

**REPORT  
of the  
Planetary Science Subcommittee  
of the NASA Advisory Council Science Committee**

**Washington, DC  
2-3 October 2008**

**Introduction**

The Planetary Science Subcommittee (PSS) of the NASA Advisory Council (NAC) Science Committee held its ninth meeting on 2-3 October 2008 at NASA Headquarters. Sixteen of the 20 members of the subcommittee attended the meeting, and one participated by teleconference.

The agenda (attached) included a broad range of presentations and discussion topics. The morning of the first day began with a briefing by James Green, Director of the Planetary Science Division (PSD) of NASA's Science Mission Directorate (SMD), on division activities, as well as responses to PSS and NAC recommendations from earlier meetings. Doug McCuiston, Mars Exploration Program Director, summarized the current status of the Mars Exploration Program, particularly concerning the status of the Mars Science Laboratory (MSL) mission. The subcommittee was then joined by SMD Associate Administrator (AA) Ed Weiler, who discussed issues currently before the Directorate and answered questions from subcommittee members for about one and a half hours.

The afternoon began with presentations by chairs of the analysis groups — including the Venus Exploration Analysis Group (VEXAG), Lunar Exploration Analysis Group (LEAG), Mars Exploration Program Analysis Group (MEPAG), Small Bodies Assessment Group (SBAG), and Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM). Those presentations were followed by one on the status of the Lunar Science Roadmap by LEAG chair Clive Neal, and one on lunar surface scenarios given by Gordon Johnston and Laurie Leshin, respectively the co-chair of the Optimizing Science & Exploration Working Group (OSEWG) and the co-chair of the OSEWG Surface Science Scenarios Working Group (SSSWG). The subcommittee spent the remainder of the day discussing issues raised and formulating recommendations.

The second day of the meeting began with a presentation by Paul Hertz, SMD Chief Scientist, on “best practices” in the Directorate’s Research and Analysis (R&A) programs. A report on the progress of the International Lunar Network (ILN) Science Definition Team (SDT) was given by Barbara Cohen, SDT co-chair. Her report was followed by one on the Venus Flagship Science and Technology Definition Team (STDT) by Mark Bullock, STDT co-chair. Presentations on the In-Space Propulsion Technology (ISPT) Program and the current status of aerocapture technology were made by David Anderson, ISPT Project Manager (Acting), and Michelle Munk, In-Space Propulsion Aerocapture Manager, respectively. Curt Niebur, Outer Planet Flagship Program Scientist, provided an update on outer planet flagship mission studies. The subcommittee then held a discussion by teleconference with Jack Burns, incoming chair of the NAC Science Committee, on near-term committee plans and activities. The meeting ended with a review of subcommittee findings and recommendations stemming from the two days of discussion.

**General Assessment of PSD Programs**

Although much of the discussion during the meeting concerned problems with MSL, the PSD has achieved significant accomplishments since the time of the last PSS meeting and can look

forward to reaching successfully a number of near-term milestones. Operating missions are generally healthy and continue to return exciting scientific discoveries. Mars Atmosphere and Volatile Evolution (MAVEN) was recently selected as the second mission in the Mars Scout series, and 10 new teams for the NASA Astrobiology Institute were announced during the meeting. Two new PSD staff members at Headquarters have been added: Mary Voytek in astrobiology and Tibor Kremic as Assistant for Flight Programs. Thirty-two proposals were received for team membership in the new NASA Lunar Science Institute, the Stand-Alone Mission of Opportunity (SALMON) announcement had been issued a month earlier, and the release of the draft Announcement of Opportunity for proposals to the New Frontiers mission line was expected later this month. The National Research Council (NRC) will be undertaking studies on how best to balance R&A with planned and ongoing missions and on the detection and mitigation of near-Earth objects, a study on radioisotope power system requirements and plutonium availability is underway, and plans have been initiated for the next decadal survey for solar system exploration.

### **Mars Science Laboratory**

The PSS devoted much of its attention at this meeting to the status of the MSL mission. The subcommittee was told that payload instrument development is proceeding well, that major flight structural elements have been delivered to the assembly floor, and that environmental testing is scheduled to begin in November. The mission was reported to be “still on track” for a launch in the fall of 2009. The remaining schedule is nonetheless very challenging. A number of flight hardware components remain to be delivered; and Assembly, Test, and Launch Operations (ATLO) will be staffed with double shifts and a 7-day workweek. At a review last month, the Standing Review Board evaluated ATLO and Verification and Validation (V&V) plans and concluded that the project had a “reasonable” chance of meeting their launch date with acceptable mission risk.

More troubling is that the cost to complete the mission continues to increase. The MSL project has spent approximately \$1.5B through government fiscal year 2008, including several increases in cost beginning last fall and continuing this year and totaling about \$200M. The project exceeded the 15% overguide threshold specified in the NASA Authorization Act last fiscal year. The Jet Propulsion Laboratory (JPL) recently indicated that the cost to complete the mission would include another increase, likely to exceed \$100M and requiring additional funds in fiscal years 2009 (to prepare for launch) and 2010 (to complete the development of flight software deferred until after launch). This most recent increase will cause the project to exceed the 30% cost growth threshold that will trigger the requirement for a detailed breach report to Congress and the possibility of a stop-work order.

Because PSD was hard pressed to cover the increases to the cost of MSL in fiscal year 2008, the latest increases — although not precisely known at the time of the PSS meeting — will be difficult to meet, concentrated as they are in fiscal year 2009. Some of the cost increases might be covered by rephasing of launch vehicle payments and reductions in carryover, both within PSD and within other divisions of SMD, but those transfers would not cover the full cost growth for MSL and would have to be repaid in later years. To continue toward a 2009 launch for MSL, PSD would have to delay or cancel one or more other missions now in development.

PSD is therefore exploring the option of slipping the launch of MSL either to 2010 or to 2011. A 2010 launch would involve one year in a 1-AU parking orbit and an Earth flyby in 2011. The cost of delaying the launch to 2010 is estimated to be about \$300M, but most if not all of those funds would not be needed until after 2009. The next launch window for an injection into a direct transfer orbit from Earth to Mars is in 2011, and the cost of slipping the MSL launch to that opportunity will exceed the \$300M figure by several tens of millions of dollars. Launch slippage would also sharply reduce the schedule risk associated with the 2009 launch, as well as any technical risk that might accompany the type of work schedule required to continue on the currently envisioned path to the 2009 launch window. Nonetheless, the cost of launching in

2010 or 2011 considerably exceeds that of launching in 2009, and it is extremely unlikely that a later launch can be accomplished without delaying or cancelling other missions currently in development or in planning. One benefit to a delayed launch is that the later need for additional funds would expand the range of budgetary solutions to covering the added cost.

**The PSS reaffirms its support for the MSL mission, its scientific goals, and the advances in our understanding of the past and present habitability of Mars that will be enabled by the successful completion of the mission.** The Mars Exploration Program has been very successful over the past decade with its strategic and competed missions designed under the theme of “Follow the Water.” The major reservoirs of near-surface water are now well delineated on a global scale. The interaction of water with the surface and interior is recorded in the mineralogy of water-bearing minerals that define the history of this interaction. Recent landed and orbital spacecraft have revealed over a dozen unique assemblages of geology and aqueous mineralogy that are highly promising targets to explore for habitability. The next steps in exploring Mars are to assess analytically the habitability of such promising sites.

MSL will carry ten instrument packages and has the overall science objective to explore and quantitatively assess a region of Mars as a potential habitat for life, past or present. The SkyCrane system provides mass savings that will enable a greater proportion of delivered mass to be devoted to instrument payload. The rover will carry an analytical laboratory with two instruments of unprecedented capability, a Gas Chromatograph–Mass Spectrometer, which includes a Harriet cell Tunable Laser System, and an X-Ray Diffractometer for state-of-the-art mineral identification. An instrument new to planetary exploration is ChemCam, a laser-induced breakdown spectroscopy for meters-distant remote sensing of elemental and chemical composition. With an instrument complement that will include the capability to detect and measure organic compounds, MSL will characterize the nature of current and ancient Martian environments and will constitute the first astrobiology mission since Viking.

That said, the PSS is extremely troubled by the continued escalation of cost for the MSL mission and by the sustained inability of project management to estimate cost reliably. The subcommittee has been presented with MSL cost increase issues at each of its previous three meetings, and PSS has heretofore recommended that solutions to cost problems be found that preserve the integrity of the most important capabilities of the payload as well as a development schedule that permits a timely launch of a fully tested spacecraft. In the report of our October 2007 meeting, the PSS urged *“that NASA and the developers of ChemCam make every effort to ensure that this important instrument fly on the MSL mission.”* In the report of our March 2008 meeting, the PSS recommended *“that NASA make every effort to solve MSL’s cost growth problems in 2008 and 2009 so that the mission may remain on schedule for its 2009 launch.”* In the report of our meeting in June 2008, a time when it appeared that all cost growth issues had been identified and a plan to meet the cost increases had been worked out, we wrote that *“we remain optimistic that the technical and fiscal challenges posed by this mission will be met so that a timely launch can be completed.”*

The latest increases to mission cost, and the demanding schedule between now and a 2009 launch, have substantially changed our views. Our confidence that a 2009 launch can be accomplished at low mission risk has been reduced, and we no longer believe that we have seen the last of the cost increases for this project. **The PSS therefore retracts its earlier recommendation that NASA make every effort to remain on schedule for a 2009 launch for MSL.** The subcommittee did not have available detailed information on latest cost figures, ATLO milestones, and schedule and technical risk to the mission for a 2009 launch. Nor were we presented with specific plans for how cost increases will be accommodated either if MSL proceeds toward a 2009 launch or if a decision is made in the near-term to delay the launch to 2010-2011. We understand that additional information from the MSL project and JPL management will be made available to NASA leadership in the week following our meeting. Therefore, **the PSS recommends that NASA make a prompt decision on a launch timeline**

**for MSL that minimizes both the risk to the full success of that mission and the impact on other programs within PSD and SMD.**

Whichever launch opportunity is selected, the increased cost of completing the MSL mission will be substantial, and securing the needed funds could have impacts across NASA's entire space science program. **Consistent with concurrent SMD policy, cost increases incurred by the MSL project should, to the extent possible, be borne by JPL, the implementing organization for the mission. Additional funds should be sought next from within the Mars Exploration Program. Impacts to non-Mars programs, as needed after those two sources of funds are utilized, should be sought through delays rather than cancellation of approved missions now under development.**

The history of multiple major increases to mission cost for MSL is a poor model for future missions, particularly at the flagship scale, and it is important that the causes of recurring cost growth be understood so that lessons learned can be applied henceforth. That said, an immediate inquiry into these issues would not be wise, inasmuch as the individuals most knowledgeable are also those most needed to ensure that MSL completes development and testing and proceeds to launch. **At the earliest appropriate time, NASA should conduct an external review to assess the causes of the MSL cost overruns and to recommend those changes to cost estimation procedures and project management needed to prevent similar situations for future missions.**

### **Outer Planet Flagship Mission**

The PSS continues to be encouraged that PSD is proceeding thoughtfully and carefully with the definition of an Outer Planet Flagship (OPF) mission. Nine-month-long studies of a Europa Jupiter System Mission and a Titan Saturn Mission System are nearing completion, and final reports from both studies are due in early November. Parallel studies are underway at the European Space Agency (ESA), and it is the expectation of both agencies that the final mission selected will be conducted jointly, perhaps with other international partners. Complete technical evaluations of both mission concepts will be carried out after the study reports are in hand, current plans call for down-selection to a single OPF mission in February 2009, and launch of the selected mission is envisioned for some time in 2018-2022.

In the report from our last meeting, we wrote that *"the PSS reiterates that an OPF mission is of the highest scientific primacy for planetary science, and we support NASA efforts to find a route toward matching mission concept and budgetary plan that will bring such a mission to reality."* The subcommittee continues to subscribe strongly to this view, and we are encouraged by the thoroughness of the mission concept study process and by the partnership arrangements that have been defined for the two cosponsoring space agencies. We look forward to hearing of further progress on mission definition and evaluation at our next meeting.

### **New Frontiers Missions**

The New Frontiers mission line offers an extremely important opportunity to fly Principal Investigator-led missions to address the broad variety of solar system targets identified in the NRC study committee on *New Opportunities in Solar System Exploration (NOSSE): An Evaluation of the New Frontiers Announcement of Opportunity*. The PSS is pleased that NASA is following the NOSSE mission concept recommendations, and we look forward to the release of the next New Frontiers Announcement of Opportunity (AO), now scheduled for January 2009.

### **Discovery Missions**

The Discovery Program remains one of the most successful mission lines within PSD, and each AO has stimulated a variety of thoughtful and exciting mission concepts that collectively address a broad range of solar system targets and scientific problems. The PSS understands that future Discovery competitions will no longer be open to mission concepts addressing extrasolar planets, a decision that should enhance the opportunities for missions that target solar system

objects and processes. The subcommittee hopes to hear, by the time of our next meeting, that a specific time in calendar 2009 has been set for the release of the next Discovery AO.

### **Research and Analysis Programs**

In our discussion of SMD R&A practices, the PSS was pleased to hear that a Science Program Document (SPD) now in preparation will mandate uniform proposal review standards across all space science disciplines. Plans to organize a working group to address issues with the NSPIRES on-line proposal engine are most welcomed. The PSS shares the view that science community members should be encouraged to provide recommendations of qualified, competent reviewers in all fields of study to help promote greater participation in the review process. The subcommittee also agreed to provide comments to the NRC panel, chaired by Lennard Fisk, that is currently studying R&A and other supporting activities within SMD.

### **Lunar Exploration and SMD**

The PSS was given a thorough briefing on the status of development of a Lunar Exploration Roadmap, led by LEAG, and on current scenarios for carrying out scientific exploration of the lunar surface being developed by OSEWG. The PSS is pleased to see that some aspects of lunar exploration architecture planning and specifics have improved, albeit incrementally, in the direction of improved science return. For instance, the requirements document has been modified to include an objective for returned mass of 250 kg, consistent with past PSS recommendations, although the threshold requirement remains 100 kg (and this mass includes material other than lunar samples). OSEWG is developing a website, with assistance from the Lunar and Planetary Institute (LPI), to improve interactions with the scientific and other communities. OSEWG and the Exploration Systems Mission Directorate (ESMD) have also initiated more contact with the lunar science community through LEAG, LPI, and the NASA Lunar Science Institute. Scenarios for lunar surface science are being explored for sortie missions as well as for traverse missions from lunar outposts, and metrics are being developed for science return from such missions.

Although the PSS has been impressed by efforts of OSEWG and other elements of lunar exploration planning to achieve better communication between the lunar science and the lunar exploration architecture communities, the key to a successful exploration program that also optimizes scientific return is continuing feedback between these two communities as the exploration architecture develops. Without such interaction there is too strong a possibility that architectural decisions made in isolation will limit rather than enable the addressing of major lunar science questions, as laid out, for example, in the NRC study report on *The Scientific Context for the Exploration of the Moon*. **The PSS recommends that a formal mechanism to enhance communication between OSEWG and the lunar science community be established.**

One way to address such a recommendation is through the establishment of a standing community-based advisory committee to ESMD. Another is by the direct engagement of an existing community-based committee (e.g., LEAG, CAPTEM) with ESMD. Whichever form of committee is chosen, this committee should work closely with both OSEWG and the NASA Lunar Science Institute to ensure continuous and consistent feedback to ESMD as the architecture of the Constellation Program progresses. Moreover, OSEWG should participate at regular intervals in science forums, e.g., at major scientific conferences in lunar and planetary science, to enhance exchange with the broad community. **The PSS further recommends that OSEWG present a regular report on lunar architecture requirements and deliberations at subcommittee meetings.**

Involving the private sector as a partner in the lunar exploration plan is seen as critical for allowing NASA to move on to Mars and beyond. The creation of commercial on-ramps during the build-up to the outpost and beyond will prevent NASA from becoming tied to the Moon to the point of precluding human exploration of Mars. Without such a transition strategy, NASA might have to abandon its lunar assets once the agency elects to go on to Mars. **The PSS**

**supports the recommendation, brought forward by LEAG in the Lunar Exploration Roadmap, that NASA formulate a transition strategy during the roadmapping process that will allow the agency to send humans to Mars and beyond without abandoning the infrastructure and capabilities built up on the Moon. Involvement of international partners and particularly the private sector is critical in the formulation of this transition strategy. The PSS recommends that NASA expand its current level of interaction with the private sector to facilitate such involvement in the next era of lunar exploration.**

### **The Next Decadal Survey for Solar System Exploration**

The PSS is pleased that the NRC has initiated a new decadal survey for solar system exploration and that the National Science Foundation (NSF) will be co-sponsoring the study along with NASA. The subcommittee is further pleased that survey panel has been charged to take a fully integrated view of the entire solar system, including Mars and the Moon. Co-sponsorship by NSF indicates that the survey will encompass important ground-based facilities, such as major telescopes, as well as spacecraft missions.

The PSS is informed that a new decadal survey is also underway for astronomy and astrophysics, and that the charge to that survey panel includes the study and characterization of planets and planetary systems around other stars. There is much to be gained by improving the scientific communication between scientists who study solar system planets and scientists who study extrasolar planets. To ensure that such communication is reflected in the next sets of decadal strategies, **the PSS recommends that the decadal survey panel for astronomy and astrophysics include solar system planetary scientists, and the decadal survey panel for solar system exploration include experts in extrasolar planetary systems.**

### **Technology Development**

Across many elements of the planetary exploration program, there are new technologies whose development and validation in space would enable missions that cannot currently be completed. The Venus community as represented by VEXAG, for instance, has identified aerocapture as a capability that could enhance the scientific return of future missions to that planet, as well as to Mars, Titan, and the outer planets. At our last meeting the PSS endorsed a recommendation from VEXAG that “*PSD should develop a plan in the near term to test and validate aerocapture system technologies.*” The PSS was given a thorough summary of the status of aerocapture technology development within NASA’s ISPT Program, and aerocapture at Venus was deemed “feasible and robust” by the In-Space Propulsion Aerocapture Manager. The PSS suspects, however, that an aerocapture technology development effort must still precede selection of a Venus mission candidate for which mission success depends on aerocapture. We reiterate our earlier recommendation.

### **Interaction with the NAC Science Committee**

The PSS had a very constructive exchange with incoming Science Committee chair Jack Burns, who is bringing to his position a number of ideas for improving two-way communications between the Science Committee and its subcommittees. The PSS endorses with enthusiasm the implementation of improved methods of communication, including the participation of a subcommittee representative at every meeting of the NAC and its Science Committee. Science Committee members, of course, are always welcome at PSS meetings.

The Science Committee, at its October meeting, will be developing a concise white paper on the values to this nation of a strong program of space science and exploration, with the goal of transmitting this white paper to the transition team for the next President-elect immediately following the 4 November election. All subcommittees have been asked to contribute ideas and written material to the development of this white paper, and the PSS appointed a small subcommittee (Ariel Anbar, Fran Bagenal, James Head, Ellen Stofan, Faith Vilas) to draft the PSS contribution for circulation to subcommittee members by the middle of the week following the meeting.

## Activities of Assessment and Analysis Groups

VEXAG chair Ellen Stofan summarized current VEXAG activities and the principal issues facing the Venus science community. Upcoming Venus mission opportunities include New Frontiers, Discovery, and SALMON. VEXAG is cosponsoring a Union session at the 2008 Fall Meeting of the American Geophysical Union on Venus-Earth-Mars Comparative Climatology, as well as a Venus Geochemistry Workshop to be held at the LPI in Houston on 23-24 February 2009. The Venus Flagship Mission STDT study now underway has concluded that understanding when and how Venus lost its water is of primary importance in understanding the origin and evolution of life on Earth-like planets, that a highly capable flagship mission can be technologically ready by 2015, that compelling science can be accomplished from an orbiter with balloons and short-lived landers, and that cost and technical risk for such a mission will be competitive with other major planetary missions. The next VEXAG meeting will be in Houston on 25 February 2009, immediately following the LPI workshop. News on VEXAG activities is posted regularly on <http://www.lpi.usra.edu/vexag/>.

LEAG chair Clive Neal summarized recent LEAG activities. LEAG continues to work toward improved communication with OSEWG. Together with CAPTEM, LEAG has initiated a review of lunar sample curation (see below). In response to a charge by the NAC to develop a Lunar Exploration Roadmap that maps science goals to objectives, needed observations, and measurement requirements, LEAG is coordinating a community-wide effort entitled "Exploring the Moon in the 21<sup>st</sup> Century: Themes, Goals, Objectives, Investigations, and Priorities, 2008." LEAG has formed five Specific Action Teams (SATs) to further the goals of this effort. LEAG held a half-day session at the Lunar Science Conference in July that featured presentations by key SATs and will be factoring the discussion at that session into the Lunar Exploration Roadmap. The next LEAG meeting will be 28-31 October in Cape Canaveral, Florida, and will be held jointly with the International Lunar Exploration Working Group (ILEWG) and the Space Resources Roundtable (SRR). Themes will include the sustainable Moon, the international Moon, and the productive Moon. News on ongoing LEAG activities is posted on <http://www.lpi.usra.edu/leag/>.

MEPAG chair Jack Mustard summarized recent activities of the group. Developments in Mars exploration since the previous PSS meeting in June include continued progress by the missions now operating at Mars, selection of MAVEN as the next Scout mission, and continued planning of Mars exploration architecture by the Mars Architecture Tiger Team (MATT) and the International Mars Architecture for Return of Samples (iMARS). MEPAG supported the 3rd MSL Landing Site Workshop last month, and the group recently responded to a request from the Mars Exploration Program for an evaluation of the scientific impact of removing the caching capability on MSL. An effort to revise goal IV of the MEPAG Goals Document is underway, and a new Science Analysis Group (SAG) is being organized to examine concepts for the 2016 mission opportunity. MEPAG also looks forward to providing input to the NRC's decadal survey for solar system exploration. The next MEPAG meeting will be during the week of 2 March 2009 in Washington, D.C. News on MEPAG activities is posted regularly on <http://mepag.jpl.nasa.gov/>.

SBAG chair Faith Vilas discussed the group's formative plans. The Small Bodies Assessment Group had scheduled its inaugural meeting for 22-23 September at the LPI in Houston, but the aftermath of Hurricane Ike delayed the meeting. The meeting will be rescheduled for November or December of this year, either at LPI or in Washington, D.C. In preparation for that meeting, a "town hall" session was held at the Asteroids, Comets, Meteors 2008 meeting in Baltimore, and a similar session is scheduled for 10 October at the American Astronomical Society's Division for Planetary Sciences meeting, during which the SBAG objectives will be discussed. Six subsections of a white paper on the state and future of small body exploration have been defined. Lead scientists have been identified and have agreed to chair the preparation of these sections. News on SBAG activities is posted regularly on <http://www.lpi.usra.edu/sbag/>.

CAPTEM chair Chip Shearer summarized recent CAPTEM activities. In response to findings and recommendations in the NRC study report on *The Scientific Context for the Exploration of the Moon*, CAPTEM and LEAG have initiated a joint review of all aspects of lunar sample curation. This review will consider documentation, collection (tools and strategy), and preservation procedures on the Moon, as well as current and future curatorial capabilities and procedures on Earth. The review group will consist of members with relevant curation and engineering expertise. In addition, several members will have joint appointments to both OSEWG and this analysis group to enhance communication and reduce redundancy across groups addressing lunar science planning. The CAPTEM facilities subcommittee continues to review the engineering study for the air handling system in the lunar sample facility at the NASA Johnson Space Center. Review of allocation requests for lunar, Stardust, Genesis, and cosmic dust samples will take place during the next CAPTEM meeting on 13-14 October. News on these and other CAPTEM activities may be found at <http://www.lpi.usra.edu/captem/>.

Outer Planets Assessment Group (OPAG) chair Fran Bagenal noted that there had not been an OPAG meeting since the most recent PSS meeting in June. Many scientists in the OPAG community have been contributing to the OPF mission concept studies (summarized at this meeting by Curt Niebur; see above) that will be discussed at the next OPAG meeting, to be held 6-7 November 2008 in Tempe, Arizona. News on OPAG activities is posted at <http://www.lpi.usra.edu/opag/>.

As a final action, the PSS discussed its next meeting. The next meeting of the NAC is 3-5 February 2009 at NASA Headquarters and the Goddard Space Flight Center, and there is some discussion of inviting all Science Committee subcommittees to meet in “jamboree” mode the day before. Pending a final decision by the Science Committee, the next PSS meeting will tentatively be on 2 February 2009 in the greater Washington, D.C., area.

**Planetary Science Subcommittee Meeting  
2-3 October 2008  
NASA Headquarters, Room 9H40**

2 October (8:00 AM – 6:00 PM)

8:00	Welcome & Other Administrativa	Sean Solomon, Michael New
8:10	Planetary Science Division & Mars Exploration Program Updates	Jim Green, Doug McCuistion
10:00	Q&A with Ed Weiler, SMD AA	
11:30	Discussion	Sean Solomon
12:00	Lunch	
1:00	Analysis Group & MOWG Reports <ul style="list-style-type: none"> <li>• VEXAG</li> <li>• LEAG</li> <li>• MEPAG</li> <li>• SBAG</li> <li>• CAPTEM</li> </ul>	Ellen Stofan Clive Neal Jack Mustard Faith Vilas Chip Shearer
2:35	Discussion	Sean Solomon
3:00	Break	
3:15	Status of Lunar Science Roadmap	Clive Neal
3:45	Lunar Surface Scenarios	Gordon Johnston, Laurie Leshin, Marguerite Broadwell
4:45	Discussion	Sean Solomon
6:00	Adjourn PSS dinner at <i>TBD</i>	Sean Solomon

3 October (8:00 AM – 3:00 PM)

8:00	Administrative Matters	Sean Solomon, Michael New
8:10	R&A Process and “Best Practices”	Paul Hertz
9:10	Report of International Lunar Network SDT	Barbara Cohen
10:00	Report of Venus STDT	Mark Bullock
10:30	Overview of In-Space Propulsion Program and Current Status of Aerocapture Technology	David Anderson, Michelle Munk
11:30	Status and future planning for OPF	Curt Niebur
12:00	Lunch	
1:00	Teleconference with Dr. Jack Burns, incoming Chair of NAC Science Committee	
2:00	Discussion, Finalization of Recommendations & Planning of Future Meetings	Sean Solomon
3:00	Adjourn	

## NASA Advisory Council Subcommittee Recommendation

Subcommittee Name: Planetary Science

Chair: Sean Solomon

Date of Public Deliberation: 2-3 October 2008

Date of Transmission to Science Committee: 9 October 2008

Short title of the proposed Recommendation

Retraction of unqualified support for 2009 launch of MSL

Short description of proposed Recommendation

The PSS reaffirms its support for the Mars Science Laboratory (MSL) mission, its scientific goals, and the advances in our understanding of the past and present habitability of Mars that will be enabled by the successful completion of the mission. However, the PSS retracts its earlier recommendation that NASA make every effort to remain on schedule for a 2009 launch for MSL.

Major reasons for proposing the Recommendation

The Mars Exploration Program has been very successful over the past decade with its strategic and competed missions designed under the theme of "Follow the Water." The major reservoirs of near-surface water are now well delineated on a global scale. The interaction of water with the surface and interior is recorded in the mineralogy of water-bearing minerals that define the history of this interaction. Recent landed and orbital spacecraft have revealed over a dozen unique assemblages of geology and aqueous mineralogy that are highly promising targets to explore for habitability. The next steps in exploring Mars are to assess analytically the habitability of such promising sites.

MSL will carry ten instrument packages and has the overall science objective to explore and quantitatively assess a region of Mars as a potential habitat for life, past or present. The SkyCrane system provides mass savings that will enable a greater proportion of delivered mass to be devoted to instrument payload. The rover will carry an analytical laboratory with two instruments of unprecedented capability, a Gas Chromatograph–Mass Spectrometer, which includes a Harriet cell Tunable Laser System, and an X-Ray Diffractometer for state-of-the-art mineral identification. An instrument new to planetary exploration is ChemCam, a laser-induced breakdown spectroscopy for meters-distant remote sensing of elemental and chemical composition. With an instrument complement that will include the capability to detect and measure organic compounds, MSL will characterize the nature of current and ancient Martian environments and will constitute the first astrobiology mission since Viking.

That said, the PSS is extremely troubled by the continued escalation of cost for the MSL mission and by the sustained inability of project management to estimate cost reliably. The subcommittee has been presented with MSL cost increase issues at each of its previous three meetings, and PSS has heretofore recommended that solutions to cost problems be found that preserve the integrity of the most important capabilities of the

payload as well as a development schedule that permits a timely launch of a fully tested spacecraft. In the report of our October 2007 meeting, the PSS urged “*that NASA and the developers of ChemCam make every effort to ensure that this important instrument fly on the MSL mission.*” In the report of our March 2008 meeting, the PSS recommended “*that NASA make every effort to solve MSL’s cost growth problems in 2008 and 2009 so that the mission may remain on schedule for its 2009 launch.*” In the report of our meeting in June 2008, a time when it appeared that all cost growth issues had been identified and a plan to meet the cost increases had been worked out, we wrote that “*we remain optimistic that the technical and fiscal challenges posed by this mission will be met so that a timely launch can be completed.*”

The latest increases to mission cost, and the demanding schedule between now and a 2009 launch, have substantially changed our views. Our confidence that a 2009 launch can be accomplished at low mission risk has been reduced, and we no longer believe that we have seen the last of the cost increases for this project.

#### Consequences of no action on the proposed Recommendation

In the absence of this recommendation, previous PSS recommendations on this topic will stand. As they no longer represent the position of the PSS, they would constitute an incorrect portrait of the PSS’s position.

## NASA Advisory Council Subcommittee Recommendation

Subcommittee Name: Planetary Science

Chair: Sean Solomon

Date of Public Deliberation: 2-3 October 2008

Date of Transmission to Science Committee: 9 October 2008

Short title of the proposed Recommendation

Approach to responding to MSL cost increases.

Short description of proposed Recommendation

PSS recommends that NASA make a prompt decision on a launch timeline for Mars Science Laboratory (MSL) that minimizes both the risk to the full success of that mission and the impact on other programs within PSD and SMD. Consistent with concurrent SMD policy, cost increases incurred by the MSL project should, to the extent possible, be borne by JPL, the implementing organization for the mission. Additional funds should be sought next from within the Mars Exploration Program. Impacts to non-Mars programs, as needed after those two sources of funds are utilized, should be sought through delays rather than cancellation of approved missions now under development.

Major reasons for proposing the Recommendation

As part of the response to the latest cost increases to the MSL project, a reassessment of the project's readiness for a 2009 launch is underway. Regardless of whether the launch date is slipped to 2010 or 2011 or retained in 2009, the impact of the new cost increases will be felt by other programs in PSD and SMD. While the subcommittee did not have available detailed information on latest cost figures, ATLO milestones, and schedule and technical risk to the mission for a 2009 launch, it was clear that a prompt decision on the launch timeline would reduce uncertainty and risk. The PSS was not presented with specific plans for how cost increases will be accommodated but was able to formulate principles governing how those accommodations should proceed based on a desire to localize the effects of the cost increases to the program and implementing center most responsible for the increases.

Consequences of no action on the proposed Recommendation

In the absence of this recommendation, resolution of the MSL cost overruns would take place without input from the planetary science community, thereby narrowing the base of support for whatever decision is to be made.

# NASA Advisory Council Subcommittee Recommendation

Subcommittee Name: Planetary Science

Chair: Sean Solomon

Date of Public Deliberation: 2-3 October 2008

Date of Transmission to Science Committee: 9 October 2008

Short title of the proposed Recommendation

Lessons learned from the MSL cost increases.

Short description of proposed Recommendation

PSS recommends that, at the earliest appropriate time, NASA conduct an external review to assess the causes of the Mars Science Laboratory (MSL) cost overruns and to recommend those changes to cost estimation procedures and project management needed to prevent similar situations for future missions.

Major reasons for proposing the Recommendation

The history of multiple major increases to mission cost for MSL is a poor model for future missions, particularly at the flagship scale, and it is important that the causes of recurring cost growth be understood so that lessons learned can be applied henceforth. That said, an immediate inquiry into these issues would not be wise, inasmuch as the individuals most knowledgeable are also those most needed to ensure that MSL completes development and testing and proceeds to launch.

Consequences of no action on the proposed Recommendation

In the absence of this recommendation, there exists a grave risk that the next flagship mission – to the Jupiter or Saturn system – will face a similar course of cost overruns.

## NASA Advisory Council Subcommittee Recommendation

Subcommittee Name: Planetary Science

Chair: Sean Solomon

Date of Public Deliberation: 2-3 October 2008

Date of Transmission to Science Committee: 9 October 2008

Short title of the proposed Recommendation

Enhancing communication with the lunar science community.

Short description of proposed Recommendation

The PSS recommends that a formal mechanism to enhance communication between OSEWG and the lunar science community be established. The PSS further recommends that OSEWG present a regular report on lunar architecture requirements and deliberations at subcommittee meetings.

Major reasons for proposing the Recommendation

Although the PSS has been impressed by efforts of OSEWG and other elements of lunar exploration planning to achieve better communication between the lunar science and the lunar exploration architecture communities, the key to a successful exploration program that also optimizes scientific return is continuing feedback between these two communities as the exploration architecture develops. Without such interaction there is too strong a possibility that architectural decisions made in isolation will limit rather than enable the addressing of major lunar science questions, as laid out, for example, in the NRC study report on *The Scientific Context for the Exploration of the Moon*.

One way to enable improved communication is through the establishment of a standing community-based advisory committee to ESMD (in the mold of MEPAG). Another is by the direct engagement of an existing community-based committee (e.g., LEAG, CAPTEM) with ESMD. Whichever form of committee is chosen, this committee should work closely with both OSEWG and the NASA Lunar Science Institute to ensure continuous and consistent feedback to ESMD as the architecture of the Constellation Program progresses. Moreover, OSEWG should participate at regular intervals in science forums, e.g., at major scientific conferences in lunar and planetary science, to enhance exchange with the broad community.

Consequences of no action on the proposed Recommendation

In the absence of this recommendation, there exists a serious risk that the scientific value of the return to the Moon will be limited by architecture decisions made in isolation from science needs.

# NASA Advisory Council Subcommittee Recommendation

Subcommittee Name: Planetary Science

Chair: Sean Solomon

Date of Public Deliberation: 2-3 October 2008

Date of Transmission to Science Committee: 9 October 2008

Short title of the proposed Recommendation

Partnerships for sustaining lunar infrastructure.

Short description of proposed Recommendation

The PSS supports the recommendation, brought forward by LEAG in the Lunar Exploration Roadmap, that NASA formulate a transition strategy during the roadmapping process that will allow the agency to send humans to Mars and beyond without abandoning the infrastructure and capabilities built up on the Moon. The PSS further recommends that NASA expand its current level of interaction with the private sector to facilitate such involvement in the next era of lunar exploration.

Major reasons for proposing the Recommendation

Involving the private sector as a partner in the lunar exploration plan is seen as critical for allowing NASA to move on to Mars and beyond. The creation of commercial on-ramps during the build-up to the outpost and beyond will prevent NASA from becoming tied to the Moon to the point of precluding human exploration of Mars. Without such a transition strategy, NASA might have to abandon its lunar assets once the agency elects to go on to Mars. Involvement of international partners and particularly the private sector is critical in the formulation of this transition strategy.

Consequences of no action on the proposed Recommendation

In the absence of this recommendation, moving on to Mars and beyond may be hampered by a lack of planning for transitioning the lunar infrastructure to non-NASA management or ownership.