The MESSENGER Mission to Mercury: Some Lessons Learned

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### Mission Milestones

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<th>Event</th>
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<td>Selection as a Discovery Mission</td>
<td>July 1999</td>
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<td>Phase B (detailed design)</td>
<td>January 2000 – June 2001</td>
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<td>Phase C/D (fabrication, assembly, &amp; test)</td>
<td>July 2001 – July 2004</td>
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<td>Launch</td>
<td>August 2004</td>
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<td>Earth flyby</td>
<td>August 2005</td>
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<td>Venus flybys</td>
<td>October 2006, June 2007</td>
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<td>Mercury orbital operations</td>
<td>March 2011 – April 2015</td>
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Managed by The Johns Hopkins University Applied Physics Laboratory and the Carnegie Institution of Washington
MESSENGER
Faced Broad Challenges

- Demanding limits to mass growth
- Hazardous thermal and radiation environment
- Complex mission design with limited launch opportunities and a long cruise phase
Some Obvious Advice for PIs

- Budget ample reserves: cost, schedule, mass, power
- Learn project management and systems engineering
- Assemble the best possible team
- Accomplish as much in Phase B as possible
**MESSENGER Solar Array**

A challenge anticipated: Solar arrays
- Multiple vendors engaged
- Thorough testing program
- Final vendor selection after all prototype testing

A challenge not anticipated: Inertial Measurement Unit (IMU)
- Expertise resided with a single vendor
- That vendor was bought out by a new vendor, who closed a key facility and had to reinvent expertise
• Manufacturer applied excess epoxy to capacitors on filter boards
• 14 flight filters had to be replaced

• Delamination (seen as missing copper shadow from inner layers) discovered in multi-layer PC boards
• 13 flight boards had to be replaced
• Spacecraft structure was made of lightweight composite material
• Manufacturer was delayed by late work on MER spacecraft
• Late delivery of structure delayed by 4 months the start of spacecraft integration
• Lessons: engineer for contingencies; schedule generous reserve
Anticipate Management Challenges During Phases B and C/D:

- MESSENGER had two Project Managers and two Deputy Project Managers
- The NASA Solar System Exploration Division had four Directors
- The Discovery Program had three Program Managers and added the position of Program Director in 2004

Lesson: Pick your own managers wisely

Max Peterson
MESSENGER PM
1998 - Jan 2003

Richard Huebschman
MESSENGER DPM
June 2001 – Oct 2002

Dave Grant
MESSENGER PM
Feb 2003 – Sept 2007
• Discovery Program was managed for several years out of the NASA Management Office (NMO)

• To provide technical oversight of Discovery projects, a Discovery Program Support Office was established at JPL

• In July 2003, technical and managerial oversight of Discovery projects was assigned to the Aerospace Corporation

• In January 2004, Discovery Program management was assigned to JPL

• In August 2004, Discovery Program management was assigned to NASA Marshall

• Lesson: Be thankful of MSFC, but be prepared

Andy Dantzler
Discovery Program Director
Appointed April 2004

Dave Jarrett
Discovery Program Manager
1999 - 2003

Discovery Program Management
Anticipate Science Team Changes

During Phase E:
- One MESSENGER Co-I passed away in 2009
- Three MESSENGER Co-Is took on major responsibilities for other NASA missions
- NASA added 23 MESSENGER Participating Scientists in November 2007
- Lesson: Develop succession plan for key science roles

Maria Zuber
GRAIL PI
2007 – present

Mark Robinson
LROC PI
2006 – present

Scott Murchie
CRISM PI
2001 – present
This is not the correct ITAR

- Plan for NASA’s tolerance for risk to change between your selection and launch
- Plan for more reviews than were initially specified
  - View them as learning opportunities
  - Learn to assess their cost and negotiate accordingly
- Learn about ITAR and its impact on team member access, hardware acquisition, and publication approval procedures
Some Final Thoughts

- A Discovery mission can accomplish novel science across a broad spectrum of science disciplines.
- Superb engineering is essential, including software as well as hardware and operations.
- So, too, are open and frequently used lines of communication between the engineering and science teams.
- Thoughtful succession plans for key personnel are required for long-lived missions.
- An openness to changing mission conditions and opportunities can greatly enhance the scientific return.