

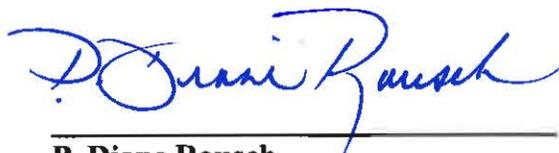
**National Aeronautics and Space Administration
Washington, DC**

NASA ADVISORY COUNCIL

July 29-31, 2015

**Jet Propulsion Laboratory
Pasadena, California**

MEETING MINUTES



P. Diane Rausch
Executive Director



Steven W. Squyres
Chair

NASA ADVISORY COUNCIL
Jet Propulsion Laboratory
Pasadena, California
July 29-31, 2015

Public Meeting Minutes
Table of Contents

Call to Order, Announcements...2
Opening Remarks by Council Chair...2
Welcome to the Jet Propulsion Laboratory...2
Remarks by NASA Administrator...3
NASA Space Flight Program and Management Requirements: NASA Procedural Requirements (NPR) 7120.5E
Governance and the Role of Center Directors...6
Institutional Committee Report...8
Joint Discussion on NRC Pathways to Exploration Report and NASA Human Exploration Strategy...10
Human Exploration and Operations Committee Report...13
Council Discussion...15
JPL Early Career Presentations...16
Science Committee Report...16
Aeronautics Committee Report...17
Council Discussion...18
Public Input...19
Technology, Innovation, and Engineering Committee Report...20
Council Discussion and Final Wrap-up...21
Appendix A Agenda
Appendix B Council Membership
Appendix C Meeting Attendees
Appendix D List of Presentation Material

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NASA ADVISORY COUNCIL**Jet Propulsion Laboratory
Pasadena, California****PUBLIC MEETING****July 29-31, 2015**Wednesday, July 29, 2015Call to Order, Announcements

Ms. Diane Rausch, Executive Director, NASA Advisory Council (NAC or Council), called the meeting to order and welcomed the Council members and attendees to the NASA Jet Propulsion Laboratory (JPL) in Pasadena, California. She explained that the NAC is a Federal advisory committee established under the Federal Advisory Committee Act (FACA). The meeting is open to the public. A dial-in capability is available for members of the public to listen to the meeting. WebEx is also available. Meeting minutes will be taken by Mr. David Frankel and will be posted to the NASA website, www.nasa.gov, soon after the meeting. Each NAC member has been appointed by the NASA Administrator, Mr. Charles Bolden, Jr., based on the member's individual subject matter expertise. All members are Special Government Employees (SGEs), subject to ethics regulations, and must recuse themselves from discussions on any topic in which there could be a potential conflict of interest. Any questions on ethics can be directed to Ms. Rausch. All presentations and comments will be part of the public record. Time has been set aside during the meeting for public comments.

Opening Remarks by Council Chair

Ms. Rausch introduced Dr. Steven W. Squyres, Council Chair, who presided over the meeting. Dr. Squyres welcomed everyone to the Council's public meeting. He noted that Mr. John Borghese, Aeronautics Committee Vice-Chair, would be standing in for Ms. Marion Blakey, Aeronautics Committee Chair. He reminded the members to use their microphones because people on line want to follow the deliberations. He reviewed the planned agenda for the meeting. Dr. Squyres noted that the NAC's Education Task Force met two weeks ago and will not be presenting at this meeting. He advised that the Council's December meeting would be at NASA Johnson Space Center (JSC).

Welcome to the Jet Propulsion Laboratory

Dr. Squyres introduced Dr. Charles Elachi, JPL Director. Dr. Squyres expressed his appreciation to everyone at JPL for hosting the NAC and the NAC committees. He stated that he was very impressed by all the young people working at JPL. He observed that a full-scale model of the Voyager spacecraft was in the JPL Von Karman Auditorium right beside their NAC conference table, and it reminded him how inspired he was when he first came to JPL in 1978 working on the Voyager mission.

Dr. Elachi welcomed everyone to JPL. He explained that JPL is a Federally Funded Research and Development Center (FFRDC) managed by the California Institute of Technology (Caltech) for NASA. He presented a short video showing JPL's major accomplishments over the last 15 years. Dr. Elachi stated that his message for young students is to simply imagine what will be done over the next 15 to 30 years – despite perennial budget issues.

Dr. Squyres thanked Dr. Elachi for his remarks.

Remarks by NASA Administrator

Dr. Squyres introduced Mr. Charles Bolden, Jr., NASA Administrator, who shared his thoughts with the NAC.

Mr. Bolden thanked Dr. Squyres and noted that it is always great to be with him and the Council. He expressed a special welcome to the newest Council member, Dr. Bradley Peterson, who is now chairing the NAC Science Committee. Mr. Bolden stated he looks forward to working with Dr. Peterson and to the exciting things that come out of the Science Committee.

Mr. Bolden noted that this also was the first NAC meeting for Dr. Dava Newman in her new capacity as a NASA official, the NASA Deputy Administrator. Until just weeks ago, Dr. Newman was a member of the NAC Technology, Innovation and Engineering Committee for a number of years. Mr. Bolden noted that Dr. Newman was not attending the NAC meeting at the moment, because she was in the midst of touring JPL. However, she had been with the Council earlier in the morning, and had attended part of the Science Committee meeting and some of other committee meetings. He remarked that it is a pleasure to have Dr. Newman onboard as the new NASA Deputy Administrator. Mr. Bolden noted that those on the Council who do not know Dr. Newman personally likely know her important work, particularly in the area of space suits, as well as from the leadership role she has demonstrated in developing space policy.

Mr. Bolden announced two other new NASA leadership appointments in the Agency since the last NAC meeting. Dr. Eugene Tu is now the Director of the NASA Ames Research Center (ARC or Ames), having replaced Dr. Simon "Pete" Worden after he retired. Dr. David Bowles is transitioning from Acting Director at the NASA Langley Research Center (LaRC or Langley) to the Director position.

Mr. Bolden stated that it has been an exciting four months at NASA since the previous NAC meeting. Everyone had just gone through "Pluto-mania," watching the NASA New Horizons spacecraft successfully accomplish its closest approach to Pluto. It is a mania that has swept the nation and the world. New Horizons was launched nine and a half years ago. He commented that everyone at the NAC meeting and online had probably seen some of the detailed images and measurements that have come from New Horizons in its first week. It is the longest-duration mission ever to reach its primary science target. It makes the U.S. the first nation to reach Pluto and the only nation to complete a survey of the Solar System. There has been public engagement around the world, including millions on social media. NASA has enjoyed this opportunity and is extremely proud of this amazing achievement. The *Washington Post* had a recent editorial entitled "Most Successful Media Outlet in America This Week is NASA." On his Facebook page, Nobel Laureate Dr. Stephen Hawking wrote, "This would have been the subject of science fiction when I was at school, but is now a science fact. I feel proud and honored for such a momentous scientific mission to be completed within my lifetime."

This past year, Mr. Bolden noted, has been one in which people were able to reflect on 25 years of the Hubble Space Telescope (Hubble). Everyone is familiar with Hubble's "greatest hits." Hubble helped scientists determine that the cosmos is 13.8 billion years old, it confirmed the presence of black holes in the center of galaxies, and its data has provided information for more than 12,800 scientific papers. The Hubble science data processing generates 10 terabytes of data and discovery every year, enough to fill the entire collection of the Library of Congress. NASA is using the occasion of the Hubble anniversary to remind people of the promise of the upcoming James Webb Space Telescope (JWST) mission. The public still connects to the Hubble as one of NASA's most recognizable and inspiring icons.

Mr. Bolden described recent activities. The journey to Mars continues to make significant progress. He explained that the Commercial Crew and Commercial Cargo programs are important to this journey, and there has been news about both priorities. On May 4, 2015, a "Humans to Mars Summit" was held. One result from that Summit was a consensus emerging around NASA's timetable and plan, and the fact that Mars should be the destination for humanity in the coming years. NASA announced the Journey to Mars Challenge, inviting the public to send ideas for developing technologies to establish a continuous human presence on the planet. That challenge will award up to \$15,000. The Mars Reconnaissance Orbiter (MRO) detected deposits of glass within Mars' impact craters. An agreement was signed with Centre National d'Etudes Spatiales (CNES) for France to provide the mast for the SuperCam component of NASA's Mars 2020 Rover. NASA has signed an agreement that extends cooperation with Spain on the Mars Science Laboratory (MSL) Curiosity Rover.

NASA teams were able to learn from the Low-Density Supersonic Decelerator (LDSD) test even as the parachutes used on that test malfunctioned. Mr. Bolden explained that sometimes a lot can be learned from things that do not work out as planned.

NASA received a Space Aging study from the International Space Station (Station or ISS). On July 22, 2015, three new crew members, including an American astronaut, were launched to the ISS on Soyuz. Despite recent setbacks, the ISS program rebounded with successful resupply missions, including Progress, after each mishap, and most importantly, the successful Soyuz crew launch last week. Despite recent SpaceX and Orbital Sciences setbacks, NASA is still making good progress with Commercial Cargo and Commercial Crew development. NASA has learned both from its setbacks and its successes. The astronauts aboard the ISS have the food and supplies they need to continue their groundbreaking research. A major landmark came a few weeks ago when NASA announced the formation of the Commercial Crew Cadre. Four astronauts from JSC – Robert Behnken, Sunita Williams, Eric Boe, and Douglas Hurley – were selected to be the first astronauts to train to fly to space on Commercial Crew carriers. Those four crew members will follow both commercial vehicles for a period of time and then, at some point in the future, they will be split into pairs. One pair will work specifically on the SpaceX Crew Dragon, and the other pair will work on the Boeing CST-100. Those astronauts are blazing a new trail, a trail that will one day land them in the history books and Americans on the surface of Mars.

Mr. Bolden explained that President Obama has it made it very clear that resuming launches of American astronauts from American soil is a top priority. The President has been persistently supporting that initiative in budget requests to the Congress. However, since 2010, NASA has received approximately one billion dollars less than the President requested. During the same period of time, the U.S. Government, i.e., the American taxpayer, has sent one billion dollars to Russia – approximately \$490 million dollars for the most recent Soyuz contract. The U.S. can do better, and NASA is persistently working to develop commercial capability to get U.S. astronauts into space. If NASA had received everything that the President asked for over the past several years, NASA would be preparing to send astronauts to space on commercial carriers this year, because NASA's original target was 2015. NASA is currently working toward launching astronauts on commercial carriers in 2017, and astronauts have begun training for those flights.

Just last week, a NASA camera on the Deep Space Climate Observatory (DSCOVR) returned its first view of the entire sunlit side of Earth from one million miles away. For those who had an opportunity to see it, it was an absolutely breathtaking image. Judging by people's comments, it was probably the best thing since Apollo 8, which was the very first time people saw the "blue marble" from a distance.

Earlier this month, NASA announced a new partnership with the Department of Agriculture to cooperate on Earth science research. NASA Deputy Administrator Newman signed a Memorandum of Understanding (MOU) with U.S. Department of Agriculture Deputy Secretary Harden at ARC in the past week. NASA was a big part of the national conversation and celebration of Earth Day in April 2015 – a few weeks after the NAC last met. More recently, NASA released data showing how temperature and rainfall patterns worldwide may change through the year 2100 because of growing concentrations of greenhouse gases in Earth's atmosphere.

In Aeronautics, NASA had a major presence at the Paris Air Show this past June 2015. NASA continues to make important progress on making air travel cleaner, greener, quieter, and safer. Deputy Administrator Newman participated in an event with the NASA Langley Research Center (LaRC) team highlighting a partnership with Boeing as they flew their 757 EcoDemonstrator into LaRC. NASA teams are making progress, testing new technologies like blended-wing body aircraft that could reduce steel costs and decrease noise.

In closing, Mr. Bolden stated that he takes Council deliberations, advice, and recommendations very, very seriously. He explained that NASA may not always agree with what comes from the Council, but it always listens. That is the reason he was attending the Council meeting at JPL along with Dr. Newman. He thanked the Council members for their willingness to serve and give up their time. He then turned the floor back over to Dr. Squyres and offered to answer questions.

Dr. Wanda Austin congratulated Mr. Bolden on NASA's successes, particularly on appointing Dr. Newman as Deputy Administrator. She asked whether the recent launch failures by the commercial launch providers, Orbital ATK (Antares) and SpaceX (Falcon 9) had changed NASA's perspective for mission assurance. Mr. Bolden explained that, "NASA is not leaning too far forward too fast." He noted that the commercial space flights were licensed by the Federal Aviation Administration (FAA) and hence the recent launch failures were not considered a NASA mishap. The FAA and the commercial launch providers had reached an agreement on how the mishaps would be investigated, and NASA had a

representative on the Orbital investigation team. Orbital is ready to release an initial accident report to the FAA. The investigation was very thorough. Orbital had been using the Russian AJ-26 rocket engine and will discontinue its use due to concerns over its reliability. Following the Orbital accident, Orbital signed a contract with United Launch Alliance (ULA) to fly the Cygnus cargo capsule on the Atlas V launch vehicle. Mr. Bolden noted that Russia had also recently lost a Progress cargo capsule and that NASA's visibility into the Russian program is not as strong as its visibility into its own commercial providers. Nevertheless, when he requested additional data about the Progress loss from the Russians, the data was provided. Mr. Bolden believes that the Russians understand the root cause for their failure – the mission had been flown using a new launch vehicle. NASA has accepted the Russian decision to fly another Progress cargo capsule on the old launch vehicle. SpaceX has identified the probable cause for its accident – shortcomings in a second stage oxidizer tank. NASA is learning from all the accidents.

Mr. Tom Young suggested that having multiple failures at one time is a message to the Agency that there are systemic problems. He noted that simply learning the cause for an accident is not the same as identifying the root cause of the problem. NASA has historically been successful because it has a continuity of expertise. The same is true in Air Force programs. Commercial programs, on the other hand, do not take advantage of NASA's expertise, and that may be the problem. Mr. Bolden responded that NASA has the same concern. Mr. Terrance Wilcutt, Chief of NASA's Office of Safety and Mission Assurance (OSMA), has stated that the Agency must always be looking for subtle indicators. What NASA is doing with the Orbital ATK, SpaceX, and Russian accidents is going back and looking at everything to learn why the problems could not have been anticipated. Following the advice of NASA's Aerospace Safety Advisory Panel (ASAP) over the last several years, NASA has put much effort into institutionalizing "lessons learned" in knowledge capture. The challenge is getting people to refer to that captured knowledge. NASA is working to instill that attitude in its employees. It cannot be said, however, whether that will carry over to the commercial programs. NASA has people embedded in the commercial programs and hopes that the proper attitude will carry over. The ASAP challenged NASA to allow its young engineers to "cut their teeth" on projects that can fail. One thing that NASA will never control, however, is the longevity of the commercial entities' workforce.

Mr. John Borghese asked Mr. Bolden for his thoughts on NASA's role with respect to Unmanned Aerial Vehicles (UAVs). Mr. Bolden responded that NASA's Aeronautics Research Mission Directorate (ARMD) has established a new strategic plan with six critical thrusts. One critical thrust is how to successfully integrate UAVs into the U.S. airspace. There is a need for sensor and avoidance systems and the development of UAV Traffic Management (UTM). He noted that Amazon recently offered to help users organize the airspace for UAVs at a low altitude, leaving it up to the FAA to regulate the upper airspace. He expressed concern that there would be a bad accident if proper oversight is not exercised. If that happens, the root cause would be the government's failure to act quickly enough.

Dr. Squyres stated that the NAC always tries to provide advice that is actionable. He noted that the Council and Agency have grappled with the issue of the degree of specificity with which the Agency should describe the journey to Mars. The Council wants to know what will be done and the cost, but recognizes that the activity is one that is decades long. The immediate issues are what will be done in the Proving Ground (a necessary interim location to transition human activity on the way to Mars). He asked what the Council can do to help the Agency as it moves into the Proving Ground. Mr. Bolden responded that it would be helpful for the Agency to provide the Council with the purpose for going to the Proving Ground. NASA intends to use the Proving Ground to understand the full impact that microgravity and a hostile radiation environment have on the human body. Also, there is needed technology that NASA has not spent the time and effort to develop, such as in-space, game-changing propulsion to speed the travel time for humans from Earth to Mars and high efficiency Solar Electric Propulsion (SEP) for moving cargo. To be successful in sending humans to Mars, it is necessary to take a step beyond low Earth orbit (LEO). The first challenge is to move away from the ISS. NASA believes that the ISS can be used safely until 2028. The U.S. should obligate to operate the Station until 2024. It would then be safe and acceptable to move into cis-lunar space. NASA has a good idea from past missions and from collaborations on what that would cost. The cost must be presented in short order. It is too soon, however, to pick an architecture for getting to Mars. There are new technologies to consider that have not yet been fully explored. NASA first needs to spend a decade in cis-lunar space learning lessons.

Dr. Squyres asked whether there is anything that the Council can do to help the Agency prepare for the end of the ISS. Mr. Bolden responded that the Council should pay attention to what the Agency is doing. NASA is trying to maximize the utilization of the ISS. He requested that the Council keep NASA "honest" and not allow NASA to repeat or duplicate experiments that have already been conducted. Challenge NASA to demonstrate the necessity for experiments or technology development. The question to be asked is whether it is worth the time and cost to put an experiment on ISS, he said.

Mr. Scott Hubbard suggested that the next NAC meeting would be a good opportunity to take a good look at ISS utilization. He noted that the Station's functionality had originally been proposed years ago to have two fundamental elements. One was the retirement of astronaut duration risks from a biomedical countermeasures point of view. That is within the purview of the Human Exploration and Operations (HEO) Committee. The second was learning about the fundamental processes of comparing something in zero-gravity (G) with something in one-G. That falls within the purview of the Science Committee. Mr. Bolden explained that in 2011, NASA chose the nonprofit Center for the Advancement of Science in Space (CASIS) to be the sole manager of the U.S. National Laboratory on the ISS. CASIS is opening the ISS to people who would not otherwise have thought about using it. NASA needs to begin to entice commercial entities to use the lessons learned from the ISS to help them decide what follow-on facilities should be commercially produced.

Dr. Austin asked Mr. Bolden to assess NASA's performance on the international stage. Mr. Bolden responded that the most important thing that NASA can do is show that it is a reliable partner, particularly during the transition to a new Presidential Administration. It is critical to help people understand that NASA is still "number one" in space exploration. Nothing makes him angrier than to go before the Congress and have them try to convince him that NASA is not the world leader in terms of exploration and discovery. Sometimes, he wonders "What planet they are living on?" When he goes to meetings of fellow Heads of Agencies (i.e., heads of foreign space agencies), he always asks the International Partners: "Where do you want to go and what do you want to do?" They all respond, "We are going where you go." The U.S. does not get to pick whether it will lead or not; every nation in the world expects the U.S. to lead. NASA has a responsibility to continue to lead and not to relinquish that responsibility.

Dr. Squyres summarized that the Council is looking to identify new things that it can do to serve the Agency. One thing that would be valuable would be to look to the future of the ISS and the end game. Another thing would be to take a hard look at ISS utilization and whether the resources are being used where they would be most productive. He asked that the NAC HEO, Science, and TI&E Committees begin to look at these issues. Mr. Ken Bowersox, HEO Committee Chair, noted that the HEO Research Subcommittee had already begun to do that.

Dr. Squyres asked Mr. Bolden to discuss the Human Spaceflight risk matrices. Mr. Bolden stated that there are 35 risks on the human side and an equally large number of risks on the technology side. Dr. Squyres suggested that it would be worthwhile for the Council to delve into the two risk matrices. Mr. Bolden agreed that that is what was wanted and that he would like to have the Council evaluate the risk matrices. In addition, the plan to transition from the ISS to cis-lunar space is being developed by Mr. William Gerstenmaier, Associate Administrator (AA) for the HEO Mission Directorate (HEOMD). Mr. Bolden explained that he does not want to hear about our leaving the ISS and then getting ready to send humans to cis-lunar space. The ISS should not be abandoned until NASA has someone in cis-lunar space.

Mr. Young suggested that the Council should also look into mission assurance for Commercial Crew. He believes that a significantly different approach for mission assurance is needed for Commercial Crew than the approach that has been used for Commercial Cargo. Mr. Bolden agreed with Mr. Young, and requested that his two advisory groups, the NAC and the ASAP, get together on this topic. He expects that the ASAP Chair, Admiral Joseph Dyer and the ASAP members are already looking at this issue. He stated that it would be advantageous to get advice from one advisory panel (i.e., ASAP) that is focused on Agency safety, and the other advisory panel (i.e., NAC) that is focused on Agency engineering. Dr. Squyres agreed to contact and coordinate with the ASAP Chair, Admiral Dyer.

Mr. Bolden expressed his appreciation for the valuable time given by the Council members. Dr. Squyres thanked Mr. Bolden for his time spent with the Council, and for a tremendously valuable conversation. He noted that Mr. Bolden had given the Council very clear direction.

NASA Space Flight Program and Management Requirements: NASA Procedural Requirements (NPR) 7120.5E Governance and the Role of Center Directors

Dr. Squyres introduced Dr. Ellen Ochoa, Director, NASA Johnson Space Center (JSC), and Ms. Teresa Vanhooser, Deputy Director, NASA Marshall Space Flight Center (MSFC) Center. They participated telephonically.

Dr. Ochoa described the Technical Authority (TA) process at JSC. The TAs provide technical assessments of programs and projects. The process at JSC is different from other Centers because JSC provides a TA review for crew flight risk. At Mr. Young's request, Dr. Ochoa explained that there are three TAs: Chief for Safety and Mission Assurance (SMA), Chief Engineer (CE), and Chief Health and Medical Officer (CHMO). They are represented at Program Control Boards (PCBs) and

Life Cycle Reviews. The Center Director (CD) receives TA inputs at informal weekly meetings, at Center Management Councils (CMCs), and at Pre-Flight Readiness Reviews (PFRRs). The PFRR is conducted prior to the Agency Flight Readiness Review (FRR) for ISS. She explained that there is always an opportunity for anyone to express a dissenting opinion. She actively solicits dissenting opinions and wants to know about any dissenting opinions that had been resolved.

Dr. William Ballhaus observed that the NASA current governance structure is much different than when he was a CD. He explained that CDs used to feel completely accountable for mission success. He asked what the CD is accountable for under the current structure in terms of mission success and program execution. Ms. Ochoa responded that she is polled at the FRR and is responsible and accountable for proper planning and execution of projects. The budgets used to go through the Centers and now go through the Mission Directorates. She does not make decisions on what resources go on the risks. She signs off overall that there is an acceptable risk and she needs to be knowledgeable about all risks that could affect the crew. Mr. Young stated “that is extraordinarily confusing.” He explained that if someone cannot say in one sentence what their responsibility is, then there is a problem. He added that while the NASA Administrator is ultimately responsible, if a problem is elevated too high, the result is ending up with someone with authority, but not the necessary information. Dr. Hubbard explained that the current TA recommendation process grew out of the Columbia Accident Investigation Board (CAIB) and was intended as a way to impose checks and balances. The process was moved to NASA Headquarters and left the CDs with “responsibility for roads and commodes.” He questioned whether there was clarity on who is in charge. Dr. Ochoa stated that she feels responsible for mission success and was never concerned that someone was not listening to her simply because she did not control the budget. She acknowledged that she does not make day-to-day decisions on how resources are allocated for programs. She has an opportunity, however, to assess the status of programs and projects at the Center, and she works with HEOMD to understand what to do to make missions successful. Mr. Wayne Hale observed that Center Chief Financial Officers (CFOs) now all report to NASA Headquarters.

Dr. Ballhaus explained that if everybody is responsible, then no one is responsible. The root cause for an accident could then be a lapse in accountability. He asserted that there is a need for a governance structure and a culture that makes it clear who is accountable for what. That must be flowed down to the people who can make a difference for mission success. Dr. Ochoa stated “We all do soul-searching and mission success is clear; program success is not as clear.” Dr. Ballhaus noted that the CAIB conclusion was that the accident was nobody’s fault. He advised that it is important for people to think about a failure before it occurs.

Ms. Vanhooser described the TA process at MSFC. The process is very similar to the process at JSC. When MSFC provides hardware to another Center, MSFC provides support to integrated CMCs.

Mr. Bolden noted that there had been only one occasion where an issue involving TA rose to his level. It involved the launch of Exploration Flight Test (EFT)-1. He had been advised late in the readiness preparation that the loss of mission probability was very high due to using the Delta Heavy launch vehicle. Dr. Ballhaus remarked that the governance structure does allow technical issues to get raised to levels where they can be resolved. Mr. John Borghese concurred and opined that it was a good approach, provided the CDs and TAs have independence and as long as their reviews are not judged on making schedule. Dr. Ballhaus noted that dissenting opinions were a huge lesson learned from the CAIB. He added that soliciting them is difficult and very few people will offer to provide them.

Dr. Squyres asked whether there was a useful recommendation or finding that could be given to the NASA Administrator. Dr. Austin commented that accountability is a leadership issue; it is critical to stress across NASA the importance of not getting comfortable and making sure that there is a focus on who is accountable for what. Dr. Squyres stated that leadership is personality driven and that strong leaders will assert responsibility. Mr. Hubbard added that good people can make any system work. He asserted that the Agency went much further with TA than was ever intended and that bypassing CDs was a horrible experiment. Dr. Ballhaus observed that it takes too long to describe NASA’s governance structure. He advised that there should be a way to simplify it and make the accountabilities clearer.

Dr. Squyres thanked Dr. Ochoa and Ms. Vanhooser for their presentation. He requested the Council members to consider the problem overnight.

Institutional Committee Report

Dr. Squyres introduced Ms. Kathryn Schmoll, Institutional Committee Chair.

Ms. Schmoll reviewed the Committee's membership and the Committee Work Plan. She described the November 14, 2014, NASA Office of Inspector General (OIG) Report entitled "NASA's Top Management and Performance Challenges." She noted that four of the seven challenges identified in the OIG's report are institutional challenges. They are:

- Overhauling NASA's Information Technology (IT) governance structure;
- Ensuring the security of NASA's IT systems;
- Managing NASA's infrastructure and facilities; and
- Ensuring the integrity of the contracting and grants processes and the proper use of Space Act Agreements (SAAs).

Ms. Schmoll presented a chart on a new Agency operating model, and she described the Business Services Assessment (BSA). The BSA addresses the NASA Strategic Plan's third goal, which states: "Serve the American public and accomplish our Mission by effectively managing our people, technical capabilities, and infrastructure." The approach used by the BSA was discussed. Ms. Schmoll explained that the BSA will impact the way NASA does business across the Agency. She presented a chart showing the BSA 2015 "Deep Dive Work Plan Schedule."

Ms. Schmoll discussed the BSA – IT Deep Dive Pilot. NASA management recently undertook a comprehensive business services assessment of five aspects of IT operations and recommended actions to the NASA Mission Support Council (MSC):

- Streamline and rationalize IT management and governance;
- Implement a federated/hybrid data center operational model;
- Address risk mitigation actions to facilitate implementation of the Network Transformation Initiative;
- Consolidate non-ACES workstations support administration and support; and
- Implement an independently-led, zero-based review of IT security spending and the alignment to the IT security strategy, and establish an improved security architecture better aligned with NASA's business risks.

Ms. Schmoll reported that the NASA Office of the Chief Information Officer (OCIO) is working on implementation plans to be presented to the MSC in September 2015. Mr. Young noted that Council members had each received a letter from the U.S. Office of Personnel Management (OPM) about a recent hacking into the U.S. Government's personnel files. He explained that the most alarming thing about the intrusion was that the hacker had been in the system for months before being discovered. Mr. Bolden explained that NASA IT security is developed with assistance from both the Department Of Homeland Security and the Security Operations Center (SOC) at NASA Ames Research Center.

Ms. Schmoll presented several Committee-level observations and findings in response to the BSA – IT Pilot. After further discussion, the Council approved the following Committee-level recommendation to the NASA Associate Administrator for Mission Support Directorate:

The Institutional Committee recommends the NASA ensure that performance plans and appraisals for individuals that are assigned IT roles and responsibilities include specific goals and objectives related to the IT Pilot deep dive implementation.

The Council also approved the following Committee-level finding to the NASA Associate Administrator for Mission Support Directorate:

In the Institutional Committee's review of the NASA Mission Support Council (MSC) Business Services Assessment (BSA) IT Pilot Decision Package, the Committee saw that these decisions were grounded on a thoughtful process based on seven sensible guidelines, led by widely-trusted NASA leaders and conducted with extensive, active participation of Subject Matter Experts (SME's) and key stakeholders at the Centers as well as Headquarters. The Committee commends NASA management for initiating the review and for carrying it out in a professional, balanced, and inclusive manner.

- *IT Security: Worthy of note is the decision to implement an independently led, zero-based review of IT security spending. In the past, new security tools have been implemented without validation that the older tools and*

manpower investments are still required, given the newer capabilities. Improvements in protection, detection, and reaction are all needed. NASA is showing noteworthy leadership in taking on that task.

- *Data Centers: The Committee believes that NASA's implementation of a federated/hybrid data center operational model, as a step toward consolidating NASA data centers, has the potential for cost saving as well as increased security.*
- *IT Governance: The proposed governance model may give the NASA Chief Information Officer (CIO) insight into most NASA IT assets and spending and thereby enable improved management of NASA's IT investment.*
- *Enterprise Architecture: The Committee would like to stress the importance of completing the IT area portfolio enterprise architectures and framework as a near term priority to facilitate the effective implementation of the full set of Mission Support Council decisions.*

In addition, the Council approved the following Committee-level finding to the NASA Associate Administrator for Mission Support Directorate:

The Institutional Committee encourages the Agency to go forward with the Business Services Assessment (BSA) process. The Agency should continue to focus on the communication aspect of the BSA rollout and decision process with their employees. BSA should address the NASA Office of Inspector General (OIG) Top Management Challenges and other external audits concerns in their deep dive assessments. The Committee encourages multi-center participants and in the BSA functional reviews. The Committee would like to continue to be apprised of the Agency decisions/recommendations on the BSA Deep Dives when appropriate.

Dr. Squyres advised that when there is a NAC committee-level finding it would be helpful for the committee to prepare a formal letter transmitting the findings to the NASA Associate Administrator (AA). The letter would then become part of the committee's permanent record. It was agreed to do so.

Ms. Schmoll presented a chart on energy metrics reported by the NASA Office of Strategic Infrastructure. She noted that NASA energy reduction efforts produced a 26 percent reduction in energy consumed. The new Executive Order 13693 "Planning for Federal Sustainability in the Next Decade," will require a further 25 percent reduction.

Dr. Squyres thanked Ms. Schmoll for her presentation.

Council Discussion

The Council discussed options for dates for the Council's next meeting to take place in December 2015 at JSC. Dr. Squyres explained that the NAC meetings used to be one and a half day meetings but now were two full days to accommodate more discussion time and additional topics. He noted that a final decision on the specific dates for the December meeting will take place before the end of this Council meeting.

Adjournment

The Council meeting was adjourned for the day at 4:45 pm.

Thursday, July 30, 2015

Call to Order, Announcements

Ms. Rausch called the NAC meeting to order and welcomed everyone to the second day of the Council meeting. She reminded Council members that the meeting was a public meeting and that all presentations and comments are considered "on the record." She stated that the NAC meeting minutes and presentations will be posted to the NASA Web site, www.nasa.gov, soon after the meeting.

Remarks by Council Chair

Ms. Rausch introduced Dr. Squyres. He described the day's agenda.

Joint Discussion on NRC *Pathways to Exploration* Report and NASA Human Exploration Strategy

Dr. Squyres introduced Dr. Mary Lynne Dittmar, Former Member, Committee on Human Spaceflight, National Research Council, and Mr. William Gerstenmaier, Associate Administrator for Human Exploration and Operations Mission Directorate (HEOMD), NASA Headquarters.

Dr. Dittmar thanked the NAC for inviting her to its meeting. She explained that she would review the highlights of the NRC *Pathways to Exploration* report and that during her presentation, Mr. Gerstenmaier would interject with NASA's position on the report. The full report is 287 pages and was published in June 2014. The report had been requested by Congress in the 2010 NASA Authorization Act after the political upheaval stemming from cancellation of the Constellation program. The report was requested to provide policy guidance to Congress regarding future direction and investments in the U.S. civil space program. The Committee's deliberations and recommendations were not bound by existing policy, with the exception of using the Space Launch System (SLS) and Orion. The underlying goal was to assemble a diverse group of experts, some of whom supported Human Space Flight (HSF) and some who did not, to investigate, evaluate, and recommend to the Nation a sustainable path forward for HSF. Mr. Gerstenmaier reviewed the provisions in the 2010 NASA Authorization Act and the 2010 U.S. National Space Policy. Ms. Dittmar reviewed the NRC Committee's membership and panel members. The Committee had four findings on a strategy for sustainability:

- The Committee endorsed continuation of human space exploration program, but noted:
 - The Nation must decide **now** on the nature of that program; and
 - The only pathways that justify expense, continued investment, and risk to crews involved are those that *ultimately place humans on other worlds*.
- The pathway principles and decision rules put forth in the report should be adopted (highest priority recommendation).
- A sustainable program of human deep space exploration must have an ultimate, "horizon" goal (Mars) that
 - provides a long-term focus less likely to be disrupted by failures, accidents, and vagaries of the political process and economic scene; and
 - is not achievable with flat funding or with rise at rate of inflation (~2.5%).
- NASA should focus now on the high-priority research and technology:
 - entry, descent, and landing (EDL) for Mars;
 - in-space propulsion and power; and
 - radiation health effects and amelioration.

Mr. Gerstenmaier discussed NASA's strategy for the Journey to Mars. He described seven strategic principles for sustainable exploration:

- Implementable in the near-term with the buying power of current budgets and in the longer term with budgets commensurate with economic growth;
- Exploration enables science and science enables exploration, leveraging robotic expertise for human exploration of the solar system;
- Application of high Technology Readiness Level (TRL) technologies for near term missions, while focusing sustained investments on technologies and capabilities to address challenges of future missions;
- Near-term mission opportunities with a defined cadence of compelling and integrated human and robotic missions providing for an incremental buildup of capabilities for more complex missions over time;
- Opportunities for U.S. commercial business to further enhance the experience and business base;
- Multi-use, evolvable space infrastructure, minimizing unique major developments, with each mission leaving something behind to support subsequent missions; and
- Substantial new international and commercial partnerships, leveraging the current ISS relationships while building new cooperative ventures.

Mr. Gerstenmaier reviewed the capabilities needed for the Journey to Mars. He presented a chart showing the largest indivisible payload element and options for the size of the Mars lander. Dr. Squyres commented that it was an excellent chart showing decisions that have to be made and that drive the architecture. Mr. Bolden explained that NASA is asking "What does Congress want?" It is critical to make a decision on whether to pursue humans going to Mars. If the answer is yes, NASA will continue planning the mission. Mr. Young asserted that Congress is not the place to provide the leadership; NASA has to provide the leadership. Mr. Bolden stated that NASA wants to finish planning the Mars 2020 mission so that it

can be executed in 2020. Dr. Squyres noted that data that will inform decisions for future missions like Mars 2020 will not be available until later in time. Mr. Gerstenmaier explained that the minimum lander size is driven by the Crew Ascent Stage. He reviewed the 2015 Human Landing Site Study. He discussed Solar Electric Propulsion (SEP) module extensibility for Mars. He discussed recent research conducted by the Foundation of Space Radiation Radiobiology and explained that there are no “show stoppers.” Mr. Gerstenmaier presented a chart showing 30 HSF health risks that have been identified by the Human Systems Risk Board (HSRB), and he noted that each risk is controlled by a NASA standard. He described the ISS One-Year Mission.

Mr. Young asserted that NASA thinks the NRC Committee was wrong. Mr. Gerstenmaier explained that rather than follow a monolithic plan for going to Mars, NASA preferred to maintain a flexible approach. Dr. Dittmar noted that the NRC Committee had been acting under a different set of assumptions and guidelines. Dr. Dava Newman, who had served as a member of the Technical Panel of the NRC Committee, stated that there is a lot of agreement between the NRC and NASA. Many options are available, and it is too soon to pick one. Mr. Gerstenmaier commented that there were no big “disconnects” between NASA and the NRC Committee. The main principles are shared: modularity, Mars as a horizon goal, and sustainability. Dr. Squyres distinguished an NRC report, which has an end date and is a snapshot in time, from Agency planning, which is ongoing. He observed that the Agency is very much in agreement with many things laid out in the NRC Committee report, while there are some differences about the degree of specificity for the architecture that should be decided.

Dr. Dittmar reviewed the NRC Committee’s findings on essential cornerstones:

- An active U.S. human spaceflight program gives the United States a stronger voice in an international code of conduct for space, enhances U.S. soft power, and supports collaborations.
- Whether human off-Earth settlements could eventually be developed that would outlive human presence on Earth and lengthen the survival of our species is a question that can only be settled by pushing the human frontier in space.
- The level of public interest in space exploration is modest relative to other public policy issues.
- The horizon goal for human space exploration is Mars.
- A program of human space exploration beyond LEO is not sustainable with a HSF budget that increases only enough to keep pace with inflation.

Dr. David Spergel stated that soft power is hard to quantify. It is important because it is how culture is led. Mr. Bolden explained that U.S. leadership in HSF facilitates the ability to engage with leaders of other nations.

Dr. Dittmar discussed the NRC Committee’s recommendations for a “Pathways Approach”:

- Between LEO and the Martian surface are regions of space with stepping stone destinations reachable with foreseeable advances in the state-of-the-art, key capabilities. These include cis-lunar space, near-Earth asteroids (NEAs), Mars, and Earth-Moon Lagrange points.
- NASA can sustain a human space exploration program with meaningful milestones that simultaneously reasserts U.S. leadership in space while allowing ample opportunity for substantial international collaboration when that program:
 - has elements that are built in a logical sequence; and
 - can fund a frequency of flights sufficiently high to ensure retention of critical technical capability, proficiency of operators, and effective utilization of infrastructure.

A chart showing three possible pathways was presented by Dr. Dittmar. She explained that the more steps that are taken along a pathway, the more that risk is reduced; however, additional steps drive up costs.

Mr. Gerstenmaier discussed a chart on Pioneering Space. The chart illustrated ISS utilization through at least 2024, crewed missions beyond LEO through the 2020s, and human missions to Mars’ vicinity in the 2030s+. He described the ISS as a precious asset contributing in an immeasurable way to Exploration, and he asserted that NASA should find ways to justify its continuation. Dr. Squyres agreed and advised that NASA will need to change its focus to the transition of the ISS to the Proving Ground. In response to a request from Dr. Spergel, Mr. Gerstenmaier explained that the three most important purposes served by the ISS are as a platform for human health research, for developing technology for life support systems, and for developing human habitation systems.

Dr. Dittmar reviewed the NRC Committee’s highest priority recommendations or “Pathway Principles”:

- Commit to design, maintain, and pursue the execution of an exploration pathway beyond LEO toward a clear horizon goal that addresses the “enduring questions” for human spaceflight:
 - “How far from Earth can humans go?” and
 - “What can humans discover and achieve when we get there?”
- Engage international space agencies early in design and development of the pathway on the basis of their ability and willingness to contribute.
- Define steps on the pathway that foster sustainability and maintain progress on achieving the pathway’s long-term goal of reaching the horizon destination.
- Seek continuously to engage new partners that can solve technical or programmatic impediments to pathway progress.
- Create a risk mitigation plan to sustain the selected pathway when unforeseen technical or budgetary problems arise. Such a plan should also include points at which decisions are made to move to a less ambitious pathway or stand down the program.

Mr. Hubbard commented that most goals can be achieved through robotic spacecraft. Humans, however, can do a better job than robots when it comes to selecting samples.

Mr. Gerstenmaier presented two charts on the extensibility of habitation systems. He explained that NASA is developing standards for components that will allow International Partners to build to the standard. Mr. Bolden explained that one example of this is the international docking standard for the ISS. He stated that the standard is an unbelievably powerful tool.

Dr. Dittmar discussed the NRC Committee’s recommendations for decision rules that should be applied when problems arise:

- If the appropriated funding level and projected 5-year budget projection do not permit execution of a pathway within the established schedule, then do not start down that pathway.
- If a budget profile does not permit the chosen pathway, take an “off-ramp” (defined as “a less ambitious pathway”).
- If the U.S. human spaceflight program receives an unexpected increase in budget for human spaceflight, the increase in funds should be applied to rapidly retire significant technology risks or increase operational tempo.
- Give priority to those approaches that solve significant existing technological shortcomings, reduce overall program cost, allow for an acceleration of the schedule, and/or reduce developmental or operational risk.
- If there are human spaceflight program elements, infrastructure, and organizations that no longer contribute to progress along the pathway, the human spaceflight program should divest itself of them as soon as possible.

Mr. Gerstenmaier explained that Pioneering Space is all about logistical efficiency. He presented a chart on designing a resilient architecture.

Dr. Dittmar reviewed the NRC Committee’s recommendations on international collaborations:

- U.S. near-term goals for human exploration are not aligned with those of our traditional International Partners (beyond ISS). Most major spacefaring nations and agencies are looking toward the Moon. U.S. plans are focused on redirection of an asteroid into a retrograde lunar orbit where astronauts would conduct operations with it. There are a number of advantages to the U.S. being a more active player in lunar surface operations.
- Noting the rapid development of China’s capabilities in space, it is in the best interests of the U.S. to be open to future international partnerships.

Mr. Gerstenmaier explained that Low Earth Orbit (LEO) operations need to be transitioned to the private sector. There needs to be a private-sector-sponsored space station. The ISS should be used to establish a private sector pull for a space station. He presented a chart showing an integrated path to risk reduction in the Human Research Program. He discussed the ISS Technology Demonstration Plan.

Dr. Dittmar reviewed a chart describing how the NRC Committee’s *Pathways* report aligns and does not align with NASA activities. She noted that the report calls for a pathways approach, where the goal is sustainability, and that NASA’s approach is capability-based, where the goal also is sustainability. She advised that the Nation has to be prepared for the loss of life. Mr. Gerstenmaier explained that NASA’s long-term, human spaceflight objective is to extend human presence into the solar

system and to the surface of Mars. Sustainability is the central idea in NASA's approach, and it is the reason NASA is implementing the journey to Mars with a pioneering approach.

Mr. Bolden thanked the Council for allocating the time for the joint presentation and for asking engaging questions. He thanked Dr. Dittmar and Mr. Gerstenmaier for giving the presentation. He stated that they are national treasures. Dr. Squyres acknowledged Dr. Dava Newman for role as a member of the NRC Committee and for her assistance in bringing the NRC presentation to the Council.

Mr. Young stated that the NRC Committee's report was unique because it focuses on programmatic issues. He suggested that the Agency respond to each element in the report so that the NRC Committee can comment on the Agency's response. Dr. Squyres agreed that there could be value in formalizing Mr. Gerstenmaier's presentation into a written response. Mr. Hale concurred. Dr. Dittmar noted that the report was very complex and that it might take a year to figure out what the Agency should respond to. Dr. Austin advised that there would be value in having the NASA Administrator write a letter back to the NRC Committee to capture where there is agreement and where there is departure.

Dr. Squyres thanked Dr. Dittmar and Mr. Gerstenmaier for their presentation.

Human Exploration and Operations Committee Report

Dr. Squyres introduced Mr. Kenneth Bowersox, HEO Committee Chair. Mr. Bowersox described the current HEO Committee membership. He presented NASA HEOMD's organization chart.

The Council was briefed on the status of the ISS. A chart summarizing ISS port utilization was presented. The crew members on Increment 43 were described. Highlights from Increment 44 were discussed. A chart showing the status of ISS consumables was reviewed. With regard to the Progress 59P anomaly, the probable cause for its failure to reach proper orbit is attributed to using a new configuration and structural resonance between the Progress and the launch vehicle. Mr. Bowersox noted that the new configuration is used for cargo first and is not to be used for launching with crew until 2020. He discussed the SpaceX-7 mission anomaly. SpaceX, with FAA oversight, is leading the investigation into the cause for the accident. NASA is supporting the investigation with personnel from the Launch Services Program (LSP), Commercial Crew Program (CCP), and ISS Program. A chart was presented showing the cargo lost on SpaceX-7. Mr. Bowersox discussed the status of the Orbital-4 mission. Orbital ATK has contracted with ULA to launch Cygnus on an Atlas V rocket. He noted that the Orbital-3 mishap investigation report had been provided recently by Orbital ATK to the FAA.

Mr. Bowersox reviewed a report from the NAC HEO Research Subcommittee on the Research Plan for Space Biology and Physical Sciences. The Subcommittee found that the stature of the scientific committee drawn to ISS research and the quality of the research is impressive. The Subcommittee also found that ISS crew time to implement labor-intensive fundamental research is greatly curtailed in NASA's plans. A chart was presented showing the allocation of ISS crew time for NASA research. Mr. Bowersox noted that the chart demonstrated how well the Center for the Advancement of Science in Space (CASIS) was performing. Mr. Gerstenmaier explained that there is a priority process for research on the ISS and that CASIS had begun to use its entire time allocation.

Mr. Bowersox discussed the status of Exploration Systems Development (ESD). He reviewed a chart showing the Exploration Mission (EM)-1 Integrated Mission Milestone Summary. He explained that the schedule drivers are the Orion crew module, European Space Agency (ESA) service module, core stage, and Interim Cryogenic Propulsion Stage (ICPS). Slides were shown on recent Orion, SLS, and Ground Systems accomplishments.

Mr. Bowersox discussed the CCP status. He noted that CCP will increase the ISS crew time available for U.S. research by an amount equivalent to one additional astronaut dedicated to research. That is critical to accomplishing the human research required for deep space exploration during the ISS lifetime. Mr. Young asked whether there was a practical business case for commercial transportation to orbit other than ISS. Mr. Bowersox responded that Bigelow Aerospace was interested in selling tourist seats. Mr. Gerstenmaier added that Boeing and SpaceX also have plans. Mr. Bowersox discussed the \$1.243 billion NASA FY 2016 President's Budget Request for CCP. If Congress fails to fully fund the budget, there would be consequences. NASA would shift milestones, rather than downselect to a single provider. The contractors would have to stop work or work "at risk" until additional funding can be obligated. The existing contracts would need to be renegotiated, most likely resulting in schedule delays and increased contract costs. NASA would have to continue to rely on the Russian Soyuz capability to meet America's requirements for crew transportation services.

Mr. Bowersox reviewed the HEOMD response to the HEO Committee's previous finding on the need to develop a U.S. domestic hydrocarbon rocket main engine. He explained that NASA is not limited in the use of Russian engines for NASA missions, but that the U.S. Air Force is prohibited from using Russian engines for national security payloads. That prohibition could affect the price that NASA has to pay for the engines it uses. Mr. Young suggested that the prohibition could cause ULA to go out of business.

Dr. Squyres noted that an issue had come up regarding Commercial Crew mission assurance and safety. He asked how the two senior NASA advisory groups – NAC and the Aerospace Safety Advisory Panel (ASAP) – interface on this topic. Mr. Bowersox responded that the HEO Committee was considering inviting the ASAP to a future HEO Committee meeting or holding a combined meeting. Dr. Ballhaus strongly encouraged that to happen. He asserted that the CCP is an experiment and that the LSP is being moved away from a position of accountability. Mr. Gerstenmaier stated that NASA has an extensive engineering safety involvement with Commercial Crew that is no different than what was done with Space Shuttle development. He explained that NASA has the authority to approve the commercial providers' processes and that they cannot fly without NASA's approval. Dr. Ballhaus observed that there is a difference between approving a contractor's processes and providing oversight. Mr. Gerstenmaier responded that NASA is duplicating the contractors' processes in-house in various areas to verify the contractors' test results. Mr. Hale explained that the CCP uses the LSP model, where NASA employees are embedded with the contractor. The CCP is about to release a document that describes the roles and responsibilities of each of the elements involved in a commercial crew launch. Mr. Young described a similar experiment conducted by the Air Force that resulted in over \$15 billion dollars of total failures. Mr. Gerstenmaier explained that NASA has looked at other programs for lessons learned. He agreed that this was still "a work in progress" and explained that the two other programs, Orion and SLS, are more traditional. The people in those organizations are getting hands-on experience and can assist with problems that arise in the CCP. He reminded everyone that the CCP is being treated as an experiment and that it is important for everyone to keep their eyes wide open and move forward very cautiously. Mr. Bowersox noted that there is a lot of expertise at the Council level on the subject. He asked whether the Council or the HEO Committee should meet with the ASAP. Dr. Squyres stated that there is flexibility on how to configure the meeting and that it would be discussed.

Mr. Bowersox described a presentation given to the HEO Committee on the HEOMD communication strategy. The HEOMD communication strategy has two communication goals:

- Enhance public and Congressional recognition of the value of human space exploration and understanding of the capabilities-driven approach in our pursuit of sending humans to Mars; and
- Enhance public awareness of the marvels associated with the ISS and its role in advancing human space exploration.

A chart showing 11 strategies being used to achieve those goals was presented. Mr. Bowersox described how well NASA is doing in social media. NASA leads the White House in followers in both Facebook and Twitter. NASA employees are allowed to participate freely in social media. Mr. Miles O'Brien stated that he likes the idea of leveraging workers and letting them tell their own story. He added that Mr. David Weaver, NASA's Associate Administrator for the Office of Communications, "has done a great job." Mr. Bowersox presented a chart showing conferences, large-scale events, and exhibits that are attended on behalf of HEOMD. A graphic summarized HEOMD's communication strategy: communicate as widely as possible; build communities of fans and followers; and transform them into advocates, ambassadors, creators, and collaborators.

Mr. Bowersox presented for the Council's approval a proposed Committee-level finding to the NASA Associate Administrator for HEOMD on the HEOMD communications strategy. The finding was approved by the Council and states:

The Human Exploration and Operations Committee noted a positive improvement in NASA's effort to communicate plans for Pioneering Space, including the Journey to Mars. Because of the critical importance of public engagement in the human exploration program, the Committee plans to request future briefings on this topic to monitor progress. During briefings on this topic, the Committee members thought that the following aspects of the communication approach were especially important:

1. *The existence of a formal strategy to guide communication efforts;*
2. *Engagement of the public using the latest communication methods including social networking;*
3. *Engagement of the public in new forums; and*
4. *Collection of data to evaluate the effectiveness of communication efforts.*

Mr. Bowersox reviewed the recent JPL study on a possible executable program for a human journey to Mars. The building blocks for a minimal architecture were described, and a chart with a notional timeline was shown. A graphic showing the overall architecture concept was presented. A 24-day short-stay surface concept was described. Mr. Bowersox explained that Aerospace Corporation had provided a “sanity check” cost assessment for the program. The assessment suggested that meeting the study team’s self-imposed cost constraint was plausible. A chart was presented to show how the tentative costs for the JPL architecture fell within the annual HSF budget, adjusted for inflation. The JPL study was aimed at showing an example, as an existence proof, that journeys to Mars using technologies that NASA is currently pursuing is plausible on a time horizon of interest to stakeholders and without large spikes in NASA budget.

Mr. Bowersox presented for the Council’s approval a proposed Committee-level finding to the NASA Associate Administrator for HEOMD on outside participation in Exploration mission planning. The Council approved the finding as follows:

The NASA Human Exploration and Operations Mission Directorate (HEOMD) is leading an effort to build the technical rationale for a sustainable human exploration effort which will allow humans to pioneer space called the Evolvable Mars Campaign. Inclusion of groups outside the core NASA team in the Evolvable Mars Campaign study process helps to build support for the study results, and also allows for a wide set of creative approaches from which to build the final plans for human exploration. The Human Exploration and Operations Committee endorses the HEOMD’s current effort to include outside participation in NASA’s planning efforts for the Journey to Mars.

Mr. Hale cautioned that cost estimates should be taken with a “big grain of salt.” Mr. Gerstenmaier stated that many concepts from the study were already being used, and some were new and are being adopted by NASA. Dr. Hubbard noted that the JPL architecture is the only architecture that has been costed recently by the same tools used by the National Academies. He asserted that it demonstrates that going to Mars is plausible, which should encourage international partnerships. Mr. Young stated that the JPL plan “is terrific.” He expressed interest in seeing NASA put together a similar integrated plan that people could rally around. Mr. Borghese commented that the funding increase at NASA is insufficient for a traditional approach to Mars. He suggested that China, with a growing gross domestic product (GDP) that will surpass the U.S., is another approach. Mr. Miles expressed concern that the JPL study could confuse NASA’s message. Mr. Gerstenmaier noted that there is a need to convince people that NASA’s approach is sustainable. He explained that the fact that NASA does not have a hard architecture allows NASA to remain open to new ideas. Dr. Austin observed that the JPL study cost assessment assumes an inflation adjusted budget. She advised that the study team needs to look at how its approach would be executed on a flat budget. At Dr. Squyres’ request, Mr. Bowersox and Mr. Young agreed to rework the language for the proposed finding.

Mr. Bowersox discussed the need to transition from the ISS to cis-lunar space. He presented a chart showing the elements required for that transition. One element would be a one-year duration “shakedown cruise” near the end of the 2020s. He explained that there are many opportunities for public-private and international partnerships in achieving the goal of a one-year duration crewed mission in cis-lunar space. Mr. Bowersox concluded his presentation by describing special topics to be discussed at future HEO Committee meetings. Mr. Young suggested adding to those topics launch readiness and mission assurance for commercial crew.

Dr. Squyres thanked Mr. Bowersox for his presentation.

Council Discussion

Dr. Squyres suggested that there should be a Council finding on the NPR 7120.5E governance discussion and the role of NASA Center Directors. Dr. Ballhaus advised that the current governance structure grew out of the CAIB Report and is not sufficiently clear and crisp; it needs to be a clear-flowing structure and have clear accountability. Mr. Hale noted that before the CAIB, the Program Managers had too much power and people were afraid to speak up. At Dr. Squyres request, Dr. Ballhaus, Dr. Hubbard, Mr. Hale, and Mr. Young volunteered to draft a finding on governance.

Dr. Squyres also noted that Dr. Austin had made an interesting suggestion that NASA should respond to the NRC *Pathways to Exploration* report with a letter from the NASA Administrator. Dr. Spergel advised that the NRC as a separate organizational entity no longer existed; it had recently transitioned to become part of the National Academies (i.e., National Academy of Sciences, National Academy of Engineering, Institute of Medicine). The National Academies would not reply to the NASA response letter. At Dr. Squyres request, Dr. Austin agreed to draft an appropriate recommendation.

JPL Early Career Presentations

Dr. Squyres announced that it was the time for the Council to hear presentations from NASA early career scientists and engineers. He re-introduced the JPL Center Director, Dr. Elachi, who then introduced the four JPL early career presenters to the Council.

Dr. Elachi first introduced Dr. Carmen Boening, GRACE Project Scientist. Dr. Boening gave a presentation entitled, “*Water Cycle and Sea Level Research.*” Dr. Squyres asked how people benefited from the mission she described. Dr. Boening responded that the mission can see underground. In answer to a question from Mr. Borghese, Dr. Boening explained that she started studying mathematics and went on to become a scientist. Then Dr. Elachi introduced Dr. Sisir Karumanchi, Technologist. Dr. Karumanchi gave a presentation entitled, “*Team RoboSimian: Software Architecture and Results of the 2015 DARPA Robotics Challenge.*” Dr. Karumanchi explained that he wanted to get robots to enter into harsh environments. He added that JPL is one of the best places in the world for robot manipulation. Dr. Elachi then introduced Dr. Farah Alibay, Systems Engineer. Dr. Alibay gave a presentation entitled, “*MarCO: Mars Cube One.*” Dr. Alibay noted that entry, descent and landing is the most challenging part of going to Mars and that the challenge is to get telemetry from the lander. The final speaker introduced by Dr. Elachi was Dr. Kevin Hand, Deputy Chief Scientist for Solar System Exploration. Dr. Hand gave a presentation entitled, “*Ocean Worlds.*” He explained that the ocean worlds of Titan, Triton, Ganymede, Callisto and Enceladus have existed for most of the existence of the Solar System. They are the best place to search for life.

Dr. Squyres thanked Dr. Boening, Dr. Karumanchi, Dr. Alibay, and Dr. Hand for their excellent presentations. The Council applauded the presenters.

Science Committee Report

Dr. Squyres introduced Dr. Bradley Peterson, Science Committee Chair.

Dr. Peterson described the Committee membership and its subcommittees. He discussed recent science results. In Heliophysics, a graphic was presented showing gravity waves in the mesopause region. The “wavy magnetopause” was described. For Earth Science, Dr. Peterson presented images from the DSCOVR satellite Earth Polychromatic Imaging Camera (EPIC) first-light release. He discussed recent cooling in the top 100-meter layer of the Pacific Ocean. It appears to be compensated by warming in the 100 to 300-meter layer of the Indian and Pacific oceans over the last decade. For Planetary Science, charts were presented on recent discoveries at Pluto. Images of Pluto taken by the New Horizons spacecraft were shown. In Astrophysics, a graphic on new, small-Kepler candidates in the habitable zone was presented. An image from the Hubble Space Telescope showing a stellar exodus in action was presented.

Dr. Peterson presented the NASA Science Mission Directorate (SMD) organization chart and described the programmatic status. All 15 missions in SMD’s Heliophysics Division were reviewed and are being extended. A chart was presented showing the Heliophysics program planning from 2015 through 2024. The Division is undergoing a review to ensure a more balanced Heliophysics portfolio and to enable robust, long-term research programs. A graphic was presented showing all Earth Science missions and instruments. Dr. Peterson discussed the future of Landsat. He explained that Landsat 9 will launch and overlap with Landsat 8. The President’s FY 2015 NASA budget called for an affordable, sustained, Land Imaging Satellite System to extend the Landsat data record for decades. Images taken by the Sentinel-2A European multi-spectral land imaging satellite were presented. Dr. Peterson described the planned Europa Multi-Flyby Mission. Its goal is to explore Jupiter’s moon Europa to investigate its habitability.

Dr. Peterson discussed the Astrophysics Decadal Survey missions. He presented a graphic showing Decadal Survey flagship missions: Hubble, Chandra, Spitzer, the Stratospheric Observatory for Infrared Astronomy (SOFIA), JWST, and the Wide-Field Infrared Survey Telescope (WFIRST). He reviewed the JWST hardware status. Pictures showing its flight telescope progress were presented. He discussed a chart showing the WFIRST milestones. A chart was presented showing a short list of candidates for the 2020 Decadal Survey Large Mission.

Dr. Peterson reviewed a report by the Planetary Protection Officer (PPO) on evolving concepts for sampling in the Mars 2020 mission. He provided an update on the Mars Curiosity Rover. It is currently heading up Mt. Sharp on Mars. A chart on methane measurements by Curiosity was discussed. Dr. Peterson described a recent discovery by the Lunar Reconnaissance Orbiter Camera (LROC) showing ongoing tectonism on the Moon. He discussed the current status and challenges for

completing establishment of the NAC's Ad Hoc Big Data Task Force and described its proposed membership. The Task Force will report to the NAC Science Committee.

Dr. Peterson presented for the Council's approval a proposed recommendation to the SMD Associate Administrator to designate the Mars 2020 mission as Category V for planetary protection purposes. The recommendation was not approved by the Council. Dr. Peterson then presented for the Council's approval a proposed Agency recommendation developed by the Science Committee's Planetary Protection Subcommittee that NASA develop a process to react to unanticipated planetary protection issues as they arise during service operations on Mars surface exploration missions. Dr. Squyres recused himself from deliberations on this subject and left the room during the Council's discussion on it, after designating Mr. Bowersox as temporary NAC Chair. Dr. Hubbard then advised that the Council should not touch this subject "with a 10 foot pole." Dr. Peterson stated that the recommendation seemed overly prescriptive. He added that the NASA Planetary Protection Officer ought to be able to overrule everyone. Mr. Young cautioned that there are world-class scientists operating the mission and that it would not be smart to put in place something that constrains how the mission is operated. Dr. Hubbard suggested tabling further consideration of the recommendation, pending an upcoming NRC review of the subject. Dr. Peterson concurred. Dr. Squyres then returned to the room. Dr. Peterson presented for the Council's approval a proposed recommendation to the NASA Administrator on the use of fueled payload adapter fittings (PAFs). At Dr. Squyres request, the item was tabled until additional information on the subject is made available.

Dr. Peterson described as an "issue to monitor" a proposed recommendation to the NASA SMD Associate Administrator developed by the Heliophysics Subcommittee for the Heliophysics Division to increase the funding size of grants or reduce the number of pages required for Research and Analysis (R&A) program proposals. No action was taken on this recommendation.

Dr. Squyres thanked Dr. Peterson for his presentation.

Aeronautics Committee Report

Dr. Squyres introduced Mr. John Borghese, Aeronautics Committee Vice-Chair (for Ms. Marion Blakey, Chair).

Mr. Borghese reviewed the Aeronautics Committee membership. He discussed the ARMD Partnership Strategy. He explained that NASA Aeronautics Research Mission Directorate (ARMD) does research that has to transition to the private sector. The hardest item to transition is new technology. Research Transition Teams (RTTs) are used to ensure that research and development (R&D) needed for NextGen implementation is identified, completed, and effectively transitioned. He noted that NextGen is going to handle three times the current traffic with fewer emissions and less fuel. Four new RTTs are being formed for autonomy, data management, applied traffic flow management (TFM) and weather integration, and system-wide safety assurance. Mr. Borghese discussed a chart on global air traffic management (ATM) and international collaboration. He discussed the Aeronautics Overseas System Projects (AOSP) International Partnership Strategy. A chart was presented on ratified AOSP collaboration.

Mr. Borghese presented for the Council's approval a proposed Committee-level finding to the NASA Associate Administrator for ARMD on the importance of partnerships for collaboration in research and for technology transfer. Dr. Squyres noted that the finding was well-worded for a sensitive subject. The Council approved the finding, which states:

The Aeronautics Committee recognizes the importance of partnerships for collaboration in aeronautics research and for the transference of technology. The Committee encourages the NASA Aeronautics Research Mission Directorate (ARMD) to continue with their domestic partnerships and with international partnerships where it makes sense, such as in research areas like air traffic management. It is not clear to the Committee how partnerships are selected and vetted to ensure who will provide the best partnerships, in particular international partnerships. The Committee feels that international partnerships are important to ensure a consistent global approach to such areas as air traffic management. However, the Committee agrees that ARMD would be better served if it is clearer about whether the partnership is for "best in class" or if it is to understand where the world is with respect to specific technologies and regulatory areas that need to be harmonized globally.

Mr. Borghese discussed the project scope and objectives for the Shadow Mode Assessment using Realistic Technologies in the national airspace (SMART-NAS). Its purpose is to explore and develop concepts, technologies, and a test bed for safe, global, gate-to-gate trajectory-based operations. He described SMART-NAS technical subjects. A chart was presented

showing SMART-NAS top project risks. Mr. Borghese presented for the Council's approval a proposed Committee-level finding to the NASA Associate Administrator for ARMD applauding the project and encouraging the project to review its top risks. The Council approved the finding, which reads as follows:

The Aeronautics Committee applauds the NASA Aeronautics Research Mission Directorate (ARMD) for establishing the Shadow Mode Assessment using Realistic Technologies – National Airspace System for Safe Trajectory Based Operations project that addresses reducing delays and increasing throughput in relation to air traffic management, and appreciates the project providing the Committee with enough detail to assess the project goals and approach. The Committee endorses the approach laid out by the project and feels that it provides tremendous benefit to the air traffic management community. The Committee would like to encourage the project to review its top risks and address these risks as part of its further development of the project technical areas. The Committee further encourages the project to carefully assess the impact of the risks if it is determined that these risks remain red, and how the project might change its scope to ensure positive benefit is achieved despite the risks.

Mr. Borghese discussed the ARMD university strategy. He explained that universities have had concerns over ARMD issuing competitive solicitations that are overly prescriptive. He presented for the Council's approval a proposed finding that ARMD use a Broad Area Assessment (BAA) white paper approach in addition to the normal solicitation process. Dr. Squyres opined that the proposal appeared to be a recommendation disguised as a finding. He left it up to the Council to determine whether it should be a finding or a recommendation, and the Council approved it as a Committee-level finding for the NASA Associate Administrator for ARMD. It reads as follows:

The Aeronautics Committee applauds the NASA Aeronautics Research Mission Directorate (ARMD) for developing a strategy to encourage universities to move into a position of leadership to tackle core technical challenges. The Committee suggests that ARMD use a Broad Area Assessment (BAA) white paper approach in addition to its use of the Request For Information (RFI) and NASA Research Announcement (NRA) solicitation process. The Committee feels that the BAA would provide an opportunity for ARMD to give greater technical guidance for a given thrust area.

Mr. Borghese described the NRC Low Carbon Study. A chart was presented on the motivation for the study.

Dr. Squyres thanked Mr. Borghese for his presentation.

Council Discussion

Dr. Squyres observed that the day had been very informative and that there were two potential Council-level actions: one on NPR 7120.5E governance and the role of NASA Center Directors, and the other on NASA's response to the NRC *Pathways to Exploration* report. Four of the five NAC committees had given reports and each had findings or recommendations for NASA Mission Directorate Associate Administrators, and none for the Administrator. He invited Council members to make comments.

Mr. Borghese stated that he was concerned about cybersecurity for embedded systems. In response to a question from Mr. Young, Mr. Bowersox explained that it would be difficult for a hacker to take command of the ISS. Dr. Squyres commented that systems that fly themselves are vulnerable and that it could be valuable to call attention to the fact that NASA faces unique and unusual cybersecurity issues with spacecraft that fly embedded systems.

Dr. Squyres identified key issues for the NAC to consider: how to transition from the ISS to the Proving Ground and how to phase out the ISS. Dr. Squyres noted that the ISS is supposed to support the Proving Ground. Other key issues to consider are: what to do about the risk matrices that the NASA Administrator asked the NAC to consider, and mission assurance for Commercial Crew. Dr. Squyres noted that the Administrator requested that the NAC work on the latter with the ASAP Chair, Admiral Joseph Dyer and the ASAP members. Another key issue is sending someone to cis-lunar space for a year.

Dr. Austin presented for the Council's approval a proposed recommendation for the NASA Administrator on responding to the NRC *Pathways to Exploration* Report. The Council approved the recommendation, which states:

The Council recommends that NASA provide a written response, in the form of a letter for the record, to the NRC Pathways to Exploration Report. This response should address the specific findings and recommendations of the report, identify which recommendations are accepted, and provide a brief rationale for choosing strategies that were different.

Mr. Young noted that NASA has stated it will have Commercial Crew flying to the ISS in 2017. He asserted that there was “no way that will happen.”

Dr. Squyres explained that based on the NASA Administrator’s comments the previous day, it would be important for the NAC to focus on safety and mission assurance for Commercial Crew. Dr. Ballhaus suggested that the HEO Committee consider the issue and include Council members with relevant experience. Mr. Bowersox explained that it would be difficult to condense the many hours of briefings needed into a short presentation for the Council. For that reason, it would be useful to have the entire Council listen to the briefings. Dr. Squyres stated that following each NAC meeting, he meets with the NASA Administrator to discuss the NAC’s findings and recommendations. He noted that the Administrator has requested the NAC to look at mission assurance and safety for Commercial Crew in conjunction with the ASAP in a to-be-determined fashion. Dr. Squyres will speak with the Administrator to obtain clarity on the request. He or Mr. Bowersox would then contact Admiral Dyer to discuss the best way for going forward. Dr. Squyres commented that the topic falls within the purview of both the ASAP and the NAC. Mr. Young reported that the ASAP has been working and focusing on this issue for some time. He cautioned that the NAC is not prepared for that meeting. Dr. Squyres explained that it would be necessary for the NAC to become educated in order to participate in the dialogue. Mr. Bowersox suggested having the ASAP brief the NAC about the relevant progress and history on what the ASAP has been doing. Mr. Hale advised that the NASA program office should then be given a “fair shot” at presenting its understanding of safety and technical oversight. Dr. Squyres stated that he wanted the NAC to “wade into this carefully.”

Adjournment

The Council meeting was adjourned for the day at 5:00 pm.

Friday, July 31, 2015

Call to Order, Announcements

Ms. Rausch called the NAC meeting to order and welcomed everyone to the third day of the Council meeting. She reminded Council members that the meeting was a public meeting and that all presentations and comments are considered “on the record.” She stated that the NAC meeting minutes and presentations will be posted to the NASA Web site, www.nasa.gov, soon after the meeting.

Remarks by Council Chair

Ms. Rausch introduced Dr. Squyres. He explained that there would be one more committee report. He also announced that the next NAC meeting would be held on December 3-4, 2015, Thursday and Friday all day, at JSC.

Public Input

Dr. Squyres invited comments from the public.

Mr. David Seidel introduced himself. He is the Deputy Manager of the JPL Education Office and is a K-12 education specialist. He asserted that the Communications Coordinating Council and the Education Coordinating Council have become “too cozy,” to the detriment of education. He discussed the difference between education and outreach. He explained that two questions need to be asked in the classroom: What is the instructional objective for what the teacher is going to do that day? What is the teacher going to do that is more valuable than what he would otherwise do to disrupt the school day? Many supposedly educational NASA activities are actually only outreach efforts to the students, with no educational value. Mr. Seidel expressed concern over the reliability and validity of Mr. Weaver’s recent claim about the outreach efforts reaching 77 percent of the planet. Mr. Seidel criticized NASA for sending 113 employees to the South by Southwest Festival, while only sending 6 people to the National Science Teachers Conference. He asserted that NASA’s Education Office at NASA Headquarters is barely in the education game. He stated that NASA was a non-player in establishing next generation science standards.

Dr. Squyres noted that the Council had formed an Ad Hoc Task Force on Science, Technology, Engineering, and Mathematics (STEM). The Task Force is expected to be present at the NAC's next meeting. Dr. Squyres requested Mr. Seidel to put his comments in writing and send them to Ms. Rausch, who would forward them to the Task Force.

Technology, Innovation and Engineering Committee Report

Dr. Squyres introduced Dr. William Ballhaus, Technology, Innovation and Engineering (TI&E) Committee Chair.

Dr. Ballhaus described the Committee membership. He noted that the Committee had recently lost from its membership Dr. Dava Newman, who was recently appointed to serve as NASA Deputy Administrator. He presented a chart showing the guiding principles of the Space Technology Program (STP). A graphic on the technology path to Pioneering Space was presented. Dr. Ballhaus discussed development objectives in the Space Technology Mission Directorate (STMD) and in HEOMD's Advanced Exploration Systems (AES) program. He described the cooperation between STMD and AES.

Dr. Ballhaus discussed a presentation by James Reuther, STMD Deputy Associate Administrator for Programs, on the consequences of STMD funding shortfalls. Funding limitations are significantly delaying critical technology demonstrations for high power SEP, long-duration cryogenic propellant storage and transfer, a large-mass EDL system for Mars, in-situ resource utilization (ISRU), a highly reliable, closed-loop environmental control and life support system (ECLSS), an advanced surface power system, optical communications, a coronagraph for exo-planet atmospheric characterization, and icy moon lander technologies. A chart was presented on STMD investments in SEP. The challenges for in-space cryogenic systems were described.

Dr. Ballhaus provided an update on Low-Density Supersonic Decelerators (LSDs). He presented a video on the Supersonic Flight Demonstration Test 2 (SFDT2). The parachute on that test deployed briefly and then failed at a speed of Mach 2.3. He described the failure investigation status. Dr. Squyres recalled that there had been chute failures on his Mars Exploration Rover (MER) program as well, and he expressed confidence that the people working on the project would be able to solve the problem. Dr. Ballhaus reviewed key LSD accomplishments.

Dr. Ballhaus presented a chart on the 2015 NASA Technology Roadmap. He noted that a fifteenth area had been added on Aeronautics. The next step will be for the Technology Roadmap to be reviewed by the National Academies.

A chart on how STMD partners with universities to solve the nation's challenges was discussed. In response to a question from Mr. Borghese, Dr. Ballhaus stated that most PhD students funded by grants from NASA would find positions after they graduate in the aerospace industry and at NASA. Dr. Ballhaus noted that the Committee had met 15 Fellows working at JPL from universities across the Nation and was very impressed with their technical knowledge and capabilities.

Dr. Ballhaus presented for the Council's approval a finding, jointly proposed by the TI&E Committee and HEO Committee, that STMD lacks sufficient resources to deliver the technology developments needed to meet NASA's future mission goals. Mr. Young stated that he did not have the basis to make a judgment on the proposed finding because the plan is not known. He observed that if the plan is to get humans to Mars in 2030, then NASA is way behind; if it is 2050, then there is too much money. Dr. Ballhaus concurred. Dr. Squyres stated that there is an Agency goal to send humans to Mars and that the proposed finding calls attention to the fact that the resources needed for that are not available. Dr. Hubbard asserted that no one is smart enough to know what to invest in the absence of a long-term strategy with long-term milestones and launches. Mr. Bowersox explained that the purpose for the finding is to show that technology and Exploration are linked and that if technology is delayed, it will delay Exploration. He added that money cannot be taken from technology development in order to do more Exploration. Mr. Young stated that there is a need to have a notional view of what is to be done. Dr. Ballhaus asserted that there are decision-makers on the legislative side who support missions, but do not want to spend money for risk reduction because they do not understand the linkage. Mr. Young reiterated that he does not know whether the funding is sufficient or not because NASA has not indicated what the plan or schedule is. Dr. Peterson agreed that there is a need to know the actual plan. Mr. Bowersox stated that the existence of a more detailed plan would help focus technology efforts. Mr. Young explained that Mr. Gerstenmaier's details are "awesome," but lack definition. At Dr. Squyres request, Mr. Young and Mr. Bowersox agreed to work together revise the language for the proposed finding.

Dr. Squyres thanked Dr. Ballhaus for his presentation.

Council Discussion and Final Wrap-up

Dr. Squyres presented a proposed Council recommendation for the NASA Administrator on NPR 7120.5E governance and the role of NASA Center Directors. The recommendation was approved by the Council and states:

The Council recommends that NASA examine the current Agency governance approach with the objective of more clearly defining the role of NASA Center Directors.

Mr. Young and Mr. Bowersox presented a finding for the NASA Administrator on the linkage between funding for technology and Exploration. The Council approved the finding, which states:

A well-defined plan for the implementation of the U.S. objective of humans to the surface of Mars is mandatory to adequately assess funding for timely development of the required technology.

Mr. Young suggested that a recommendation was needed on developing a well-defined plan. Dr. Squyres stated that this topic would be considered at the Council's next meeting and hence would like to table the proposed recommendation until then.

Mr. Hubbard suggested that the Council provide assistance to NASA on the movement from LEO to the Proving Ground. Dr. Squyres agreed, noting that the NASA Administrator would appreciate help from the Council on formulating the ISS end game and the transition to the Proving Ground. Dr. Spergel observed that the problem is similar to turning off telescopes in space. He added that it is important to determine as soon as possible what the criteria should be for turning off the ISS.

In closing, Mr. Hubbard thanked Dr. Squyres for his leadership of the Council. Dr. Spergel suggested that NASA hold a workshop as a response to the NRC *Pathways to Exploration* Report. Mr. Hale stated that he was impressed by the number of young people at JPL.

Dr. Squyres cautioned everyone not to lose sight of the sheer wonder of what the Agency is doing. He commented that when he is in Washington, DC, he always enjoys going to the National Air and Space Museum and watching the young people get inspired by the exhibits. He thanked the Committee chairs for their leadership of their respective committees, the Council at-large members, Mr. Borghese for stepping in for Ms. Blakey, the NASA Headquarters NAC support staff, all the Executive Directors, the people at JPL for making the meeting a success, and Mr. David Frankel for taking the meeting minutes.

Adjournment

The Council meeting was adjourned at 11:30 am.

NASA ADVISORY COUNCIL

Jet Propulsion Laboratory
Von Karman Auditorium
Pasadena, CA

PUBLIC MEETING

July 29-31, 2015

Wednesday, July 29, 2015

1:30 – 1:33 pm	Call to Order, Announcements	Ms. Diane Rausch Executive Director NASA Advisory Council NASA Headquarters
1:33 – 1:40 pm	Opening Remarks by Council Chair	Dr. Steven W. Squyres Chair, NASA Advisory Council
1:40 – 2:00 pm	Welcome to the Jet Propulsion Laboratory	Dr. Charles Elachi JPL Director
2:00 – 3:00 pm	Remarks by NASA Administrator	Mr. Charles F. Bolden, Jr. NASA Administrator
3:00 – 3:30 pm	NASA Space Flight Program and Management Requirements: NASA Procedural Requirements (NPR) 7120.5E Governance and the Role of the Center Directors	Dr. Ellen Ochoa (<i>via telecon</i>) Director, NASA JSC Ms. Teresa Vanhooser (<i>via telecon</i>) Deputy Director, NASA MSFC
3:30 - 4:00 pm	Institutional Committee Report	Ms. Kathryn Schmoll, Chair
4:00 – 4:30 pm	Council Discussion	

Thursday, July 30, 2015

9:00 – 9:01 am	Call to Order, Announcements	Ms. Diane Rausch Executive Director NASA Advisory Council NASA Headquarters
9:01 – 9:05 am	Remarks by Council Chair	Dr. Steven W. Squyres Chair, NASA Advisory Council
9:05 – 10:30 am	Joint Discussion on NRC <i>Pathways to Exploration</i> Report and NASA Human Exploration Strategy	Dr. Mary Lynne Dittmar Member, Committee on Human Spaceflight National Research Council National Academies Mr. William Gerstenmaier Associate Administrator for Human Exploration and Operations Mission Directorate NASA Headquarters

10:30 – 11:15 am	Human Exploration and Operations Committee Report	Mr. Kenneth Bowersox, Chair
11:15 am – 12:00 noon	Council Discussion	
12:00 noon – 1:00 pm	Lunch	
1:00 – 2:30 pm	JPL Early Career Presentations: <i>Water Cycle and Sea Level Research</i>	Dr. Carmen Boening GRACE Project Scientist, JPL
	<i>Team RoboSimian: Software Architecture and Results of the 2015 DARPA Robotics Challenge</i>	Dr. Sisir Karumanchi Technologist, JPL
	<i>MarCO: Mars Cube One</i>	Dr. Farah Alibay Systems Engineer, JPL
	<i>Ocean Worlds</i>	Dr. Kevin Hand Deputy Chief Scientist for Solar System Exploration, JPL
2:30 – 3:15 pm	Science Committee Report	Dr. Bradley Peterson, Chair
3:15 – 4:00 pm	Aeronautics Committee Report	Mr. John Borghese, Vice Chair (for Ms. Marion Blakey, Chair)
4:00 – 5:00 pm	Council Discussion	
5:00 pm	Adjourn	
<u>Friday, July 31, 2015</u>		
9:00 – 9:02 am	Call to Order, Announcements	Ms. Diane Rausch Executive Director NASA Advisory Council NASA Headquarters
9:01 – 9:05 am	Remarks by Council Chair	Dr. Steven W. Squyres Chair, NASA Advisory Council
9:05 – 9:15 am	Public Input	
9:15 – 10:00 am	Technology, Innovation and Engineering Committee Report	Dr. William Ballhaus, Chair
10:00 – 11:30 am	Council Discussion and Final Wrapup	
11:30 am	Adjourn	

**NASA ADVISORY COUNCIL
Membership – July 2015**

Role	Council Members
Chair – NASA Advisory Council	Dr. Steven Squyres , <i>James A. Weeks Professor of Physical Sciences , Cornell University</i>
Member at Large	Dr. Wanda M. Austin , <i>President and CEO, The Aerospace Corporation</i>
Chair – Technology, Innovation and Engineering Committee	Dr. William F. Ballhaus Jr. , <i>President and Chief Executive Officer, The Aerospace Corporation (Ret.); Former Director, NASA Ames Research Center</i>
Chair – Aeronautics Committee	The Honorable Marion Blakey , <i>President and CEO, Rolls Royce North America; Former Administrator, Federal Aviation Administration</i>
Chair – Human Exploration and Operations Committee	Mr. Kenneth Bowersox , <i>U.S. Naval Aviator (Ret.); Former NASA Astronaut</i>
Member at Large	Mr. N. Wayne Hale , <i>Consultant, Special Aerospace Services; Former Program Manager, Space Shuttle Program, NASA Johnson Space Center (Ret.)</i>
Member at Large	Prof. G. Scott Hubbard , <i>Professor, Department of Aeronautics and Astronautics, Stanford University; Former Director, NASA Ames Research Center</i>
Member at Large, Ex-Officio	Gen. Lester Lyles , <i>Chair, Aeronautics and Space Engineering Board, National Academy of Engineering; USAF (Ret.)</i>
Chair – Science Committee	Dr. Bradley Peterson , <i>Professor Emeritus, Ohio State University</i>
Member at Large	Mr. Miles O’Brien , <i>Independent Journalist</i>
Chair, Institutional Committee	Ms. Kathryn Schmoll , <i>Vice President, Finance and Administration, University Corporation for Atmospheric Research (Ret.)</i>
Member at Large	Dr. David Spergel , <i>Chair, Space Studies Board, National Academy of Sciences; Professor, Charles Young Professor of Astronomy, Princeton University</i>
Member at Large	Mr. A. Thomas Young , <i>Executive Vice President, Lockheed Martin (Ret.); Former Director, NASA Goddard Space Flight Center</i>

**NASA ADVISORY COUNCIL
 Jet Propulsion Laboratory
 Pasadena, California
 July 30-31, 2015**

MEETING ATTENDEES

NASA Advisory Council Members:

Dr. Steven W. Squyres, <i>Chair</i>	Cornell University
Dr. Wanda Austin	The Aerospace Corporation
Dr. William Ballhaus	The Aerospace Corporation (<i>Ret.</i>)
Mr. John Borghese (<i>for Ms. Marion Blakey</i>)	Rockwell Collins Advanced Technology
Mr. Ken Bowersox	U.S. Navy (<i>Ret.</i>)
Mr. N. Wayne Hale	Special Aerospace Services
Prof. G. Scott Hubbard	Stanford University
Mr. Miles O'Brien	Independent Journalist
Dr. Bradley Peterson	Ohio State University
Ms. Kathryn Schmoll	University Corp. for Atmospheric Research (<i>Ret.</i>)
Dr. David Spergel	Princeton University
Mr. A. Thomas Young	Lockheed Martin (<i>Ret.</i>)
Ms. P. Diane Rausch, <i>Executive Director</i>	NASA Headquarters

NASA Attendees:

Alibay, Farah	Jet Propulsion Laboratory
Baker, John	Jet Propulsion Laboratory
Bentel, Katrin	Jet Propulsion Laboratory
Boening, Carmen	Jet Propulsion Laboratory
Brennan, Pat	Jet Propulsion Laboratory
Burdick, Garry	Jet Propulsion Laboratory
Carpenter, Kalind	Jet Propulsion Laboratory
Chuhat, Nacea	Jet Propulsion Laboratory
Coulter, Dan	Jet Propulsion Laboratory
Cwik, Tom	Jet Propulsion Laboratory
Decrossas, Emmanuel	Jet Propulsion Laboratory
Denning, Elaine	NASA Headquarters
Edelberg, Kyle	Jet Propulsion Laboratory
Ellison, Doug	Jet Propulsion Laboratory
Gerstenmaier, William	NASA Headquarters
Green, Mike	NASA Headquarters
Hand, Kevin	Jet Propulsion Laboratory
Hausman, Jessica	Jet Propulsion Laboratory
Hook, Simon	Jet Propulsion Laboratory
James, Geoffrey	Jet Propulsion Laboratory
James, Larry	Jet Propulsion Laboratory
Karumanchi, Sisir	Jet Propulsion Laboratory
King, Marla	NASA Headquarters
Krajewski, Joel	Jet Propulsion Laboratory
Kummer, Allen	Jet Propulsion Laboratory
Landerer, Felix	Jet Propulsion Laboratory
Leichty, John	Jet Propulsion Laboratory
McCleese, Dale	Jet Propulsion Laboratory
Muirhead, Brian	Jet Propulsion Laboratory

Mular, Brenda	NASA Headquarters
Mullins, Todd	NASA Headquarters
Nash, Jeremy	Jet Propulsion Laboratory
Paquin, Krista	NASA Headquarters
Schlegel, Nicole	Jet Propulsion Laboratory
Seibert, Michael	Jet Propulsion Laboratory
Seidel, David	Jet Propulsion Laboratory
Shekels, Matt	Jet Propulsion Laboratory
Siegel, Bette	NASA Headquarters
Smith, Stephanie	Jet Propulsion Laboratory
Strange, Nathan	Jet Propulsion Laboratory
Swanson, Brett	NASA Management Office/Jet Propulsion Laborator
Thomas, Allyson	NASA Headquarters
Viese, David	Jet Propulsion Laboratory
Watkins, Marcus	NASA Management Office/Jet Propulsion Laborator
Whalen, Mark	Jet Propulsion Laboratory
Williams, Calvin	NASA Headquarters
Yuan, Dahning	Jet Propulsion Laboratory

Other Attendees:

Boning, Jusa	[not affiliated]
Boning, Nina	[not affiliated]
Capdenila, Lucia	Purdue University
Eicker, Annette	Uni Bonn
Frankel, David	PB Frankel, LLC
Friedman, Louis	[not affiliated]
Thompson, Andrew	California Institute of Technology
Winsler, Rebecca	[not affiliated]

Telecon Attendees:

Andrucyk, Dennis	NASA Headquarters
Angleman, Alan	National Academy
Barton, Michael	AI Solutions, Inc.
Bedell, Darren	NASA Kennedy Space Center
Berger, Eric	Houston Chronicle
Bland, Natalie	NASA Johnson Space Center
Bornenstein, Seth	Associated Press
Bransome, Darrell	DRB Associates, Corp.
Bress, Kent	NASA Headquarters
Broadwell, Marguerite	NASA Headquarters
Campbell, Paul	NASA Johnson Space Center
Clark, Stephen	Spaceflight Now
Clark-Williams, Angela	Zantech IT Servcies
Conti, Alberto	Northrop Grumman
Cowling, Keith	[not affiliated]
Dittmar, Mary-Lynne	National Research Council
Dyster, John	Orbital ATK
Eisen, Howard	Jet Propulsion Laboratory
Eisenman, David	Jet Propulsion Laboratory
Floyd, Mary	Zantech IT Services
Foust, Jeff	Space News
Fries, Marc	NASA Johnson Space Center

Gilbert, Chris	Self-Employed Consultant
Graham, Sandra	National Academies
Hay, Jason	NASA Headquarters
Hill, Paul	NASA Johnson Space Center
Huntsman, Dave	[not affiliated]
Isbell, Douglas	Jet Propulsion Laboratory
Jurczyk, Steve	NASA Headquarters
Kamm, Shari	NASA Headquarters
Klaus, Kurt	Boeing
Krupiarz, Chris	[not affiliated]
Mahoney, Chris	Jet Propulsion Laboratory
Mann, Gregory	NASA Headquarters
Manning, Josh	U.S .Senate
Marsh, Celinda	Office of Management and Budget
McKay, Meredith	NASA Headquarters
Moloney, Michael	National Academy of Sciences
Muirhead, Brian	Jet Propulsion Laboratory
O'Brien, Michael	NASA Headquarters
Ochoa, Ellen	NASA Johnson Space Center
Ortiz, James	NASA Headquarters
Papa, Richard	NASA Langley Research Center
Passmore, Richard	European Space Agency
Pugel, Betsy	NASA Headquarters
Ramirez, Martin	Private Investor
Reuter, Jim	[not affiliated]
Rummel, John	East Carolina University
Scheld, Dan	N-Science
Seidel, David	Jet Propulsion Laboratory
Sengupta, Medhurita	[not affiliated]
Simberg, Rand	Media
Smith, Marcia	spacepolicyonline.com
Smith, William	Science Works
Solyd, Mary	NASA Headquarters
Stigberg, Ellen	NASA Headquarters
Stumpp, Tim	Jet Propulsion Laboratory
Tomek, William	NASA Langley Research Center
Vanhooser, Teresa	NASA Marshall Space Flight Center
Vergano, Dan	Buzzfeed News
Worley, Lauren	NASA Headquarters
Zamka, George	Bigelow Aerospace
Zimmerman, James	Retired NASA
Zimmerman, Robert	Symbiotek

NASA ADVISORY COUNCIL
Jet Propulsion Laboratory
July 29-31, 2015

LIST OF PRESENTATION MATERIAL

- 1) Technical Authority, Programmatic Authority, and the Role of the Center Directors [Ochoa, Vanhooser]
- 2) Institutional Committee Report [Schmoll]
- 3) Joint Discussion: National Research Council *Pathways to Exploration* Report and NASA Human Exploration Strategy [Dittmar, Gerstenmaier]
- 4) Human Exploration and Operations Committee Report [Bowersox]
- 5) Science Committee Report [Peterson]
- 6) Aeronautics Committee Report [Borghese]
- 7) Technology, Innovation and Engineering Committee Report [Ballhaus]
- 8) *Water Cycle and Sea Level Research* [Boening]
- 9) *Team RoboSimian: Software Architecture and Results of the 2015 DARPA Robotics Challenge* [Karumanchi]
- 10) *MarCO: Mars Cube One* [Alibay]
- 11) *Ocean Worlds* [Hand]

Other material distributed at the meeting:

New Space, Scott Hubbard, Editor-in-Chief