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Washington, DC**

**NASA ADVISORY COUNCIL**

**PLANETARY SCIENCE SUBCOMMITTEE**

**October 2-3, 2008**

**NASA Headquarters  
Washington, DC**

**MEETING MINUTES**

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**Michael H. New**  
**Executive Secretary**

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**Sean Solomon**  
**Chair**

**PLANETARY SCIENCE SUBCOMMITTEE  
NASA Headquarters, Washington, DC  
October 2-3, 2008**

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*Meeting Report Prepared By:  
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PLANETARY SCIENCE SUBCOMMITTEE MEETING  
NASA Headquarters  
Washington, DC  
October 2-3, 2008

*Thursday, October 2*

Welcome and Administrative Matters

Dr. Sean Solomon, Chair of the Planetary Science Subcommittee (PSS), called the meeting to order at 8:05 a.m. and welcomed members and attendees. He announced that Dr. Jack Burns from the Department of Astrophysical and Planetary Sciences at the University of Colorado, is the new Chair of the NASA Advisory Council (NAC) Science Committee. Dr. Burns wants to improve communication and coordination between the Subcommittees and the Science Committee, and has asked the Chairs of the Subcommittees to participate in the Science Committee and to attend the NAC meetings. The Subcommittee Reports go to the Science Committee and those inputs are most effective if they reach that group before its next meeting later this month. Dr. Solomon requested that the Analysis Group Chairs provide a summary of their activities, including issues, to him before leaving town tomorrow. Due to a prior commitment, Dr. Solomon indicated that he would not be able to attend the upcoming Science Committee and NAC meetings. He asked if there was any Subcommittee member who could attend these meetings for him on October 15-16, 2008, at the Kennedy Space Center (KSC).

Planetary Science Division and Mars Exploration Program

Dr. Jim Green, Director of the Planetary Science Division, updated the Subcommittee on Division activities, including mission status, an overview of the Mars Program, and the status of the Mars Science Laboratory (MSL). He announced that Dr. Mary Voytek is a new detailee from the U.S. Geological Survey (USGS) in Astrobiology, replacing Dr. John Rummel. Dr. Tibor Kremic is a new detailee from the Glenn Research Center (GRC) serving as Assistant Division Director for Flight Programs. The Division would like to have a permanent replacement for Dr. Rummel, but hiring has slowed significantly and it may be months before the Division obtains approval for new personnel.

Congress has asked the National Academy of Sciences (NAS) to assist NASA with several studies: Research and Analysis (R&A) balance with missions, Radioisotope Power System (RPS) requirements and availability of plutonium, and issues in the detection and mitigation of Near Earth Objects (NEO). The R&A Committee has been posted but has not yet met. On its own, NASA has directed two additional NAS studies: Science opportunities enabled by the Constellation System; and planetary protection for Mars Sample Return (MSR). NASA will also ask the Academy to begin the next Planetary Decadal Study. The study charge to the NAS should be delivered by the end of 2008. The National Science Foundation (NSF) has agreed to join NASA in the request. The task statement has been briefed to the Committee on Planetary and Lunar Exploration (COMPLEX) and iterated several times. Dr. Green briefly reviewed the content of the task. He noted that it covers the entire solar system, including Mars and the Moon, but does not include extrasolar planets, which will be included in the Astrophysics Decadal Study that has already started. In the last PSS report, the Subcommittee recommended that the decadal study structure be inclusive and provide a comprehensive list of missions. This element was brought to COMPLEX for discussion. NASA has not yet been told how the NAS plans to organize the study, but all of the studies that have already been started will feed into the decadal study. The study should take about two years, and NASA should get the report in 2011. One of the ground rules is that the NAS will delta from the existing mission set.

Dr. Green discussed the upcoming 2008 opportunities. The Exploration Systems Mission Directorate (ESMD) is not participating in the 2008 Research Opportunities in Space and Earth Science (ROSES) LASER call, but will maintain its 2007 ROSES commitments; however, ESMD will participate in the Lunar Science Institute (LSI) call. Thirty-two LSI proposals have been received and are in evaluation. The Stand-Alone Mission of Opportunity Notification (SALMON) was released September 3, 2008. The New Frontiers 3 Announcement of Opportunity (AO) is in signature cycle and should be released in draft form in October 2008. Final release is planned for January 2009. Discovery is currently under review, but the Division would like to release an AO this fiscal year. Dr. Green indicated that he has been monitoring the

formulation of the panels for the LSI and is very comfortable in terms of avoidance of conflict. It is impossible for NASA to have subject matter experts on every panel; however, everyone on the panels will read the reports and contribute to analysis and review.

Recent selections include the Mars Atmosphere and Volatile Evolution (MAVEN), which is targeted for launch in November 2013, and the Astrobiology Cooperative Announcement Notice (CAN) 5. There have been ten selections. The press release will be out today or tomorrow. Of the ten selections, five are new and five are returning. Two of the returning teams will have new Principal Investigators (PIs).

Noteworthy upcoming planetary mission events include a second flyby of Mercury by MESSENGER and a fly-by of Enceladus on October 9th by Cassini.

NASA-ESA joint studies of Jupiter System Science and Saturn System Science are ongoing. The study reports should be delivered on November 3, 2008. Selection is planned for January, and one destination will go forward as a joint NASA/ESA effort. The results of the study that is not selected will feed into the next decadal study. Dr. Solomon raised the question of whether or not a decade (2011 – 2020) is the right timeframe for the decadal study. There are top priority science questions that may not fit neatly into the 2020 timeframe. Dr. Green observed that NASA tried very hard to make the top priority mission from the last decadal study happen. Perhaps several flagships should be considered, and when the technology matures, the direction would become obvious. The charge to the Academy should not be “only one flagship.” NASA must have the flexibility to take the available budget with the technologies needed to execute the mission. Currently, there are three major Academy studies underway. The sooner the decadal can move forward and the program can be integrated, the easier it will be. With respect to the extrasolar planets approach, Dr. Green noted that the Astrophysics decadal must have key planetary scientists on the study committee, and this is a good opportunity to start investigating what parts of the community could be available to help. There will not be a call in Discovery for extrasolar planet missions.

Dr. Green reviewed the expected events of the Lunar Science Program. The Lunar Atmosphere and Dust Environment Explorer (LADEE) should be launched on a Minotaur V from Wallops Flight Center. NASA is working on two demonstrations of optical communications; one on LADEE from the Moon and another from Mars. An extended Time History of Events and Macroscale Interactions during Substorms (THEMIS) mission will be at the Moon at the same time as LADEE. There are eight international partners on the International Lunar Network (ILN).

Dr. Green noted that there were four recommendations from the last PSS meeting. A response to the recommendation regarding the breadth of the Decadal Committee was reported to COMPLEX on August 20. There will be presentations on the other three topics—MSR, lunar rover mobility, and aerocapture technology—at this meeting.

Dr. Doug McCuiston provided an update on the Mars Exploration Program (MEP). Phoenix is doing well. The primary mission was over on August 24 and it was extended to the end of September. The mission has been further extended until its end of life. Water ice was found in a trench dug by the robotic arm. Meteorology is the theme for the remainder of the mission. Dust devils showed up for the first time a few weeks ago. There are early morning clouds (water ice) as well as ground fog, and water frost has been seen on the ground. Wind has now increased to 9-10 mph in the mornings. An upward-looking Lidar has detected snow from Martian clouds, and the weather team believes that this snow is reaching the ground inside the fogbank. The Microscopy, Electrochemistry, and Conductivity Analyzer (MECA) is doing well and the full mission success criteria have been met. The Thermal and Evolved Gas Analyzer (TEGA) is still having some problems. As the sun goes down on Mars, the power levels on Phoenix will deteriorate. There are maybe two or three weeks of power level left. Batteries can be kept alive until the November timeframe. The extended mission will likely end at conjunction (around the middle of November). The workforce has funding until the middle of December. A “Lazarus mode” will attempt to re-boot the lander after the Martian winter. Survival is not expected, but if the mode is successful, any passing orbiters will hear it. The Senior Review called out the priority for the extended mission, which is to collect the D/H ratio of the ice and make meteorological surveys.

MAVEN is the fulfillment of a high-priority NAS science objective. It addresses key science objectives for the upper atmosphere, solar wind interaction, and escape to space as defined by the Mars Exploration Program Analysis Group (MEPAG) and the National Research Council (NRC). Goddard Space Flight Center (GSFC) is the lead center.

The overall status of the MEP is good. Both of the rovers are in good health; Spirit survived the winter, and Opportunity is roving the plains outside the Victoria Crater. Mars Reconnaissance Orbiter (MRO) is doing very well. The prime mission will complete in November 2008.

The major issue in the program is MSL. From a hardware delivery and software development perspective, things are going well. The third community-based landing site workshop was completed in September. Seven landing sites were evaluated and three were rated high for scientific value. The cache status is TBD, and discussions are ongoing within the community. Mr. McCuiston showed several photographs of flight hardware and payload hardware in the high bay area. He noted that the majority of the flight hardware has been delivered. The Standing Review Board (SRB) met last week for a replan of the Validation and Verification (V&V) test plan. The result was a baseline plan and a required plan. There will be a formal out-brief next week. Funding is one issue; the other issue is schedule. The issue is whether or not the 2009 launch date can be met with confidence. The schedule is somewhat fragile, but can be met. However, if there is one big incident or major disruption, the program will not be able to make a 2009 launch. Since the plan has not been vetted with senior management, Mr. McCuiston could not discuss it in detail; however, he noted that launch has been pushed to later in the window (early October).

MSL has already spent \$1.5B. For a 2009 launch, the budget is \$223M in FY09; \$64M in FY10; and \$55M in FY11. In FY08, over \$200M over budget has already been added to MSL. The Jet Propulsion Laboratory (JPL) pending request for additional funding for FY09 is expected to be over \$100M. This level of request will exceed the 30% threshold and necessitate a detailed Breach Report to Congress and a potential "stop work" requirement. Launch slips to 2010 or 2011 are being studied, but would require an additional \$300M, above the pending request.

Additional funding needs for MSL will impact the Division and the SMD. The Mars Program has exhausted all sources of funds and MSL descopes are no longer viable, short of outright cancellation. Any additional funding must come from a JPL mission. Payback must come from the future missions budget line. Mr. McCuiston briefly reviewed the MSL cost history since June. On a positive note, it was observed that the estimate-at-completion has started to flatten, and the probability of meeting the launch window has increased.

Mr. McCuiston provided a brief overview of the MEP in the next decade. The Division is still carrying a landed mission of some kind in 2016, but everything beyond 2018 is under review. The Mars Architecture Tiger Team (MATT) has been asked to take a look at several budget levels and come back with the community's view. These inputs will go into the 2010 budget process. Drivers for the next decade will be the viability of the MEP architecture, with or without MSR, and MSL.

Dr. Green discussed the MSL overrun trade space. He noted that there will be a meeting with the NASA Administrator on October 10 to decide if MSL will launch in 2009 or not. The SMD is developing a solution space to cover the costs. Approximately \$70M could come from rephrasing, finding efficiencies, and reducing carryover. The balance must come from delaying or cancelling a variety of developing missions. The source list includes: Juno (\$160M) delay or cancel; GRAIL (\$45M) delay or cancel; LADEE (\$21M) delay or cancel; NASA instruments on ExoMars (\$5M); and MAVEN (\$2M). Delays or cancellations will affect the release of AO's. If MSL is moved to a 2010 launch, there will be new technical issues, including design changes. The cost increase would be approximately \$300M. If MSL is moved to 2011, there would be a few \$10M above the 2010 estimate. The next step is to replan technical, budget, schedule, and cost. Additional solution space in FY10 and FY11 could include MSR technology development, Mars 16, and elimination of one instrument on ExoMars. There is always the possibility of complete cancellation of MSL due to Congressional action. In response to a question about other Division budget items, Mr. McCuiston noted that R&A is about \$15M and operating missions run about \$80M per year. In response to a question from Dr. Solomon, Dr. Green felt that discussion and input from the

Subcommittee on the MSL cost issue would be extremely valuable and could be noted at the briefing with the Administrator on October 10.

Question and Answer with Dr. Edward Weiler, Associate Administrator

Dr. Weiler shared some of his thoughts on MSL. He noted that SMD found ways to fund the last overrun with almost no impact to other programs. However, there are no further sources of money. Some budget estimates expect the problem to be \$120M - \$150M. Delaying the MSL mission is one option. Although there would be additional cost (beyond the overrun) for a delay, the Directorate could save money in 2009. The other option is to cut missions and go ahead with MSL in 2009. The decision cannot be delayed until January. Dr. Weiler stated that any philosophical thoughts that the Subcommittee could give the Directorate would be appreciated. About one-third of the funding problem could be solved painlessly by JPL reducing its carryover to one month. He emphasized that the JPL team working on MSL could not be pushed to the brink of making mistakes. JPL must convince NASA management that it has a solid plan to make the launch. Best case (a delay, use of carryover funds, and other savings), the impacts to the rest of the Planetary program would probably mean delays to schedules and AO's, rather than cancellations. R&A is not on the list as a funding source—should it be? Dr. Weiler stated that his number one concern on MSL is risk—successful launch, landing, and science return. An important question is whether this mission will make a major science impact on the public as well as the science community. The present MSL experience argues even more strongly for a series of moderately-scaled missions leading up to a MSR mission. The next decadal study will evaluate Mars along with the rest of the program.

With respect to the future NASA budget, there has never been a period before where there have been so many unknowns. Congress has taken the necessary action that will allow NASA to have the option of using Soyuz instead of keeping Shuttle going. The science budget, at worst, should remain stable. The public sees the science side of NASA very positively, and there are some strong advocates on the Hill. If there is any new money, Earth science is probably in the best position for an increase. With respect to Europa or Titan, an Outer Planets Program should be established. ESA is on board and wants to participate in every mission; however, international collaboration should not complicate the program. Rather, it should get NASA and the science community more money or more science. The interfaces should be clean. Mr. McCuiston noted that an ExoMars collaboration has been on-going for the past four years and there is an excellent international community. For MSR, it is even larger—a twelve-nation membership as well as a bilateral engineering association. The international collaborations on Mars are very strong. Realistically, collaboration will be necessary on any MSR mission. With respect to lessons learned on MSL, Dr. Weiler mentioned several: early investments are crucial and standing review boards are very important; extended Phase A's and Phase B's may be advisable; "faster, better, cheaper" may not be the best approach for large missions. In addition, the entire philosophy of how missions are funded may need to be re-examined.

With respect to the conflict of interest problem that occurred during the Mars Scout evaluations, Mr. McCuiston indicated that he could not address the details, which are protected by procurement regulations that govern the process. To avoid a recurring problem, he emphasized that the community should read the AO carefully and follow the ethics rules to the letter.

In response to a question about Hubble, Dr. Weiler indicated that NASA was extremely lucky. The Shuttle launch was only two weeks away when the data management unit problem arose. NASA made the prudent decision to delay the launch, take the Science Instrument Command and Data Handling (SIC&DH) spare out of stores and prepare it for launch. The SIC&DH will be added to the manifest and the servicing mission will be rescheduled for mid-February.

Subcommittee Discussion

Dr. Solomon reviewed the agenda for the remainder of the day. He opened the floor to reactions to the morning's presentation and remarks. If the Subcommittee is going to make a finding, it must be produced by Friday afternoon, before the meeting ends.

Dr. Hamilton posed the question: What are the near-term and longer-term implications of a delay in MSL launch? Dr. Solomon observed that there are "three and a half" options. One would be to terminate the

MSL mission. Another would be to decide at the meeting next week that there is too much technical and/or programmatic risk to continue with a 2009 launch. This opens the trade space for what to do next. There is a cost to making this delay (\$300 M, spread out over several years), but the cost in 2009 would not be as high. There are some questions as to what the true cost would be. The third option would be to proceed with the 2009 launch, recognizing that there will be a new cost-to-complete number. Any additional money would have to be found in 2009, outside the Mars Program. There is still a question whether the schedule could be met, and the confidence level is somewhere around 60 to 80 percent. The “half” option is to wait a month or two before making the decision, allow JPL to proceed toward a 2009 launch, and see if the actuators will come in on time and the program will enter the ATLO phase in a timely way. Mr. McCuiston noted that the “half option” puts NASA squarely into Administration uncertainty, and replacing Dr. Griffin and his knowledge-base is a risk in itself. The Division will see the number from JPL next week. Dr. Green noted that delaying launch to 2011 could mean delay or cancellation in one or more missions; pushing forward to launch in 2009 might require delay or cancellation of several missions. Other questions are: Should R&A be in the discussion? Philosophically, what about the concept “last in, first out?” The ripple effect outside of the Mars Program would be greater if MSL is launched in 2009 rather than in 2011. Philosophically, delaying missions is preferable to cancellation. In general, the Subcommittee was not in favor of cancellation of MSL at this point.

Dr. Frances Bagenal offered to draft a Subcommittee recommendation on MSL for discussion. It would recognize the risks of a 2009 and the impact of that on the Exploration of the Solar System Program. Funds should be found at JPL first. After that, any additional funds needed should first and primarily come from the Mars Program. There should be an external review of what happened and lessons learned. Dr. Solomon asked Dr. Bagenal to draft this at lunch and present it to the Subcommittee later in the day. Dr. Vilas suggested that if other missions are delayed to accommodate MSL, those missions’ budgets should not be penalized. Dr. Green agreed, and indicated that any missions delayed under those circumstances would be “re-baselined.” Another question posed was: What is the implication to the Mars Program timeline if MSL is delayed to 2011? Mr. McCuiston commented that the intent is to impact the 13 Scout as little as possible. The 16 mission has not been descoped yet. The Sample Return wedge and the 16 mission wedge would be a source of funds to “pay back” money taken for MSL. Dr. Solomon reminded the Subcommittee that it is on record (from a prior meeting) advising NASA to do whatever would be necessary to launch MSL in 2009. If the Subcommittee recommends something different now, that change in advice must be explained.

Analysis Group and Management Operations Working Group (MOWG) Reports

Venus Exploration Analysis Group (VExAG)

Dr. Ellen Stofan reviewed the status of Venus. There were about 60 people at the last VExAG meeting. The next meeting will be on February 25, 2009, at the Lunar Planetary Institute (LPI). There will be a Venus-Earth-Mars Comparative Climatology Union Session at the Fall AGU in December. The Venus Flagship Science and Technology Definition Team (STDT) study is nearing completion. The Venus Geochemistry Workshop will be February 23-24, 2009 at LPI. New Frontiers, Discovery, and SALMON will offer Venus opportunities. The Venus white paper is being updated. The first of two JGR-Planets volumes on Venus Express (VEx) is going to press shortly. More than thirty VEx articles will be published. All instruments are healthy. The mission extension will attempt to go to December 31, 2012. The decision on the extension will be made in November. The next Science Working Team (SWT) meeting will be a joint meeting with Mars Express in January 2009.

Despite myths to the contrary, a highly capable Venus flagship mission can be ready by 2015. Great science can be done from orbit, from landers, and from atmospheric balloons. A Venus flagship mission will be cost and risk competitive with the Mars mission and Outer Planets Flagship. Understanding how and when Venus lost its oceans is of primary concern in understanding the origin and evolution of life.

Lunar Exploration Analysis Group (LEAG)

Dr. Clive Neal reported on the LEAG activity. The next LEAG meeting will be a joint meeting with the International Lunar Exploration Working Group (ILEWG) and the SRR on October 28-31, 2008, at Cape Canaveral, Florida. There are a number of different themes and some Lunar Google X-Prize Team

presentations. Similar to the last LEAG meeting, there will be plenary and concurrent sessions that will focus on questions pertinent to achieving the "Vision." The first day will consist of a plenary session and the space agency reports on upcoming missions and priorities for robotic exploration. The following days will consist of a plenary session in the morning and concurrent sessions in the afternoon. Better communication and cooperation has been initiated between the LEAG and the Optimizing Science and Exploration Working Group (OSEWG).

#### Mars Exploration Program Analysis Group (MEPAG)

Dr. Jack Mustard reported on the MEPAG. He briefly reviewed the developments since the June PSS meeting. There has been a lot of effort in architecture planning for the next decade. Rover concepts are in development for the 2016 opportunity. The last MEPAG meeting was last month in Monrovia, CA. There were reports and discussion on Phoenix, MAVEN, MSL, MATT, the international Mars Architecture for the Return of Samples (iMARS), and planning for the 2016 opportunity. MEPAG and the NRC had previously concluded that MSR is essential to achieve NASA's expectations for Mars. During the past year, MEPAG has supported iMARS in the preparation of a potential plan for an international MSR. This activity drew heavily on MEPAG's Next Decade-Science Analysis Group (ND-SAG) analysis. Long-lead funding for partnership-forming, technology development, and international coordination is currently under consideration by both ESA and NASA. NASA is developing possible architectures and feed-forward considerations leading up to MSR.

Dr. Mustard discussed the MSL landing site workshop. It was a stimulating three days. The workshop showed multiple compelling sites that could support the mission's scientific objectives. There was excellent cross-mission support between orbital and landed teams. In response to a question, Dr. Mustard indicated that the MEPAG has not considered implications of MSL cost overruns or a 2011 launch on the on-going missions. Dr. Solomon suggested that it might be worthwhile for MEPAG to look at the impact of MSL launch delay on Mars science.

The MSL cache has been raised as a potential issue, and MEPAG was asked to comment. The cache was added late and not designed as a technical solution to MSR. It is not adequately designed to meet planetary protection requirements. The cache samples would be of low scientific quality and the existence of the cache would not bring a meaningful benefit to the design of MSR. In addition, the MSL cache presents significant risks to meeting the science goals of MSL itself. Dr. Shearer noted that the cache could present an opportunity for a greater operational understanding of sample collection. The cache will be discussed at the meeting next week.

There are seven landing sites, ranging from sedimentary sites to sites that offer a window into the environments when minerals were forming. Dr. Mustard gave an example of the kinds of science goals one would have at the various sites. MSL is the first astrobiology mission in the modern era. MSL allows the mineralogical probing of sites that will answer the question of whether habitable conditions ever existed on Mars. At the workshop, each site was examined in great detail. The revision of the MEPAG Goals document should be complete by the end of the year.

The MATT has been looking at architectures to fill the gap between the previous two architectures. Four different mission capabilities were examined: Mars Science Orbiter (MSO), Mars Science Prospector (a MER or MSL class rover), MSR, and Mars Network Landers. Dr. Mustard showed several mission scenarios using these capabilities.

In future work, the MEPAG will evaluate and assess the science priorities for the 2016 opportunity, assess the outcomes of the MATT activity, and assess the outcomes of the Red Team reviews. The next MEPAG meeting is schedule for March 3-4, 2009, in Washington, DC.

#### Small Bodies Assessment Group (SBAG)

Dr. Faith Vilas briefly reported on the SBAG. There was a Town Hall meeting in July, and another Town Hall meeting will be held at the American Astronomical Society (AAS) meeting this month. The first SBAG meeting was deferred due to Hurricane Ike in Houston, TX.

Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM)

Dr. Chip Shearer reported on CAPTEM. It has several functions: it plans an important role in the allocation of NASA-collected planetary materials; it sponsors sample science based initiatives and workshops; it provides analysis and guidance for NASA sample curation; and it provides sample science expertise. CAPTEM is participating in a review of JPL's 31N facility redesign. At the next meeting, CAPTEM will discuss its response to the curation finding of the NRC's Committee on the Scientific Context for Exploration of the Moon. CAPTEM has started a joint CAPTEM-LEAG initiative on lunar sample acquisition, documentation, and curation. The types of things CAPTEM will review are all related to curation. Curation actually starts with the science questions and the site selection. It continues with the tools and instruments, the sample packaging and storage, and finally, the sample allocation. The initial steps of the analysis focus on the Earth with the terrestrial curation facilities for lunar samples. The other aspect is tied to what is done on the Moon—sample selection, sample documentation, and sample storage and packaging. Another aspect that CAPTEM will be considering is the sample mass, volume, and what power will be needed to return samples undiminished and uncontaminated. With respect to Mars, there is a subcommittee that guides CAPTEM on potential MSR issues.

Discussion on MSL

Dr. Bagenal presented a draft PSS MSL recommendation for consideration. The draft recommended delaying the launch of MSL to 2011. It also said that to whatever extent possible, the cost overruns incurred by MSL should be absorbed within JPL and any additional funds needed should be sought primarily from the Mars Program. Impacts on non-Mars programs should be confined to delays rather than cancellations. NASA should sponsor an external review of the causes of the MSL cost overruns and recommend lessons learned for future missions.

Dr. Solomon suggested that the R&A question be addressed separately. Dr. Green added that the proper term for what NASA really funds is supporting research and technology (SR&T). It was noted that the PSS was no longer advising going forward with MSL in 2009 at all costs. Dr. Green showed a phasing comparison of a 2009 LRD compared to a 2011 LRD. He observed that the Mars Program has no money in missions until 2012.

It was noted that most of the discussion at the senior management meeting next week will be whether the 2009 launch risk is acceptable at all. The SRB will have an opinion. If the 2009 launch risk is acceptable, then the issue will be funding.

Status of Lunar Science Roadmap

Dr. Neal reported on the progress of the Lunar Science Roadmap, a community effort coordinated by the LEAG. There are 3 themes (not yet in priority order): the science theme, the feed-forward theme, and the sustainability theme. Also, there are several cross-cutting themes. The LEAG felt very strongly that there should be a cross-over between NASA and commerce to achieve sustainability of the infrastructure. Within the science theme, the goals are: to understand the formation, evolution, and current state of the Moon; use the Moon as a "witness plate" for solar system evolution; use the Moon as a platform for astrophysical, heliophysical, and Earth-observing studies; and use the unique lunar environment as a research tool. The feed-forward goals are: to identify and test technologies on the Moon to enable robotic and human solar systems science and exploration; and to use the Moon as a testbed for mission operations and exploration techniques to reduce the risks and increase the productivity of future missions to Mars and beyond. The sustainability goals are: to expand science—provide support, services and infrastructure to enhance and enable new science to the moon, on the moon, and from the moon; to expand human exploration – expand in-space and surface transportation capabilities beyond initial NASA transportation architecture to discover and research new territories; to enhance security—protect and benefit Earth, and guarantee peace and safety both for settlers and for the home planet; to promote space commerce—promote and enable the creation of value and wealth from space-related activities that satisfy human needs, enable space economic activity to benefit Earth and lunar settlement, and to enable NASA to explore beyond the Moon; and to sustain human presence on the Moon.

Ongoing activities will include time-phasing, prioritization, and community input (web based and meetings). The goals, objectives, and investigations will be unveiled at the LEAG meeting for discussion and comment. Version 1 should be up on the Web for comment. Version 2 will include community input and should be completed by January 2009.

#### Lunar Surface Scenarios

Dr. Gordon Johnston reported on the OSEWG. The OSEWG was chartered by ESMD and SMD in FY 2007 and updated in FY 2008. Its scope is to coordinate and guide science and exploration planning, identify and provide science objectives for consideration of inclusion into the development of the Constellation architecture, engage the science and exploration communities, serve as liaison to LEAG, and remain cognizant of related activities. OSEWG is focusing on three areas: collaboration on the surface science scenarios; ESMD-SMD coordination and communication in analog missions, science objectives, and lunar data integration; and engaging industry and academia for input. Now is the ideal time for the science community to be engaged with ESMD, through the OSEWG, on the planning for a system that will be deployed on the surface. The sub-goals and objectives are on the LEAG website for community input. The Lunar Reconnaissance Orbiter (LRO) will be launched next year.

Dr. Johnston described the conceptual design for Ares V. The Ares V launch vehicle is more capable than the Saturn V. The lunar lander, Altair, will carry four crew to and from the surface. It will have global access capability, can return anytime to Earth, and will have the capability to land 14 to 17 metric tons of cargo. Altair will have the capability to carry two Apollo-like rovers. Surface concepts have been scoped out.

#### Lunar Surface Scenarios

Dr. Laurie Leshin reviewed the charter of the OSEWG Surface Science Scenario Working Group. This Working Group constructs science scenarios and designs reference science investigations to drive concepts of operations and requirements and planning for analog studies. The LEAG document incorporates all of the previous work and is an input to the Working Group. Dr. Leshin described the activity flow for the Working Group. Ultimately, the product will be candidate requirements. One of the next serious tasks will be to engage with LEAG to understand the new set of goals and objectives and develop science scenarios for different mission types and sites. “Sortie” missions with “Apollo-like” mobility at two sites have been developed. The Working Group has recommendations from the community regarding priority objectives. Dr. Leshin noted some preliminary recommendations from the workshop that looked at two craters. A robotic mission designed as a precursor and a follow-up is fundamental to maximize success of the human mission. Flexible extravehicular activity (EVA) plans are important. The mass of returned samples should be about 300-kg for a 7-day sortie mission. The Working Group is going to be working over the next several months with the science community, perhaps through a peer group with representatives from LEAG, MEPAG, NLSI, and the NAC.

In response to a comment, Dr. Leshin noted that the entire sample strategy for the Moon is a topic of high interest. Everyone supports the importance of outcrops. The Subcommittee discussed the scope of the science community input on surface science scenarios, and how the Working Group plans to get its arms around the input without over-constraining it.

#### Transition Whitepaper Planning and Discussion

Dr. Solomon introduced a topic raised by Dr. Burns, the new NAC Science Committee Chair—a white paper on the importance of space science for the transition team of the next Administration. The Science Committee will be working on this paper and is soliciting help from the Subcommittees. Planetary science should be well-represented in this discussion. Dr. Solomon asked for a few members of the Subcommittee to volunteer to take on the charge and draft something to present to the Science Committee at its next meeting. Dr. Solomon called on Dr. Head to share his thoughts on this task because he served on the Reagan transition team. Dr. Head noted that the transition team’s focus will be: What are the key issues and opportunities in the first 100 days (November – January) after the election? Inspiration is the key, *e.g.*, space science can be inspirational and provide future opportunities (call out specific opportunities). Put the emphasis on a succinct, hard-core paragraph, *e.g.*, on origin of the Earth and the planets, the origin and evolution of life in the solar system, inspiration in science, technology, and math and bringing the level in

these fields up in the country. One of the key, high level issues for the next Administration will be what to do with Constellation and the Shuttle. Drs. Stofan, Head, Bagenal, Anbar, and Vilas agreed to work on a draft statement and present at least an outline to the Subcommittee on Friday.

General Discussion

Dr. Hodges noted that it might be valuable to have another recommendation concerning the need for continual feedback and communication between scientists and engineers during architecture development. There needs to be a lot more engagement and iteration. There is progress, but the pressure needs to be maintained, from the NAC down and from the LEAG up through the mission directorates. The issue is more than just communication. Dr. Solomon suggested that the next recommendation on this topic be more straightforward and specific.

The Subcommittee continued discussion on the draft recommendation on MSL. It was agreed that MSL should not be cancelled. The Subcommittee heard a lot of ideas and opinion regarding push to launch versus delay. Dr. Green noted that if NASA cannot make the 2009 launch, there is a path forward that has a strategic process for solving the problem. The Administrator has said that he wants to make the decision earlier rather than later. If the community is in support of that approach, it would help him to know it. Dr. Solomon commented that the recurring overruns have generated a lot of skepticism. Another issue is risk. Also, the implications of the current estimate for launch in 2009 can have large impacts on other missions.

The Subcommittee felt that it should step back from its former position on MSL. NASA will get new information in the next week or two. Some members felt that the Subcommittee did not have enough information to make a definitive recommendation at this time. The major concern is driving for a 2009 launch and not making it. Whatever decision is made, it should result in the least impact to non-Mars science. The cancellation of another mission to solve this problem would be unacceptable.

Dr. Bagenal agreed to do a revision of the PSS recommendation based upon the Subcommittee discussion and present it to the Subcommittee on Friday.

Dr. Solomon adjourned the meeting at 5:45 p.m.

***Friday, October 3***

Administrative Matters

Dr. Bagenal offered to attend the Science Committee and the NAC meetings at KSC on October 15 and 16, 2008.

R&A Process and “Best Practices”

Dr. Paul Hertz, Chief Scientist, discussed R&A practices in SMD. There is an entire life cycle of R&A events. Although input to the planning process occurs all year, planning activity comes to a peak in the fall with the ROSES preparation, which is released in February each year. Evaluation is almost 100% community peer review. There is a considerable amount of documentation that governs how the process is accomplished. SMD is in the process of writing a new Science Program Document (SPD) for management of SMD’s R&A peer reviews. Several iterations were completed under Dr. Stern and Dr. Pendleton. The new SPD does not mandate uniform practices across all disciplines, but it does mandate uniform standards. The current draft is twenty-one pages long and will be completed soon. It is intended to be a public document and will be posted on the web page, along with all of the other SPDs. This document applies to all SMD divisions. “Standards” refers to levels of quality, competence, conflict of interest, and minimum requirements; however, different disciplines have different practices, and this is acceptable.

Dr. Hertz briefly reviewed the principles of SMD peer reviews. The R&A program is managed strategically. R&A must be relevant to NASA. It must address and advance NASA’s scientific goals. This drives the relevance criteria. The input of the community is sought in evaluating proposals. SMD does not make the selected proposals available for distribution. The intellectual property of the proposal belongs to the proposer. SMD also does not release lists of unsuccessful proposers or the membership of

the peer review panels. NASA is partnering with NSF in “research.gov,” which is intended to be a one-stop shopping place for research grant information. The website lists all of NASA’s new grants. SMD releases funding information to Congress, and this is available to the public. In order to facilitate an understanding of the evaluation and promote communication and feedback, proposers receive the panel reviews. One of the elements that took the longest in preparation of the SPD was working through the inconsistency of terms among the divisions. Dr. Hertz showed examples of the standard nomenclature.

Many different people can be used for managing peer reviews. A community member can be used to do this, and that person is called a “Review Chief.” There must be a civil servant responsible for every panel. This person is called the “Panel Official.” Every panel must have a Chair. In the Planetary Sciences Division, this person is not a civil servant, but in other divisions, it may be. Every review must have a Program Officer, who has the ultimate responsibility and authority for the review of proposals. The Program Officer may appoint review managers or chiefs. Every proposal must be reviewed by more than one unbiased, competent reviewer. Non-panel (mail-in) reviewers are encouraged, but not required except in certain circumstances, *e.g.*, when no one on the panel has sufficient knowledge or when fewer than four panel reviewers can vote on the proposal due to conflict of interest issues. The peer review is neither expected nor allowed to formulate selection recommendations. The Subcommittee discussed its experiences with mail-in reviewers. It was noted that on average, only about forty to sixty percent of the people requested for mail-in reviews on the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) actually do so. Both proposals and reviews are now electronic.

Dr. Hertz noted that he would take an action to make sure that all Program Officers consciously make the choice on whether or not to request mail-in reviewers in advance. He also took an action to solicit volunteers in the community to form a working group to address issues with NSPIRES. SMD is trying hard to find ways to spread the burden of reviews and expand the reviewer pool. One of the future NSPIRES upgrades is to track, by reviewer, the number of proposals submitted and the number of reviews performed.

The Subcommittee discussed the question: What can be done to encourage greater review participation from the community? Dr. Hertz noted that the legislation that created the authority to give a grant does not permit serving on a peer review to be a condition of the grant. One thing that can be done is to ask people who cannot do a review to provide several recommendations of qualified, competent people who could do so. It was noted that a reviewer is not required to have a Ph.D.; the only requirement is to be competent in the field. Post-docs that meet the competency criterion could serve as reviewers. SMD expects people who do NASA research to be part of the community of reviewers; however, SMD does not tell institutions what their time-charging procedures should be. NASA gives honoraria for panel reviewers, but does not give honoraria for mail-in reviews. It was noted that a personal call requesting a mail-in review usually gets a better response than an electronic request.

Dr. Hertz reviewed the standards that are uniform across SMD. Dr. Hamilton suggested that SMD seek comments on the draft SPD before finalizing it. She observed that when the process becomes very different across disciplines or programs, there is less confidence within the community on how well the standards are actually being met. Dr. Hertz noted that every Program Officer must defend the appropriateness of the reviews as well as the selection recommendation. Dr. Weiler will be reviewing the R&A program at his level once a year to ensure that it is being managed in the best way possible. Dr. Hamilton commented that when unexpected things occur that delay the process or present problems, information often does not get communicated to the external proposers. She suggested that NASA send out a letter to all proposers regarding any expected delays or problems. Dr. New commented that when he communicates with proposers on a regular basis about the status of the process, the number of inquiries and concerns drop considerably.

In response to a comment regarding panel plenaries, Dr. Hertz noted that the new SPD addresses this subject. If a panel does not have a plenary, there should be some other way of cross-checking the reviews. The NRC, at the request of Congress, is doing a study on R&A and other supporting activities. Dr. Lennard Fisk is the Chair of the Committee. Dr. Hertz encouraged the PSS to provide comments to this group.

Report of International Lunar Network (ILN) Science Definition Team (SDT)

Dr. Barbara Cohen, SDT Co-Chair, discussed the ILN anchor nodes. The purpose of the ILN is to take advantage of the natural synergy of all of the participants going to the moon. The U.S. nodes of the ILN are currently scheduled for the 2013-2015 timeframe. Three missions provide a robotic lunar flight program for the next decade: LRO, LADEE, and ILN. These missions complement SMD's lunar R&A initiatives to build a robust lunar science community and increase international participation in NASA's exploration plans. The focus of the SDT is to address what science is uniquely enabled by the synergy of a network. It is guided by the community reports, *i.e.*, the Scientific Context for the Exploration of the Moon (SCEM), Tempe, New Frontiers in the Solar System, etc. The SDT was chartered in March 2008. There have been multiple telecons and one meeting. Science and measurement goals have been formulated and prioritized. The final report is in preparation and should be released soon. The ILN is a cooperative effort designed to coordinate individual lunar landers in a geophysical network on the lunar surface. Each ILN station will fly a core set of instruments. The ILN charter was signed in July. The U.S. is currently planning to provide two ILN nodes (the anchor nodes). SMD is also considering a second pair in 2017.

Several concepts have been developed by the science community for small, robotically-deployed geophysical networks. The complete Apollo seismic network (four nodes) operated for about five years (1972 – 1977). The next generation of geophysical measurements must improve on current knowledge by having a wider geographical placement, more sensitive instrumentation, and a longer baseline of observations. Dr. Cohen reviewed what we currently know about the lunar interior structure. There are a number of unresolved science questions associated with how a planet differentiates and evolves. The goal of a Lunar Geophysical Network is to understand the interior structure and composition of the moon. Seismometry is uniquely enabled by a network of missions. The first U.S. mission should provide anchor nodes that substantially improve on the Apollo instruments and ensure that first-order science questions will be answered. Dr. Solomon observed that the Apollo instruments showed that heat flow cannot be measured by a robotic mission—although the thermal gradient can be measured, there remain great uncertainties in the thermal conductivity of the material in which a probe would be embedded and these uncertainties would dominate the error of inferences about heat flow. He opined that heat flow measurement may not be a good investment. Dr. Neal debated this point, based on the technology that now exists.

Dr. Cohen reviewed the network objectives: to understand the current seismic state and determine the internal structure of the Moon; to measure heat flow to characterize the temperature structure of the lunar interior; to use electromagnetic sounding to measure the conductivity structure of the lunar interior; and to determine deep lunar structure by installing next-generation laser ranging capability. Dr. Solomon commented that four nodes is the minimum number of nodes, but it will not be very accurate. There has to be enough information to get a three-dimensional structure model of the moon's interior structure and to localize the source of seismic disturbances (moonquakes). He cautioned about overselling this network. Dr. Cohen indicated that she would talk with Dr. Solomon off-line about his concerns.

Dr. Cohen discussed the network science baseline, the anchor nodes baseline, and the science floor. The seismometers are mandated. There is a strong science desire for farside placement for at least some nodes. Due to dependency upon communications satellite, SDT also identified suitable nearside sites. Site selection criteria will also involve desires from engineering for  $\Delta V$  and communications. Initial mission design guidelines came from NASA Headquarters before the SDT met. The SDT has defined the floor and baseline science measurements and priorities. The mission goal life cycle cost, including launch vehicle, is about \$200M. Pre-phase A activities have been running concurrently with the SDT, and the engineering team is delivering its executive report on October 6, 2008. The pre-Phase A engineering assessments confirm the concept feasibility with multiple solutions to achieve floor and baseline science. The ILN anchor nodes will provide the backbone of the network in a way that accomplishes new science and allows other nodes to be flexible contributors. Dr. Neal noted that a radioisotope power system (RPS) is needed so that the initial two nodes will be around long enough for additional nodes. For batteries, the issue is number of charging cycles. In response to a question, Dr. Green stated that SMD has the plutonium necessary for an RPS.

### Report of Venus STDT

Dr. Mark Bullock, Venus STDT Co-Chair, reported on the Venus Flagship Study. The STDT was initiated in January 2008 and will wrap up in December 2008. The mission architecture includes: a capable, long-lived orbiter; two instrumented balloons; and two landers with extended surface life plus the possibility of additional science with a long-lived instrument package. The STDT is fairly large, and was originally divided into four subgroups: atmosphere, geochemistry, geology and geophysics, and technology. There is also a JPL Venus Flagship Study that is doing the reference mission. For the study, the assumptions were launch in the 2020-2025 timeframe, achieve TRL 6 by 2015, have a life cycle cost range of \$3B-\$4B, launch on something less than a Delta IVH equivalent launch vehicle, have up to 34M KA band DSN capability, and assume no foreign cost contribution (although the actual mission is anticipated to have international participation). The major science questions are associated with why Venus is so different from Earth. From the perspective of habitable planets, we will not be able to understand observations of terrestrial planets around other stars without understanding Venus. In addition, the study of Venus has deepened and broadened the study of the Earth.

Dr. Bullock described the Venus STDT process for choosing the mission architecture. Several members went into the study with a bias for a mobile lander system; however, this is very difficult and expensive to do and it quickly came off the table. The Team did a science and technology figure of merit and costing for each architecture element. The science-driven architecture combines technologically mature elements (TRL 6) with moderate technology developments, which include: environmental testing; pressure and temperature mitigation; sample acquisition and handling; a capable inSAR system; and high temperature *in situ* instrumentation. The multi-element architecture lends itself to international collaboration. ESA, JAXA, and Russia are all very interested in Venus projects. Dr. Bullock highlighted the potential input to New Frontiers and Discovery, as well as valuable precursor R&A science, that would be of benefit to the flagship mission. In terms of feeding-forward to Venus Sample Return, site selection can be a prime area where a flagship mission could help.

The Design Reference Mission is complete, but that information is not yet in hand. Dr. Bullock explained the science rationale for the architecture and described the payloads for the orbiter, balloons, and landers. The payload costs (without accommodations) total about \$428M. The STDT is now looking at descope options and prioritization. The JPL Team X study results should be available next week. The "Rapid Cost Estimate" method that was used was based on a large database of past missions and exponential complexity indices. Aerospace will be doing a complete, independent cost estimate. The mission may sound somewhat fanciful, but a Venus mission is necessary to answer key questions on how Earth-like planets work. NASA and the community need to continue to examine what the realities are for exploring Venus.

### Overview of In-Space Propulsion Technology (ISPT) Program and Current Status of Aerocapture Technology

Dr. David Anderson, ISPT Project Manager, provided an overview of the ISPT Project. The current ISPT Project focus is on completing the near TRL 6 products. The ISPT objective is to develop in-space propulsion technologies that can enable or benefit near- to mid-term NASA science missions by significantly reducing travel times required to transit to distant bodies. The ISPT Project is working on two electric propulsion system technologies and a high temperature rocket. The Advanced Materials Bi-propellant Rocket (AMBR) is a high temperature rocket that was test-fired last week for the first time. The benefit of this technology would be increased engine performance and significant mass savings. The AMBR technology is an improvement upon the existing High Performance Apogee Thruster (HiPAT) engine. During the test, the design pressure limits were not reached, but increased performance was achieved without increasing the chamber pressure. It was a good first test. The project expects to be at TRL 6 in 2009.

There are two major electric propulsion products: NASA's Evolutionary Xenon Thruster (NEXT) Ion propulsion system; and the High Voltage Hall Accelerator (HiVHAC) thruster. The objective of the NEXT Ion system is to improve the performance and life of gridded ion engines to reduce user costs and enable a broad range of SMD missions. NEXT is nearing TRL 6 validation. The objective of the HiVHAC

Thruster is to develop low power, long-life Hall thrusters to reduce the cost of Discovery-class electric propulsion.

The Project has been working with different types of tools for doing mission design for aerocapture and state-of-the-art propulsion. ISPT products are nearing infusion readiness into NASA science missions. The upcoming New Frontiers 3 AO will provide an incentive to infuse NEXT or AMBR into the proposed missions.

Dr. Michelle Munk, the In-Space Propulsion Aerocapture Manager, discussed the aerocapture technology development by the ISPT Project. She specifically addressed the applications at Titan, Venus, and Neptune. Aerobraking has been performed at Mars. It involved a hyperbolic approach, and atmospheric drag reduces the orbit period by about 300 passes through the upper atmosphere. Aerocapture uses active control to autonomously guide the vehicle to an atmospheric exit target, establishing a final low orbit about a body in a single atmospheric pass. Aerocapture offers significant increase in delivered payload. It would enhance missions to Venus and Mars, and strongly enhance or enable missions to Titan and Uranus. It would enable missions to Jupiter, Saturn, and Neptune. Dr. Munk described the Titan aerocapture reference concept. Studies were done for aerocapture of the orbiter that was in the Solar System Exploration (SSE) roadmap around 2001. Aerocapture with electric propulsion system results in about 2.4 times more payload at Titan compared to an all-propulsive mission for the same launch vehicle. Since the 2002 study, there have been aerothermal updates as a result of improved data from Cassini-Huygens and improved aeroheating estimates from aerothermal modeling investments and testing. For Titan, no new enabling technology is required, although there are some enhancing technologies that would provide significant benefit to the mission.

In 2004, the ISPT Project looked at a Venus mission. Aerocapture delivers 1.8 times more mass into orbit than aerobraking and 6.2 times more mass into orbit than an all-chemical propulsion system. The study focused on the autonomous control system that would be necessary to have a reasonable  $\Delta V$  to establish a science orbit. For Venus, aerocapture is feasible and robust. One hundred percent of the Monte Carlo cases captured successfully. There was a detailed system study for Neptune in 2003. For a Neptune mission, precise insertion is essential. A significant amount of aerodynamic work would be needed for the vehicle. For this mission, two probes could be carried to Neptune, using a Delta IVH. Aerocapture at Neptune buys a lot more mass; however, there are significant challenges for aerothermal and the thermal protection system (TPS) interfaces will require a significant effort. Currently, no facility for testing exists.

Dr. Munk described some low-risk aeroshell mass improvements that the ISPT Project has been working on. The ISPT Project also looked at a family of new materials that would make the TPS more dense and robust against heating levels. During thermal testing, good performance of the system was achieved. The ISPT Project's aerocapture system technology for planetary missions was one of five competitors for NASA's New Millennium Program Space Technology 9 mission. It was not selected for that mission, which has now been deferred. For the next year, the project is building a 2.65 meter aeroshell with the new ablator. The material, with a seam, has been through arc-jet testing successfully. The Project will be performing space environmental effects testing on promising materials for both rigid aeroshells and inflatable decelerators. It will also continue aerothermal modeling efforts. There is a question whether ISPT ground development plus MSL hypersonic guidance plus CEV skip entry is equivalent to aerocapture validation. The bottom-line question is whether or not a flight validation is necessary. Dr. Munk stated that technically, flight validation for some destinations is not really needed, but flight validation would help perception and hasten use of the technology.

#### Status and Future Planning for Outer Planets Flagship (OPF)

Dr. Curt Niebur, OPF Program Scientist, discussed the OPF mission studies. NASA is currently finishing a nine-month long outer planet flagship mission study which is being conducted jointly with ESA. Two missions are being considered: the Europa Jupiter System Mission (EJSM) and the Titan Saturn System Mission (TSSM). NASA plans to select a single OPF mission in February 2009, which will be pursued jointly with ESA and other international partners.

For the Jupiter Europa System, the teams are finishing a technical assessment on whether there is anything in the mission that would preclude use of an Advanced Stirling Radioisotope Generator (ASRG). The launch would be in the 2018 to 2022 timeframe, although 2020 is the preferred launch date. The mission would include a tour phase of 24-33 months that would consist of three to five Io flybys, eight to ten Ganymede flybys, and four to six Callisto flybys, and finally enter a Europa orbital phase of nine to twelve months. The spacecraft would eventually impact the surface. Radiation is the driver on the mission. The radiation dose is 2.9 Mrad. The Titan Saturn system includes a NASA orbiter with ESA *in situ* elements. NASA will provide the launch vehicle and the Radioisotope Power System (RPS) for the balloon. This would be a four-year prime mission, consisting of a two year Saturn tour, two month Titan aerosampling, and an eighteen month Titan orbit. The launch date would be 2020 with an 8.8 year travel time. The balloon would be released on the first Titan flyby, and the Lander would be released on a subsequent flyby. End of mission would be impact on the surface.

Dr. Niebur reviewed the decision process. The final report is due November 3. International cooperation is integral to both concepts, but the Titan team had a more integrated approach. ESA is the primary international partner. JPL leads the partnership with the Applied Physics Laboratory (APL) and other NASA centers. For each mission concept, the NASA-ESA study teams will produce three reports: a NASA Study Report, an ESA Assessment Report, and a NASA-ESA Joint Summary Report. NASA and ESA will each conduct independent reviews of the results of their own studies. NASA and ESA management will meet in early 2009 to discuss the study results and select a mission.

#### Teleconference with Dr. Jack Burns

Dr. Jack Burns, incoming Chair of the NAC Science Committee, joined the PSS meeting via telecom. Dr. Solomon indicated that the PSS would be providing input to the white paper that the Science Committee is developing for the NAC.

Dr. Burns thanked the PSS for its hard work. He talked about how the Science Committee could do a better job in communicating and interacting with the Subcommittee. Dr. Burns briefly reviewed the history of the Science Committee. He noted that Dr. Edward David, the former Chair of the Science Committee, has rotated off the committee. Also, the term of the NAC Chair, Sen. Harrison Schmitt, ends at the completion of the meeting this month, and he will be rotating off the Council. The new NASA Administrator may wish to make some changes to the NAC. The principle goal of the Science Committee with the transition paper is to provide a solid foundation for the next Administrator and Administration in terms of science at NASA. Science is a key component of NASA and its continued strong support is in the best interests of the nation, from an economic, intellectual, and educational perspective. The goal is to transition into the next Administration with science an integral part of the Agency. Progress in future directions will depend on funding and support of ambitious sets of agenda that each of the Directorates represent. The theme of the white paper will be driven by the Subcommittees to make the case for science and provide robust recommendations. There are some big issues, and one of the biggest is MSL. There are equally important issues in the other Subcommittees, i.e., the Decadal Review in Earth science, issues in global climate change, and the Hubble repair mission.

Dr. Burns has talked with each of the Division Directors. The main goal is to improve communication and coordination between the Subcommittees and the Science Committee. One of the ways this can be done is to have the Chair talk with him on a more regular basis, have a representative from the Subcommittee present at the Science Committee and the NAC meetings, and have Dr. Green and the other Division Directors participate in the Science Committee. The group can examine cross-cutting themes and make more robust, meaningful recommendations to the Administrator. In the future, Dr. Burns would like to attend at least one PSS meeting a year.

Dr. Solomon noted there are some exciting missions underway as well as some exciting opportunities in the near term. The PSS should have something for the white paper to submit to Dr. Burns by next week. Dr. Burns noted that at the meeting, the Science Committee has set some time aside to talk with the Subcommittee Chairs about working their points into the paper for the transition team. Dr. Bagenal indicated that she would be attending the meeting on behalf of the PSS.

Dr. Solomon also reported that the PSS is working on a recommendation on MSL. The Subcommittee is very disappointed with the financial management of the mission. Dr. Burns noted that the Science Committee is also extremely frustrated. Dr. Solomon added that there is a major meeting on Monday with Dr. Weiler at which some clarity will be brought to the question of cost and technical milestones to make a 2009 launch. The Subcommittee was told that there would be a meeting on October 10 at which the Administrator will participate and may make a decision on how to proceed. Dr. Burns indicated that he would like to be able to make a recommendation to the Administrator on the strategy and the possible options put forward. What would be useful to the Science Committee would be to place into perspective the MSL mission, its value to Mars, and its value to Solar System Exploration in general. Dr. Solomon noted that the Subcommittee discussed essentially three options: continuing to meet a 2009 launch; delaying the mission to 2010 or 2011; or cancelling the mission. There was no strong support for cancellation, as MSL is viewed as a very important mission. The Subcommittee debated whether to stay on course or to back off on the launch date to give more flexibility on the financial side.

At Dr. Solomon's request, Dr. Mustard relayed the importance of MSL. MSL is the first mission that is going beyond the "follow the water" theme and beginning to understand the environments that may or may not have been habitable. MSL can target specific environments. The instruments on the surface would enable quantitative measurements. From a science point of view, it is a step forward in addressing the life question. Dr. Burns noted that it would be important for the Science Committee and the Administrator to place MSL in perspective with the solar system as a whole. Another thing to address is the question: What can we learn so that this kind of technology development can be better managed? Dr. Solomon indicated that the Subcommittee would make a recommendation in that area, but noted that the people who are best able to answer the question are working flat out to get MSL to launch and would not be able to answer that aspect of the recommendation in the near term. Dr. Burns asked that the Subcommittee be very frank and forthright in its recommendation. He indicated that the Science Committee had reviewed MSL with Dr. Green at its meeting in April and noted the strain on SMD at that time due to overrun; however, it recommended that the Administrator move forward with the mission. Dr. Burns emphasized that he needed some good ammunition to make the case to the NAC. Dr. Green indicated that the Division had looked at some options for additional funds, including using FY 08 carryover from operating missions and delaying missions. The trade space was presented to the Subcommittee at this meeting. By the time of the Science Committee meeting, SMD will have been through the briefing with JPL and the meeting with the Administrator, as well as have a recommendation from the Subcommittee. Dr. Green noted that he was on the Science Committee agenda on Wednesday afternoon. Dr. Neal added that the Subcommittee does not want to make everything else "sick" through cancellations, which dramatically impacts other programs. Dr. Burns asked that the LEAG update be distributed to the Science Committee.

Dr. Burns would like to have all the Subcommittees meet for a plenary session right before the Science Committee meeting in February. This idea will be discussed at the Science Committee meeting this month. There is reluctance on the part of the leadership to make too many advisory committee or subcommittee changes before the changeover in Administration. Dr. Solomon extended an open invitation for Dr. Burns to attend any of the Subcommittee meetings. Dr. Burns likewise extended an invitation for any Subcommittee members to attend the Science Committee meetings.

Dr. Neal noted that the PSS has not been getting feedback on the recommendations it sends forward to the Science Committee. Dr. Burns gave the following action to Dr. Greg Williams: at end of each Science Committee meeting, write to the Subcommittee Chairs and provide feedback on what happened to their recommendations. The formal NAC replies, when received, will also be shared with the Subcommittees. Dr. Solomon indicated that Dr. Burns would be receiving a report on this Subcommittee meeting within a week.

#### Discussion of Recommendation and Planning of Future Meetings

The Subcommittee discussed the revised PSS recommendation prepared by Dr. Bagenal. As written, the recommendation stated that funds should be sought primarily from the Mars Program. Dr. Green raised the question of whether this implied that funds should be taken from the operating Mars missions, *i.e.*, turn them off, before taking funds from other planetary programs. Drawing funds primarily from the Mars program would impact the 2016 mission. The Subcommittee felt that first and foremost, NASA should

make a decision that optimizes the success of the MSL mission. This should be in the recommendation. Any unavoidable impact on non-Mars programs should be sought through delays of missions rather than mission cancellations. In addition, NASA should sponsor an external review of the causes of the MSL cost overruns and recommend lessons to be learned for future missions.

Dr. Solomon indicated that he would send out the revised recommendation to the Subcommittee for any further comments. All inputs on the recommendation must be back to him by October 8 so that the recommendation could be forwarded to Dr. Burns as requested.

The next PSS meeting will be the Tuesday before the NAC meeting – February 3, 2009. (The NAC meeting is February 4-5, 2009.)

Dr. Solomon adjourned the meeting at 2:20 p.m.

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

2 October (8:00 AM – 6:00 PM)

8:00	Welcome & Other Administrativia	Sean Solomon, Michael New
8:10	Planetary Science Division & Mars Exploration Program Updates	Jim Green, Doug McCuiston
10:00	Q&A with Ed Weiler, SMD AA	
11:30	Discussion	Sean Solomon
12:00	Lunch	
1:00	Analysis Group & MOWG Reports	
	• VExAG	Ellen Stofan
	• LEAG	Clive Neal
	• MEPAG	Jack Mustard
	• SBAG	Faith Vilas
	• CAPTEM	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	Transition Whitepaper Planning and Discussion	Sean Solomon
5:30	General Discussion	Sean Solomon
6:00	Adjourn PSS dinner at <i>TBD</i>	

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	

## PLANETARY SCIENCE SUBCOMMITTEE

Membership List – August 28, 2008

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<p>John F. Mustard Department of Geological Sciences Brown University 324 Brook Street Providence, RI 02912 Telephone: 401-863-1264 Fax: 401-441-9243 <a href="mailto:John_mustard@brown.edu">John_mustard@brown.edu</a></p>	<p>Dr. Ellen Stofan Proxemy Research 20528 Farcroft Lane Laytonsville, MD 20882 Telephone: 540-364-0092 Fax: 540-364-1071 <a href="mailto:ellen@proxemy.com">ellen@proxemy.com</a></p>
<p>Clive R. Neal Department of Civil Engineering and Geological Sciences 156 Fitzpatrick Hall University of Notre Dame Notre Dame, IN 46556 Telephone: 574-631-8328 Fax: 574-631-9236 <a href="mailto:Neal.1@nd.edu">Neal.1@nd.edu</a></p>	<p>Dr. Faith Vilas MMT Observatory P.O. Box 210065 University of Arizona Tucson, AZ 85721-0065 Telephone: 520-621-1269 Fax: 520-670-5740 <a href="mailto:fvilas@mmt.org">fvilas@mmt.org</a></p>
	<p>Hal Weaver Space Department Johns Hopkins Applied Physics Laboratory 11100 Johns Hopkins Road Laurel, MD 20723-6099 Telephone: 240-228-8078 <a href="mailto:hal.weaver@jhuapl.edu">hal.weaver@jhuapl.edu</a></p>

**Planetary Science Subcommittee Meeting  
October 2-3, 2008  
NASA Headquarters  
Washington, DC**

**MEETING ATTENDEES**

*Subcommittee Members:*

Solomon, Sean <i>Chair</i>	Carnegie Institution of Washington
New, Michael H. <i>Executive Secretary</i>	NASA Headquarters
Anbar, Ariel	Arizona State University
Bagenal, Frances	University of Colorado, Boulder
Borg, Lars	Lawrence Livermore National Lab
Cravens, Tom	University of Kansas
Hamilton, Vicky	Southwest Research Institute
Head, James	Brown University
Herzog, Gregory	Rutgers University
Hodges, Kip	Arizona State University
Johnson, Jeffrey	U.S. Geological Survey
Mihran, Robin Canup	Southwest Research Institute
Mustard, John F.	Brown University
Neal, Charles	University of Notre Dame
Pratt, Lisa	Indiana University
Shearer, Charles	University of New Mexico
Stofan, Ellen	Proxemy Research
Vilas, Faith	University of Arizona

*NASA Attendees:*

Allen, John	NASA Headquarters
Allen, Marc	NASA Headquarters
Anderson, David	NASA/GSFC
Beaty, Dave	NASA Headquarters
Bernstein, Max	NASA Headquarters
Billings, Linda	NASA Headquarters
Broadwell, Marguerite	NASA Headquarters
Cohen, Barbara	NASA/MSFC
Feeley, T. Jens	NASA Headquarters
Flaherty, Chris	NASA Headquarters
Fogel, Bobby	NASA/Headquarters
Graham, Dan	NASA/JPL
Green, Jim	NASA Headquarters
Hertz, Paul	NASA Headquarters
Johnson, Natasha	NASA Headquarters
Johnston, Gordon	NASA Headquarters
Kelley, Mike	NASA Headquarters
Kinney, Anne	NASA/GSFC
Kremic, Tibor	NASA Headquarters
Leshin, Laurie	NASA/GSFC
Lindsten, Marilyn	NASA Headquarters
Lindstrom, Dave	NASA Headquarters
May, Lisa	NASA Headquarters
McCouston, Doug	NASA Headquarters

McGrath, Melissa	NASA/MSFC
Meyer, Michael	NASA Headquarters
Munk, Michelle	NASA/LaRC
Niebur, Curt	NASA Headquarters
Noble, Sarah	NASA Headquarters
Norris, Marian	NASA Headquarters
Ocampo, Adriana	NASA Headquarters
Roemer, Voleah	NASA Headquarters
Senske, David	NASA/JPL
Tahu, George	NASA Headquarters
Vohuser, Lindley	NASA Headquarters
Vondrak, Richard	NASA/GSFC
Voytek, Mary	NASA Headquarters
Wargo, Michael	NASA Headquarters
Weiler, Ed	NASA Headquarters

*Other Attendees*

Bullock, Mark	Southwest Research Institute
Carrell, Randall	Ball
DiBiasi, Lamont	Southwest Research Institute
Frankel, Paula	[consultant – Minute Recorder]
Groswald, Lewis	NRC
Malay, Jon	Lockheed Martin
McCarthy, John	Orbital Sciences
Ostdiek, Paul	APL
Smith, David B.	Boeing
Zaneth, Larry	JHU/APL

**PLANETARY SCIENCE SUBCOMMITTEE  
NASA Headquarters  
Washington, DC  
October 2-3, 2008**

LIST OF PRESENTATION MATERIAL<sup>1</sup>

- 1) Planetary Science Division Update [Green]
- 2) Mars Exploration Program [McCuistion]
- 3) VExAG Update [Stofan]
- 4) LEAG Update [Neal]
- 5) MEPAG Update [Mustard]
- 6) SBAG Update [Vilas]
- 7) CAPTEM Update [Shearer]
- 8) Status of Lunar Science Roadmap [Neal]
- 9) Lunar Science Scenarios [Johnston, Leshin]
- 10) R&A Process and “Best Practices” [Hertz]
- 11) Report of International Lunar Network SDT [Cohen]
- 12) Report of Venus STDT [Bullock]
- 13) In-Space Propulsion Technology Program [Anderson]
- 14) Status of Aerocapture Technology [Munk]
- 15) Status and Future Planning for OPF [Niebur]

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<sup>1</sup> Presentation material is available electronically on the following Website: [www.science.hq.nasa.gov](http://www.science.hq.nasa.gov). After signing onto this site, go to “Planets,” then “NAC Planetary Science Subcommittee.”