR) with normal prudent project milestone reviews
- Use existing contractor systems wherever possible
Metrics Status (Faster, Better Cheaper)

• Met goal of 22 month development through spacecraft test

• Project completed inside cost box and exceeded performance goals

• Athena II low cost launch vehicle first use successful

• Innovative website received >100M hits and won numerous awards
Neutron Spectrometer Data

- Circular polar orbit ensured high quality data from target polar regions
- Telltale dips in the counts of epithermal neutrons indicate excess hydrogen
- Large amounts of excess hydrogen are likely deposits of cometary water ice

Lunar South Pole

Dips indicate presence of hydrogen = water ice
Lessons Learned Assessment

• Discovery Program experiment and FBC worked, and:
  – Adequate reserves are key for even mature design
  – Personal “team chemistry” is important in small program
  – Risk management, including off-nominal assessment, must be considered continuously throughout program
  – Education and public outreach has become major effort

• Balance of management insight versus oversight must be appropriate for scope of program