

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

NASA ADVISORY COUNCIL

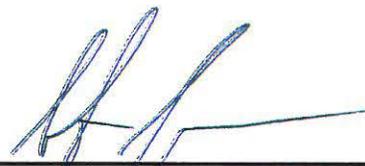
April 9-10, 2015

**NASA Headquarters
Washington, DC**

MEETING MINUTES



**P. Diane Rausch
Executive Director**



**Steven W. Squyres
Chair**

NASA ADVISORY COUNCIL

**NASA Headquarters
Washington, DC
April 9-10, 2015**

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*Meeting Report prepared by
David J. Frankel, Consultant
P B Frankel, LLC*

NASA ADVISORY COUNCIL**NASA Headquarters
Washington, DC****PUBLIC MEETING****April 9-10, 2015****Thursday April 9, 2015**Call 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 NASA Headquarters in Washington, D.C. She stated 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 and will be posted to the NASA web site, 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. All presentations and comments will be part of the public record. Time has been set aside the next day for public comments.

Opening Remarks by Council Chair

Ms. Rausch introduced Dr. Steven W. Squyres, Council Chair, who presided over the meeting. He 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.

Remarks by NASA Administrator

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

Mr. Bolden stated that he would not give his normal "speech" to the NAC; rather, because his time was limited, he would go through some of the highlights on NASA's current status so that he could more expeditiously address the Council's questions. He noted that NASA had formally responded to the NAC's two recommendations from the January 2015 meeting regarding the Asteroid Redirect Mission (ARM), and contractor travel to conferences, but invited questions from the Council if there were any remaining issues to be discussed. Mr. Bolden reminded that Council that they would be getting a briefing later in the meeting on the ARM and on some of the other Exploration topics.

Since the last meeting held at NASA Stennis Space Center on January 14-15, 2015, NASA has continued to push its key objectives of extending humanity's reach into space while strengthening America's leadership here on Earth. Last month, NASA Astronaut Scott Kelly and Russia Cosmonaut Mikhail Kornienko were launched on their one-year mission aboard the International Space Station (ISS). Mr. Bolden stated that he was privileged to have opportunity to spend some time with Astronaut Kelly and his crew at Baikonur before they launched. He noted that the visit also gave him an opportunity to hold his first face-to-face meeting with the new General Director of Roscosmos, Mr. Igor Komarov, who is a very interesting person – a very forward-looking, positive gentleman. Mr. Bolden observed that Mr. Komarov is different from the other heads of Roscosmos because, due to reorganization of the Russian space program, he now has almost everything related to space under his purview. He is not only responsible for the new space industry and the original, or "classic" Roscosmos, but also many of the medical and research institutes. Mr. Bolden reported that it was interesting to talk to him about what he sees for the future. Mr. Komarov made it very clear that despite where the Russian position was before, they are dedicated to supporting the

ISS through 2024. Mr. Bolden added that another big “takeaway” for him was Mr. Komarov’s interest in continuing to work with all of the international partners and even expanding the number of participants that are looking at the Global Exploration Roadmap. Mr. Bolden observed that this interest is a positive indication.

Last month’s successful Space Launch System (SLS) booster hot fire ground test in Utah was a major milestone. This was the first test of the five-segment solid rocket motor. In January 2015, the SLS RS-25 engine hot fire ground test was run successfully on the test stand at NASA’s Stennis Space Center (SSC) in Mississippi. In the science area, continuing research has suggested that a primitive ocean on Mars once held more water than the Earth’s Arctic Ocean. That discovery, in addition to discoveries finding evidence of water on more moons and other planets, excites people about the prospects of one day demonstrating that there may be some form of life elsewhere in the universe, if not in the Solar System.

Mr. Bolden highlighted Commander Barry Wilmore’s return from the ISS last month. Commander Wilmore had an incredible run as the ISS Commander – he was there for 167 days during his mission. During those times, he participated in several hundred science experiments and did several spacewalks that helped prepare the ISS to receive the commercial crew transportation vehicles that are scheduled for 2017. Perhaps more importantly, Commander Wilmore installed the first 3D printer on a spaceship and actually printed out some tools and other components. Those tools and components returned with him and are already in test at NASA’s Marshall Space Flight Center.

The SpaceX Dragon spacecraft returned about 3,700 pounds of cargo from the ISS, which again points out Dragon’s invaluable ability to both take cargo to orbit and bring it back. The returned cargo included many science and technology demonstration samples that were taken mainly during the time that Commander Wilmore was there.

Mr. Bolden remarked that a number of major milestones have been achieved by NASA’s Dawn mission. Several years ago the Dawn spacecraft orbited the asteroid Vesta in the Main Asteroid Belt, and last month Dawn reached its second destination, the dwarf planet Ceres. Dawn became the first spacecraft to achieve orbit around a dwarf planet.

New Horizons’ arrival at Pluto in July 2015 will be a momentous occasion. Mr. Bolden acknowledged that everybody on the Council knows about it and remarked that everyone who has anything to do with planetary science should be overjoyed, because it will mark a time when every single planet in orbit in the Solar System has been visited by a NASA spacecraft. Counting the Voyager interplanetary mission, NASA will not only have visited every planet in the Solar System, but will have a man-made object that is outside of the Solar System.

The Magnetospheric Multiscale (MMS) mission was launched last month. It is a constellation of four spacecraft on the first-of-a-kind mission to study magnetic reconnection. Mr. Bolden noted that magnetic reconnection is a process that is thought to be the catalyst for some of the most powerful explosions in our Solar System.

Mr. Bolden reported that scientists continue to learn more about the most important planet in the Solar System, Earth, notwithstanding the advice that NASA sometimes receives from Congress that NASA does not need to explore our planet. Scientists have recently determined that 2014 was the warmest year in modern history – at least since records started being kept in 1880.

Another recent launch was the Soil Moisture Active Passive (SMAP) mission. It has been collecting global observations of surface soil moisture, and it has already begun to produce results. Mr. Bolden noted that NASA’s Earth Science Division, along with a team of scientists, participated in two farm conferences, one in Iowa and one in Ohio, several weeks ago. At the Ohio conference, one of the participants commented that he did not realize that “NASA did that kind of stuff.” It was good for NASA to be there, Mr. Bolden observed. Mr. Bolden recounted that at the dinner with Council members the previous evening, there was a discussion about how wine farmers in California are able to take advantage of SMAP. The farmers are using data from missions like SMAP to determine exactly when to water a vine and how much to use so that the water is optimized. That is particularly important due to the current drought conditions in the West.

NASA has recently marked several historic milestones. Last month was the 100th anniversary of NASA’s predecessor organization, the National Advisory Committee for Aeronautics (NACA). This month is the 25th

anniversary of the launch of the Hubble Space Telescope. NASA Headquarters and every NASA Center around the country will be having a Hubble 25th Anniversary event on the 23rd or 24th of April.

In closing his remarks, Mr. Bolden mentioned that this would be the last Council meeting for Dr. David McComas, member of the Council and Chair of the Science Committee. He noted that would like to formally recognize Dr. McComas for his service on the NAC and the Science Committee at an appropriate time in the future.

Mr. Bolden then invited questions from the Council members. Mr. Wayne Hale asked Mr. Bolden to comment on the prospects for the Senate to confirm Dr. Dava Newman's appointment as NASA's Deputy Administrator. Mr. Bolden observed that he first met Dr. Newman when she was a principal investigator for the Space Shuttle. She is an incredible educator and will help in Science, Technology, Engineering, and Mathematics (STEM) and in STEM for women. He explained that it is a critical issue to find a way to recruit and retain women. Dr. Wanda Austin asked Mr. Bolden to comment on the challenges resulting from the directive to cease using Russian-made RD-180 engines. Mr. Bolden responded that NASA is working with the Air Force on finding ways to introduce a new, integrated system. United Launch Alliance (ULA) and Blue Origin, LLC, a privately-funded aerospace company owned by Amazon.com founder Jeff Bezos, have entered into an agreement to jointly fund development of Blue Origin's BE-4 rocket engine. Mr. Bolden encouraged continued patience to allow industry an opportunity to provide a solution. In response to a question from Mr. Thomas Young, Mr. Bolden explained that science missions are not affected by the prohibition against using the Russian rockets for national security payloads and that a request by NASA for clarification about the prohibition would not be necessary.

Dr. Scott Hubbard noted that Senator Barbara Mikulski has announced her retirement, and asked Mr. Bolden for his insights on how that would affect NASA. Mr. Bolden responded that there is strong bipartisan support for NASA in Congress. He acknowledged that there are "strong drum-beats" against Earth science, particularly in the House Science Committee, where there has been a growing mantra opposing Earth science and climate change studies. He noted that NASA has been working with the western U.S. states to let them know what data are available that might help them with the current drought problem. Dr. Hubbard expressed concerns regarding high levels of secrecy at Blue Origin. Mr. Bolden explained that NASA provides some funds and advisory assistance to Blue Origin pursuant to a NASA Space Act Agreement (SAA) awarded under the Commercial Crew Development Round 2 (CCDev2) initiative. NASA has limited insight; however, that is typical of the way that NASA is working with all the entrepreneurial companies. He expressed belief that NASA has sufficient insight, particularly because NASA operates the test stand system.

Mr. Miles O'Brien asked Mr. Bolden to comment on NASA's public messaging about the Evolvable Mars Campaign (EMC). Mr. Bolden explained that he is never satisfied with messaging and that he is bothered by the fact that NASA's work is appreciated by less than one percent of the public. He explained that the more NASA promotes STEM with NASA content, the more people will understand what NASA does. He noted that NASA's Chief Scientist, Dr. Ellen Stofan, devotes much of her time to developing STEM and STEM for women.

Dr. Squyres asked Mr. Bolden for his perspective on NASA's decision that the ARM should pursue Option B, which calls for lifting a large boulder from the target asteroid. Mr. Bolden explained that the NAC had recommended using the ARM to demonstrate progress in learning to operate in a low or no gravity environment and that Option B would demonstrate that better than Option A. Dr. Squyres observed that another advantage to Option B is that a smaller boulder can be plucked if performance of the solar electric propulsion stage falls short of current projections.

Mr. Bolden concluded his remarks by counseling that one of the lessons on leadership he learned many years ago that if one is going to lead people, one must pick a path and go, making changes along the way. He then stated: "The place we want to go is Mars."

Dr. Squyres thanked Mr. Bolden for his time and remarks.

The President's Fiscal Year 2016 Budget Request for NASA

Dr. Squyres noted that the annual Council meeting at NASA Headquarters is the time each year when the Council hears about NASA's new budget. He then introduced Mr. Andrew Hunter, Deputy Chief Financial Officer, Budget

and Performance, NASA Headquarters. Mr. Hunter observed that a year and a half ago he would have said that the picture looked bleak for NASA's FY 2015 budget. Subsequently, "a miracle occurred," and Congress came forth with an \$18 billion (B) budget for NASA. That provided stability and encouraged NASA's stakeholders.

Mr. Hunter described the various budget cycles. He noted that for fiscal year (FY) 2014, NASA received a clean audit for the fourth year in a row, which gains NASA credibility with its stakeholders. Congress is deliberating the FY 2016 NASA budget request under budget resolution dynamics. FY 2017 Strategic Budget guidance has been released, and NASA programs are formulating plans in accordance with that guidance. Mr. Hunter reviewed management considerations for the current environment. He noted that NASA has to drive out uncertainty in its mission planning. There is a path, and the uncertainty gap has to be narrowed down so that NASA does not have to carry budgets to cover all alternatives. The President's second term, management-agenda priorities were reviewed. A chart was presented showing NASA's overall buying power in constant dollars from FY 2005 through predictions for FY 2020. Mr. Hunter observed that NASA's budget "doesn't look good when one looks at the value that those dollars can buy." He noted that NASA's overall budget has experienced a steady decline in real dollars since FY 2009. He explained that civil service dollars keep escalating at more than three percent per year, which means that there are fewer funds for contractors. Graphs on budget enactments for NASA's major programs from FY 2009 through FY 2016 were shown. Mr. Hunter commented that Space Technology "is a sad tale." He cautioned that new programs are difficult to establish. In response to a comment from Dr. William Ballhaus, Mr. Hunter agreed that procurement dollars in the Space Technology Mission Directorate (STMD) budget are "squeezed" due to mandatory increases in funding for Small Business Innovation Research/Small Business Technology Transfer (SBIR/SBTT) programs.

Mr. Hunter reviewed a chart on Cost Performance Improvement. He discussed highlights in the FY 2016 budget. He noted that the \$18.5B budget for FY 2016 builds on U.S. preeminence in science and technology, improves life on Earth, and protects the home planet, while creating jobs and strengthening the American economy. He explained that the budget provides for extending operation of the ISS to at least 2024. A chart on anticipated accomplishments in FY 2016 was presented. The President's FY 2016 Budget Request was reviewed and contrasted to the FY15 Enacted Budget. Program changes were described.

Mr. Young thanked Mr. Hunter for a good presentation and remarked that the "clear macro strategy" is to take funding away from Science and Exploration and apply it to Commercial. That is a strategic issue, Mr. Young explained, that should be highlighted. Mr. Hale observed that the whole intent of commercial space flight is to "get NASA out of the business." He added that NASA will eventually be paying Russia \$75 million (M) to \$80M per seat to fly astronauts to the ISS. Mr. Young suggested that it would be cheaper to continue to purchase Russian seats indefinitely. Dr. Squyres advised that the most significant and fundamental problem, which is not apparent from the FY 2016 budget chart, is that there is too much program for not enough budget. Dr. Hubbard cautioned about the need to consider a strategic budget planning issue. He explained that the hope had been that funds would flow to the Exploration program as the Space Shuttle program was phased out. It is a leadership and management challenge to make sure that the hopes come true.

Mr. Hunter concluded his presentation with a chart showing all upcoming NASA mission launches for FY 2015 through FY 2020.

Dr. Squyres thanked Mr. Hunter for his presentation.

NASA Human Exploration Strategy

Dr. Squyres introduced Mr. William Gerstenmaier, Associate Administrator for Human Exploration and Operations Mission Directorate (HEOMD), NASA Headquarters.

Mr. Gerstenmaier discussed NASA's current strategy for going to Mars. A chart entitled "Journey to Mars" was presented. He explained that the "swirls" on the chart are intended to show that the mission is more than a HEOMD strategy; it also includes the Science Mission Directorate (SMD) and the Space Technology Mission Directorate (STMD). He emphasized the importance of the chart's lower section; it shows three phases of the strategy: Earth Reliant, Proving Ground, and Earth Independent.

A chart describing principles for sustainable exploration was presented. The principles are:

- 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; and
- Substantial international and commercial participation, leveraging current ISS and other partnerships.

Dr. Hubbard advised that the strategy must be executable as well as implementable, and that there is a need to use independent cost estimates, because the “sticker shock” from the estimates will be an important influence. Mr. Gerstenmaier stated that it is hard to evaluate the cost for many things in the Mars program realistically. Dr. Hubbard noted that “sanity check” is a great phrase. Mr. Gerstenmaier explained that main-line projects should not have to wait for low TRL projects to be infused.

The recently launched ISS One-Year Mission was described. Astronaut Scott Kelly and Cosmonaut Mikhail Kornienko will be on board the ISS for 12 months – the longest mission ever assigned to a U.S. astronaut. Mr. Kelly’s twin, retired Astronaut Mark Kelly, will be included in the studies conducted for the mission. The twins provide an unprecedented opportunity to research the effects of space flight on twin genetic makeup and to better understand the impact that space flight has on the human body. Dr. Squyres advised that twins’ genomes diverge over time, and he asked whether the Kelly genomes have been characterized. Mr. Gerstenmaier responded that a full genomic makeup has been established for the twins. Dr. David Spergel asked whether there were plans to study genomic changes using animal models over generations. Mr. Gerstenmaier answered affirmatively, noting that fruit flies, plants, and rodents would be studied using tools and instruments commonly employed by the scientific community. In response to a question from Mr. Hale, Mr. Gerstenmaier explained that the one-year increment will make more crew seats available and that NASA is debating the advantages and disadvantages to having more one-year increments.

Mr. Gerstenmaier reviewed the status of the Commercial Crew Program (CCP). NASA recently awarded Commercial Crew transportation Capability (CCtCap) fixed price contracts to Boeing and SpaceX. He noted that CCtCap was the second phase of a two-phase acquisition strategy. The first phase was the Certification Products Contracts (CPCs). Boeing and SpaceX have successfully completed their initial milestones, including the mandatory Certification Baseline Review. Mr. Gerstenmaier noted that the commercial crew transportation systems are very complex and that the development and test activity planned over the next three years will be extremely challenging. The FY 2016 President’s Budget Request for CCP is \$1.2B, which supports the CCtCap contracts and keeps things on track toward the goal of returning human space flight launches to U.S. soil by the end of 2017. He noted that if NASA does not receive the full requested funding every year, down-selecting to one provider would not be possible, and NASA would have to delay the milestones for both partners proportionately, extending sole reliance on Russia for crew access to the ISS.

Mr. Gerstenmaier discussed the Evolvable Mars Campaign (EMC). Its goal is to define a pioneering strategy and operational capabilities that can extend and sustain human presence in the Solar System, including a human journey to explore the Mars system starting in the mid-2030s. Mr. Young asked whether money was in the NASA budget for going to Mars. Mr. Gerstenmaier responded that there is a notional budget through 2016 and that there are sufficient funds through the notional program. Mr. Young questioned whether it could be accomplished within a current budget that is not growing. Mr. Gerstenmaier responded affirmatively, with industry and international partners to augment the budget. Mr. Hubbard asked who is responsible for making trade-space balancing decisions. Mr. Gerstenmaier explained that it is not HEOMD acting in isolation, but rather there is a loose management group at NASA Headquarters that acts as a board of directors.

Proving Ground objectives for enabling human missions to Mars were described. A chart showing major results to date was presented. Mr. Young remarked that one option to consider is deciding that NASA should not go to Mars and to use the resources for something else. He added, “The transition team for the next Administration will have a tremendous effect upon NASA, as did the last one.” Mr. Gerstenmaier explained that NASA needs a sustainable approach that enables it to move forward toward the overarching goal. A chart on EMC ground rules and constraints were discussed. Mr. Gerstenmaier noted that sending humans to the Mars system could imply orbital missions, Phobos or Deimos, or Mars’ surface. He indicated that an SLS/Orion launch rate of one per year would be sustainable after Exploration Mission-2 (EM-2).

Mr. Gerstenmaier reviewed a series of EMC questions being examined in FY 2015 by NASA working groups. He noted that they are working to identify a plan that identifies ways to leverage investments in ISS, SLS, Orion, the ARM, and an Exploration Accommodation Module (EAM). Dr. Squyres commented that he is encouraged to hear about the development of the EAM. A chart was presented on SLS Block 1B and mission element concepts that are under study.

Mr. Gerstenmaier briefed the Council on the ARM and the Asteroid Redirect Robotic Mission (ARRM). He explained that the ARM has been instrumental in identifying the potential of Solar Electric Propulsion (SEP) and Distant Retrograde Orbits (DROs) around the Moon for efficiently transporting large masses in space. The ARRM is in the Mission Concept Review (MCR) phase. The MCR Board is chaired by Mr. Robert Lightfoot, NASA Associate Administrator. The concept for a split-propulsion mission, where SEP would be used to transport cargo separately from crew, was described. A chart on SEP Module Extensibility for Mars was discussed. Dr. Squyres remarked that the chart was helpful in clarifying issues.

Mr. Gerstenmaier discussed the EMC *In Situ* Resource Utilization (ISRU) strategy. Multinational involvement is expected based on expertise and the long-term objectives. Dr. Spergel asked whether it would be open to the broader international community. Mr. Gerstenmaier responded that that would be open after discussions with the four ISS Partners. Dr. Spergel asked whether it would be permissible to mention the “C” word – China? Mr. Gerstenmaier declined to respond.

A chart was presented to show the table of contents for a new booklet to be published, entitled “Pioneering Space: Progress and Next Steps on the Journey to Mars.” Mr. Borghese asked whether a radiation source for propulsion was being considered. Mr. Gerstenmaier responded that it was not being considered because it would require another large development activity. Mr. Gerstenmaier concluded his presentation with a quotation from President Obama’s April 15, 2010, speech at NASA Kennedy Space Center:

Fifty years after the creation of NASA, our goal is no longer just a destination to reach. Our goal is the capacity for people to work and learn and operate and live safely beyond the Earth for extended periods of time, ultimately in ways that are more sustainable and even indefinite. And in fulfilling this task, we will not only extend humanity’s reach in space – we will strengthen America’s leadership here on Earth.

Dr. Squyres thanked Mr. Gerstenmaier for his presentation.

Discussion on NASA Space Flight Program and Management Requirements (NPR 7120.5E) and Program Affordability/Sustainability

Dr. Squyres introduced Mr. Robert Lightfoot, NASA Associate Administrator, Mr. Ralph Roe, NASA Chief Engineer, and Ms. Sandra Smalley, Science Mission Directorate, NASA Headquarters.

Mr. Lightfoot explained that Mr. Roe, as NASA’s Chief Engineer, has full responsibility for the NASA Procedural Requirements (NPR) 7120.5E document. Mr. Roe noted that Ms. Smalley was instrumental in drafting the document and turned the presentation over to her. Ms. Smalley described the key overarching program and project management principles. She explained that program and project management is based on a life-cycle with key decision points for each phase supported by life-cycle reviews (LCRs). NPR 7120.5E requires the use of a single, independent review team called the Standing Review Board (SRB) to conduct LCRs. A designated decision authority decides transition through the life cycle with review by a governing Program Management Council (PMC). She noted that NPR 7120.5E is an evolving document. It is designed to be “tailored,” as necessary, for specific

purposes. Ms. Smalley acknowledged that there are challenges with the tailoring process, but not with the underlying policies.

Mr. Ken Bowersox inquired as to the responsibility and accountability of Center Directors for program execution. Ms. Smalley responded that the Project Manager is ultimately responsible for a project or mission, with oversight by the Center Director. Mr. Young suggested that that is a weak definition for a Center Director's responsibility. Dr. Ballhaus remarked that the governance "used to be clean," and that the Associate Administrator (AA) controlled the major milestones. That changed over time, and by the time of the James Webb Space Telescope (JWST), there was considerable confusion. He advised that clear lines on communication and accountability are needed. Mr. Borghese asked how management is structured when multiple Centers are involved in a project. Mr. Lightfoot responded that the PMC works under Mr. Gerstenmaier's oversight, and any issues that the PMC cannot resolve are referred to him (Mr. Lightfoot). Mr. Young advised that the PMC can be valuable in communicating, but cannot be accountable for execution because it is not where the authority resides.

Ms. Smalley discussed the distinction between Programmatic Authority and Institutional Authority. She noted that Institutional Authority is further divided between Technical Authority and Mission Support. Programmatic Authority resides with the Mission Directorate and its respective programs and projects. Institutional Authority resides with Headquarters and associated Center organizations. There are three Technical Authorities: Engineering, Safety and Mission Assurance, and Health and Medical. Mr. Bolden interjected that anyone can come to him directly if they see a problem. Dr. Ballhaus, noting that decisions have to be made at a level high enough to mitigate risks and with sufficient resources to mitigate those risks, asked Ms. Smalley to describe how NASA assures a culture of accountability. Ms. Smalley responded that it is assured by the SRB process, where decisions are either reached by consensus or elevated. Mr. Borghese observed that most organizations are good at identifying risk, but funding risk mitigation is much more difficult. Ms. Smalley replied that NASA projects carry a lien to fund potential risks. Mr. Young commented that SRBs are not very valuable for programs with major problems and cited JWST as an example. Dr. Squyres recalled that the SRB on his Mars Exploration Rover project, just by its existence, made everyone work harder.

Mr. Hale commented that the tailoring process is so difficult that many project managers do not attempt it. Mr. Roe suggested that a tiger team should be provided to help people through the process. Dr. Ballhaus stated that diffused authority presents a challenge because there is often no single channel to go to for decisions. Mr. Roe acknowledged that 7120 has many requirements owners and that it is too difficult to go to each one.

Dr. Squyres thanked Ms. Smalley for her presentation.

Human Exploration and Operations Committee Report

Dr. Squyres introduced Mr. Kenneth Bowersox, Chair, Human Exploration and Operations (HEO) Committee. Mr. Bowersox described the current Committee membership. He presented HEOMD's organization chart. Major events since the last meeting involving ISS, Commercial Crew, Orion, and Advanced Exploration activities were reviewed. He briefed the Council 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 43 and Increment 44 were discussed.

A chart showing the status of ISS consumables was reviewed. In response to a question from Mr. Borghese, Mr. Bowersox explained that if there was a problem with the next cargo delivery flight by SpaceX, there would be a re-allocation on the following cargo flight, and materials for science activities would be off-loaded and replaced with cargo. Mr. Bowersox discussed a chart showing crew utilization time for ISS Increments 43-44. He described advancements by the NASA Microencapsulation Processing System (MEPS) team towards the development of chemical markers for future FDA approval. A graphic describing an approach to Revolutionize ISS for Science and Exploration (RISE) was presented.

Mr. Bowersox briefed the Council on the CCP. The Boeing and SpaceX concepts for commercial crew capsules were described. The Boeing capsule can carry four people, while the SpaceX capsule may carry more than four people. He explained that Soyuz can carry only three people and that the additional seats controlled by NASA through the CCP would give NASA additional bartering leverage. Various flight test programs were described.

Mr. Bowersox cautioned that the commercial crew transportation systems are very complex and that things most likely will not go as expected. Both Boeing and SpaceX are scheduled to fly crew to the ISS in 2017.

Mr. Bowersox described the ARM. He noted that the ARM enables NASA to utilize the following capabilities needed for future exploration purposes:

- Advanced high-power, long-life, high throughput SEP;
- Autonomous rendezvous and proximity operations;
- Capture and control of non-cooperative objects;
- Rendezvous and docking systems;
- Deep space trajectory and navigation methods;
- Advanced crew extra-vehicular activity (EVA) technologies and techniques;
- Crewed sample collection and containment;
- Demonstration of basic asteroid deflection techniques that will inform future planetary defense approaches; and
- Opportunities for science and partnership interests, such as *in-situ* resource utilization and follow-on use of the SEP based spacecraft.

Mr. Bowersox observed that where there is a mission, technology development advances better. A graphic showing an ARRM concept for the capture module was presented. Dr. Squyres advised that science would be better served if several small rocks were captured, rather than one homogeneous boulder.

A new planned NASA publication was described, to be entitled, "Pioneering Space: the Evolvable Mars Campaign." Mr. Gerstenmaier explained that it would be a public document and would show the "plan for the plan." Mr. Bowersox presented a chart on the goal for the EMC. The goal is to define a pioneering strategy and operational capabilities that can extend and sustain human presence in the Solar System, including a human journey to explore the Mars system starting in the mid-2030s. A graphic showing the Mars Split Mission concept was discussed. Lander payload options were described. Different alternatives for the first short-stay mission could require one to four landers. Mr. Bowersox discussed a graphic on cis-lunar space, showing how Earth and the Moon interact to create bends in the energy contours that can be used to lower the energy needed to move around the Earth-Moon system and beyond. The lunar DRO leverages the equilibrium and low energy contours to enable a stable orbit with respect to Earth and the Moon. A chart was presented on SEP Module Extensibility for Mars.

Mr. Bowersox described a joint briefing given to the HEO and Science Committees on the space radiation risks to humans on a flight to Mars. The space radiation challenge comes from two sources: galactic cosmic rays (GCR) and solar particle events (SPE). The SPE are easier to shield against and may not require much hardware to mitigate. GCR are more difficult to shield against and are long-term, cancer inducing risks. Post-mission and in-mission risks were identified. Current space flight health standards were reviewed. A chart was discussed showing the post-mission cancer risk for a 900-day Mars mission. Dr. Squyres remarked that exposing astronauts to the radiation risks has become primarily an ethical issue, because the risks might not be mitigated sufficiently. Mr. Borghese stated that a flight to Mars would be a risky endeavor regardless of radiation, because there is some probability that the crew might not make it back. Dr. Squyres cautioned against avoiding the ethical issues; he suggested there could be value in a statement that "radiation risks have been well studied, they are not small or trivial, and it is worthwhile to continue to investigate mitigation of the risk and the ethical issues." He advised that the risk can only be expressed as a percent increase in developing cancer later in life. Mr. Young stated that the radiation risk "sounds like a show stopper."

Mr. Bowersox described a Committee fact-finding session on NPR 7120.5E. He presented a proposed Council recommendation calling for NASA to examine the current approach for tailoring mandatory NASA management requirements. After discussion, the proposed recommendation was tabled to afford Mr. Roe an opportunity to review the tailoring process himself and make appropriate changes.

Dr. Squyres thanked Mr. Bowersox for his presentation.

Council Discussion

Dr. Squyres raised two subjects for potential findings or recommendations. The first subject was whether NASA should provide health care to astronauts throughout their life. The Council's consensus was that health care should be provided by NASA to astronauts throughout their life. The second subject was whether NASA should continue to pursue the ARM. Dr. Squyres expressed the opinion that resources allocated to robotically acquiring a boulder from an asteroid would contribute more directly to the goal of sending humans to Mars if they were devoted instead to other elements that would be useful in a Mars campaign. Dr. Ballhaus commented that SLS and Orion are budget priorities and that the budget is insufficient to do the technology maturation needed for Mars, as well as SLS and Orion. Mr. Hale advised that technology development without a mission is a target in the budget cycle. Dr. Ballhaus quipped that, unless needed for a mission, technology cuts "do not bleed." Dr. Squyres noted that the Origins Spectral Interpretation Resource Identification Security Regolith Explorer (OSIRIS-REx) is a planned NASA asteroid study and sample return mission that is intended to return 60 grams of matter. He suggested that spending only \$1.25B "to relocate a rock" with a mass of hundreds of metric tons using a new high performance solar electric propulsion system does not stand up to scrutiny given that OSIRIS-REx is already going to perform a far simpler mission for \$800M. Dr. Squyres acknowledged, however, that the ARM has forced NASA to learn about SEP's value.

Dr. Squyres noted that the Council's consensus was that executing the ARM for \$1.25B probably would not be credible, and that the funds should be put into a mission that would be needed for Mars exploration and that would utilize SEP. Phobos might be a good destination for a return sample mission. He assigned to Mr. O'Brien, Mr. Young, and himself the task to draft a finding.

Institutional Committee Report

Dr. Squyres introduced Ms. Kathryn Schmoll, Chair, Institutional Committee. Ms. Schmoll reviewed the Committee's membership and the Committee Work Plan.

Ms. Schmoll discussed 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.

A chart describing the Institutional Committee's March 2015 meeting topics was presented. Ms. Schmoll reviewed Committee observations from that meeting. The Committee commended the Human Capital Leadership Development Program for presenting a positive message with a strong focus on innovation. The Committee also commended Protective Services for its inclusiveness and collaboration.

Ms. Schmoll presented a chart showing NASA's top 10 domestic partners with active SAAs. She noted that private industry is the largest segment, while the Department of Defense (DoD) is by far the largest single partner. A recent NASA phishing exercise was described. A graph was presented showing how senior management visibility leads to fewer employees being fooled by phishing. Ms. Schmoll concluded her presentation by describing the topics on which detailed briefings have been requested for future Committee meetings.

Dr. Squyres thanked Ms. Schmoll for her presentation.

Technology, Innovation and Engineering Committee Report

Dr. Squyres introduced Dr. William Ballhaus, Chair, Technology, Innovation and Engineering Committee. Dr. Ballhaus reviewed the last Committee meeting and presentations given at that meeting. He discussed a chart on Agency leadership and NASA Technical Fellows. He explained that the recent selection process in the Office of Chief Engineer (OCE) for Technology Fellows resulted in only one female out of 15 Fellows. Mr. Ballhaus

presented a proposed Council finding on NASA workforce gender diversity. The finding was approved by consensus, with the language to be finalized into the Council's standard format by Dr. Ballhaus and Ms. Rausch. The finding provides:

The recent Office of Chief Engineer Tech Fellows selection resulted in only 1 female out of 15 Fellows. The Council finds that a gender diversity issue extends beyond the Office of Chief Engineer Tech Fellows. There is a need for NASA to follow best practices for future selections and to determine what additional steps should be taken to effect a more gender-diverse workforce.

Supporting data:

- *Out of 138 Science and Engineering ST/SL, 86% are male*
- *For Science and Engineering SES, 81% are male*
- *For Science and Engineering GS-15, 75% are male*

Dr. Ballhaus discussed the impact on the STMD program from budget reductions. He explained that the STMD budget has also been adversely impacted by Congressionally mandated funding for two programs: SBIR and SBTT. STMD is obligated to carry those programs in its budget and has no discretion over their funding. A graphic showing a diminishing number of major STMD events and milestones over time was reviewed. The impacts on the STMD program from the budget reductions were discussed. Approximately \$30M less is available to the NASA Center Innovation Fund for procurement. That eliminated the NASA Centers' abilities to conduct larger technology initiatives that leverage Center talent and capabilities. Dr. Ballhaus presented a proposed Council finding that STMD lacks sufficient discretionary resources to deliver all the technology developments required across the TRL spectrum to meet NASA's future mission goals. Dr. Squyres noted that the Council had not in the past sent the NASA Administrator a finding that a particular NASA segment was underfunded. He asked whether STMD's funding requirements were important enough that STMD should be singled out for additional funding. Mr. Bowersox remarked that this situation was a leading indicator to show that there is not enough money to go to Mars. Dr. Squyres cautioned that having the Council approve one committee's finding that its area of interest is underfunded could lead to an inference that additional funding is not needed in other areas. Mr. Young commented that the combined funding on technology in the near-term is inadequate for making acceptable progress to Mars. At Dr. Squyres' request, Dr. Ballhaus agreed to attempt to revise the proposed finding to account for the concerns that had been expressed and to present the revised finding to the Council later in the meeting.

Dr. Ballhaus provided the Council with an overview on the SBIR/STTR program. He explained that the 1982 Small Business Innovation Development Act requires that Federal agencies must have an SBIR program if the agency has \$100M in extramural research and must have an STTR program if the agency has \$1B in extramural research. The programs' goals are to:

- Stimulate technological innovation;
- Meet Federal research and development needs;
- Foster and encourage participation in innovation and entrepreneurship by socially and economically disadvantaged persons; and
- Increase private-sector commercialization of innovations derived from Federal research and development funding.

A chart showing NASA's SBIR/STTR portfolio was reviewed. Dr. Ballhaus presented for the Council's information two Committee findings on SBIR/STTR for the STMD Associate Administrator. The first finding addressed the impact of congressionally mandated SBIR/STTR funding increases. Dr. Ballhaus agreed to convert the finding, with assistance from Ms. Rausch, into the Council's standard format. The finding provides:

The Technology, Innovation and Engineering Committee finds that the SBIR/STTR management/budgets are consolidated and well managed in the NASA Space Technology Mission Directorate (STMD). However, as the STMD planned budget increases have not materialized, and as SBIR/STTR allocations have increased as mandated by Congress, STMD's primary programs have been severely impacted.

Supporting data:

	<u>FY 2012</u>	<u>FY 2015</u>
- Total STMD Budget	\$574M	\$596M
- SBIR/STTR	\$172M	\$191M
- Core Space Tech Programs	\$402M	\$405M

The second finding notes that SBIR/STT proposals would be enhanced by conducting pre-solicitation interactions with industry to define NASA technology needs and priorities. After discussion, Dr. Ballhaus agreed to bring that finding back as a Council recommendation after the Committee considers the cost for implementation. Dr. Squyres noted that the Council would use findings: (i) when it would want to make a statement on something that is important, but contrary to directions that had been given to the Agency; or (ii) when there is an insufficient basis for submitting the proposal as a recommendation.

Dr. Ballhaus described NASA's Technology Portfolio System (TechPort), which is a comprehensive resource for locating information about NASA-funded technology development activities. TechPort enables the public to explore NASA's technology portfolio and learn about technology programs and projects. He discussed progress on the update to the NASA Technology Roadmap. The update will incorporate advances in technology development and new needs in the Human Exploration, Science, and Aeronautics missions. A chart summarizing activity in the Technology Transfer Program was presented. In response to a question, Dr. Ballhaus remarked that the cost to obtain patents is greater than the cost covered by the royalty stream. He presented a chart demonstrating the increase in the number of new patent licenses. He described the STMD Centennial Challenges Program. This Program is unique because it uses Congressionally appropriated funds to competitively award cash prizes to stimulate innovation. Dr. Ballhaus concluded his presentation with a chart summarizing STMD's key milestones in 2015-16.

Dr. Squyres thanked Dr. Ballhaus for his presentation.

Aeronautics Committee Report

Dr. Squyres introduced Mr. John Borghese, Vice-Chair, Aeronautics Committee. Mr. Borghese reviewed the areas of interest explored at the Committee's last meeting and the Calendar Year (CY) 2015 Committee Work Plan. He discussed the FY 2016 Aeronautics Research Mission Directorate (ARMD) budget. A chart was presented on major changes in the budget. Funding has been increased for flight demonstrations to show additional efficiency and environmental benefits for future aircraft, developments to enable safe operations of Unmanned Aircraft Systems (UAS), low-carbon propulsion research, fundamental hypersonics research, and research to generate breakthrough new ideas. He presented a chart showing that NASA is leading the world in UAS integration research. Mr. Borghese noted that there is continued success in transitioning NextGen Air Traffic Management (ATM) technologies to the Federal Aviation Administration (FAA).

Mr. Borghese described the Safety Program Reorganization Strategy. The ARMD vision is to: (i) pursue innovative solutions in all programs aligned to the ARMD Strategic Thrusts; and (ii) enable all programs to clearly define the most compelling technical challenges and retire them as supported or required by stakeholders. He presented to the Council for its information a Committee finding on aviation safety research for the ARMD Associate Administrator. The finding provides:

The Committee endorses the approach that ARMD has taken to maintain its commitment to Aviation Safety research even though it will no longer exist as a standalone program in the current organization restructure. The Committee finds that ARMD has taken a thoughtful approach to embed Aviation Safety research across the other programs, and has maintained those areas especially critical to national needs, such as research in verification and validation.

Mr. Hale questioned whether removing safety independence was a good choice.

Mr. Borghese discussed the Aeronautics Investment Strategy. It has six strategic thrusts:

- Safe, efficient growth in global operations;
- Innovation in commercial supersonic aircraft;
- Ultra-efficient commercial vehicles;
- Transition to low-carbon propulsion;
- Real-time system-wide safety assurance; and
- Assurance of autonomy for aviation transformation.

ARMD's 10-year investment strategy was described. The reason for a 10-year investment strategy is to (i) forecast programmatic and budgetary trends, allowing for better workforce and facility planning; and (ii) better capture dynamics of strategic investment plans. A chart showing strategic thrust outcomes for 2015, 2025, and 2035 was reviewed. Mr. Borghese presented to the Council for its information a Committee finding on the strategy for the ARMD Associate Administrator. The finding provides:

The Committee strongly supports the strategic approach toward research portfolio management that ARMD has put in place and as reflected by the ARMD Strategic Implementation Plan (SIP). The Committee finds that the SIP is extremely well thought out and forward leaning, and will enable ARMD to approach research portfolio management in a more comprehensive and deliberate manner. In particular, the Committee feels that the SIP addresses the broad range of research efforts in the ARMD portfolio in a balanced manner including both fundamental and integrated research as well as research targeted toward more specific solutions sets such as rotorcraft and supersonic aircraft.

Mr. Borghese discussed the Innovation in Commercial Supersonic Strategic Thrust. A graphic was presented on overcoming the barriers to practical high-speed vehicles. There are both environmental barriers and efficiency barriers. The environmental barriers are sonic boom, airport noise, and high altitude missions. The efficiency barriers are airframe and propulsion, light weight vehicles that are durable, and operations. Mr. Borghese noted that solutions to barriers would drive the selection of research themes. Recent supersonic flight research was described. He discussed a future supersonic low-boom flight demonstration. There would be two requirements: (i) demonstrate that sonic booms can be reduced to a level acceptable for the population, and (ii) create a community response database and develop a noise-based rule for supersonic over-flight. Mr. Borghese explained that NASA is in a position to lead the effort, but industry, regulatory, and community support and partnership would be needed for success.

The FAA certification process was discussed. Mr. Borghese noted that increased regulations by the FAA have hindered and jeopardized the transition of NASA innovation to production. Based on the number of documents that have to be submitted, the effort for certification has doubled between 2005 and 2014. This is causing young engineers, who do not view certification efforts as innovation, to leave the industry. Mr. Borghese concluded his presentation with a chart showing how increasing regulation is inhibiting innovative design for aircraft electronics. The chart stated that certification causes manufacturers to propose what solutions that have been certified in the past, not what is the most effective approach.

Dr. Squyres thanked Mr. Borghese for his presentation.

Adjournment

The Council meeting was adjourned for the day at 5:45 pm.

Friday, April 10, 2015Call 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.

Opening Remarks by Council Chair

Dr. Squyres welcomed everyone back to the second day of the meeting. He noted disappointment that the agenda would not allow time for a favorite part of the meeting – hearing from early career NASA scientists and engineers.

Public Input

Dr. Squyres invited comments from the public. There were no comments.

Science Committee Report

Dr. Squyres introduced Dr. David McComas, Chair, Science Committee. Dr. McComas reviewed the Committee membership. He described recent results from science missions. Solar TERrestrial RELations Observatory (STEREO) - A and STEREO - B, together with near-Earth spacecraft data, have shown that approximately one third of the solar energetic particles arriving at Earth originate on the opposite side of Sun. The Van Allen Probes have tracked an interplanetary shock through the inner magnetosphere. A chart on a possible resolution to a Ulysses-IBEX enigma was presented. The Global Precipitation Measurement (GPM) Microwave Imager (GMI) observed extreme rates of almost 100.9 mm (almost 4 inches) rain per hour on the southern side of Super Typhoon Hagupit's eye as it approached the Philippines. New indicators of climate change have been revealed by leveraging NASA remote sensing resources. Space-borne measurements have been used to improve air quality decision support systems for Texas. NASA's Dawn probe has begun orbiting the dwarf planet Ceres. A short video was presented showing Pluto-Charon as a rotating binary planetary system. NASA researchers, using three ground-based infrared telescopes on Earth to study the remaining water molecules in the Martian atmosphere, have estimated that today Mars has only 13 percent of the water it once had. NASA's Chandra has detected a record-breaking outburst from the Milky Way's Black Hole. NASA's Kepler has made its 1,000th exoplanet discovery.

Dr. McComas discussed the President's proposed budget for FY 2016 as it pertains to the Science Mission Directorate. The budget:

- Provides for a sustained land imaging capability beyond Landsat 8;
- Supports the Mars 2020 mission and formulation of a potential Europa mission;
- Increases efforts to detect and study near Earth objects (NEOs);
- Enables release of a New Frontiers Announcement of Opportunity (AO) in FY 2016;
- Increases collaboration with NASA's STMD; and
- Implements the revised and competed STEM education program to ensure that the most meritorious activities within SMD are supported.

Dr. McComas noted that significant work and funding for that work had been shifted in the budget to NASA from the National Oceanic and Atmospheric Administration (NOAA). He remarked that Dr. John Grunsfeld, SMD Associate Administrator, has reiterated his full support for Heliophysics as a critical, independent Directorate. Slides were presented to show the launch and deployment of the MMS mission, which will study how magnetic fields around Earth connect and disconnect, explosively releasing energy via a process known as magnetic reconnection. A graphic was presented on the Heliophysics System Observatory. Dr. McComas discussed the first image from a test of the radar instrument on NASA's SMAP satellite. The President's FY 2016 Budget Request for Planetary Science was reviewed. Dr. McComas explained that the budget increases funding for the Near Earth Objects (NEO)

Observation Program to accelerate hazardous asteroid detection and characterization. He reviewed a chart from the Joint Agency Satellite Division (JASD) showing reimbursable launch commitment dates.

Dr. McComas proposed a Council recommendation on returned extraterrestrial samples. The Council approved it unanimously. The finding provides:

The Council recommends that NASA establish a requirement for retention of a large fraction (e.g. 75% has been used historically) of the samples obtained by all sample return missions, robotic and human, for future scientific studies.

Dr. McComas presented a proposed Council recommendation on NASA contractor participation at scientific conferences. Dr. Squyres noted that the Council had previously approved this same recommendation because there was a serious problem, a “self-inflicted wound,” standing in the way of scientists attending conferences that would be beneficial to the Agency for them to attend. NASA had responded that it was not a problem. Mr. Borghese asked whether there was hard data to support the contention about the problem. Dr. McComas stated that there was no data, but that the damage could be estimated. Mr. Young commented that the problem with NASA’s response was that it had not been reviewed at a senior level. Dr. Squyres reported that the NASA response had arrived only a few days before the NAC meeting, giving him no time to discuss the response with Mr. Bolden. Dr. Spergel commented that the issue affects scientists’ lives and morale. Dr. McComas added that the recommendation was in response to a recommendation from NASA’s Inspector General (IG). Dr. Squyres stated that the success of space science missions depends on disseminating results to space scientists. At his request, Dr. McComas agreed to revise the recommendation to stress the importance of successfully demonstrating the distribution of science to scientists around the world.

Dr. McComas presented a proposed Council finding developed jointly by the HEO Committee and the Science Committee on successful collaboration between the HEOMD and the SMD. Dr. Squyres noted that the finding is a positive endorsement of the NAC’s reorganization. The Council unanimously approved the finding, which states:

Through the series of joint meetings that the NAC HEO and Science committees have had, we have seen productive collaboration between science, engineering and operations within NASA, and also between NASA and academia. We find that this collaboration leads to broader understanding and better outcomes for both Human Exploration and Science. We see opportunity for more synergy, and encourage enhanced and more formal and informal collaboration between these organizations.

Dr. McComas presented for consideration a Council recommendation on the need for NASA to communicate openly about the radiation risks to humans on missions to Mars. He described a joint meeting on this issue that had been held by the HEO Committee and the Science Committee earlier in the week. Dr. McComas reported that there were no known “show-stoppers,” as had been briefed to the Council by the NASA Chief Health and Medical Officer at its previous meeting in January 2015 at NASA Stennis Space Center. However, the science community does not understand the science behind this statement because the underlying facts are changing. Mr. Young advised that the science should be understood better before spending tens of billions of dollars to send a human to Mars. At Dr. Squyres’ suggestion, Dr. McComas agreed to rewrite the recommendation to indicate that there is a need to keep studying the problem.

Dr. McComas presented for consideration a Council recommendation on the need for NASA to provide continued health care to astronauts. Mr. Hale noted that there was a serious hardship on the astronauts’ families after the Columbia accident. After further discussion, the Council approved the recommendation, which states:

The NASA Advisory Council finds it unacceptable that the NASA is not able to provide free life insurance for astronauts while they are in space or lifetime health care after their service. Human spaceflight is an intrinsically risky endeavor both while in space and potentially from space-related effects long after returning to Earth. The Council feels that the nation has a responsibility to our men and women that we send into space and that the present arrangement where astronauts are responsible for buying their own life insurance for space missions and health care after they retire from the Corps is simply unacceptable and not befitting our space agency or great nation.

Dr. Squyres thanked Dr. McComas for his presentation. Dr. Squyres noted that Dr. McComas was retiring as chair of the Science Committee and thanked Dr. McComas for the outstanding work that had been done by the Science Committee while he served as its Chair. The Council applauded Dr. McComas.

James Webb Space Telescope Project Status

Dr. Squyres introduced Mr. William Ochs, JWST Project Manager, NASA Goddard Space Flight Center (GSFC). Dr. Spergel and Dr. Ballhaus recused themselves from the discussion. Dr. Squyres noted that the Council had requested a briefing on the JWST status due to the resources it would consume. Mr. Ochs reviewed the project's schedule. He explained that the critical path runs through the Integrated Science Instrument Module (ISIM) and then to the Optical Telescope + ISIM (OTIS). Secondary and tertiary critical paths were described. He explained that all critical paths separate by approximately two months. Reserves are being tightly conserved. A graph on the total schedule reserve was reviewed. In response to a question from Mr. Borghese, Mr. Ochs stated that the reserve schedule is continually updated.

Mr. Ochs noted that JWST is in fabrication and Integration and Testing (I&T). Approximately 99 percent of the observatory mass has completed Critical Design Review (CDR). He discussed a graphic showing an overview of the telescope architecture. He reviewed the status of the backplane support frame, center section, and wings. The Telescope Pathfinder was described. It is a partial telescope that is intended to reduce the implementation risk of the assembly, integration, and cryogenic optical testing of the JWST optical assembly. Pictures were shown of the Optical Telescope Element (OTE) assembly deployment hardware. Sunshield testing and the manufacturing process for the sunshield's flight membrane were described. The ISIM was discussed. Its four instruments, the fine guidance sensor, the mid-infrared instrument, the near infrared camera, and the near infrared spectrometer have been delivered and integrated. A flowchart was presented on the ISIM I&T verification flow. Mr. Ochs explained that ISIM cryo-vac testing is occurring in three phases, with ambient testing and build up to the final flight configuration in between.

The status of the spacecraft was discussed. Mr. Ochs noted that it had been considered the lower risk piece of the project. He described OTIS testing and explained that it would be a major effort over the next two years. OTIS cryo-optical testing will be performed in the world's largest cryo-vac chamber, located at NASA's Johnson Space Center (JSC). A chart was reviewed on the current flow status for OTIS.

Mr. Ochs discussed current risks. There has been a problem with the Mid-Infrared Instrument (MIRI) cooler compressor assembly. It is the only actively cooled piece and is required for the mirror. The problem arose because the manufacturer did not understand the complexity. The Non-Explosive Actuator (NEA) is a device used to release the telescope from the spacecraft once in orbit. During performance testing, it was discovered that the shock it creates was greater than expected. A redesign effort is nearing completion but has taken longer than planned. The OTE harness is an issue. During harness installation, it was discovered that some of the wires had nicks on them from the assembly process. Further review indicated that there is a systemic workmanship concern on all the harnesses coming from the vendor. The project has embarked on an extensive review of all the harnesses.

Mr. Ochs concluded his presentation by stating that JWST is on track for an October 2018 launch. Dr. Squyres thanked Mr. Ochs for his presentation.

Ad Hoc Task Force on STEM Education Report

Dr. Squyres introduced Mr. James Stofan, Chair, Ad Hoc Task Force on STEM Education. Dr. Squyres noted that the Task Force had been established to help fill in the gap from the demise of NASA's Education and Public Information Office (EPO) activities. Mr. Stofan presented his report via telecon and WebEx. He described the Task Force's membership and reviewed its terms of reference. He noted that the Task Force's scope covers all NASA education programs, projects, missions, and activities across all NASA Mission Directorates. He explained that the initial topics for Task Force consideration were:

- Position of NASA Education as a leader in CoSTEM;
- Articulation of success using data and story;
- Structure of NASA Education efforts and ability to conduct rigorous program management reviews;

- Sustainability of education program over the next several years;
- Competitive allocation of funds to elicit the best projects; and
- Advice on NASA Education Implementation Plan.

Mr. Stofan presented the cross-agency STEM Goal Statement:

Improve STEM education by implementing the Federal STEM Education 5-Year Strategic Plan, announced in May 2013, specifically:

- Improve STEM instruction;
- Increase and sustain youth and public engagement in STEM;
- Enhance STEM experience of undergraduate students;
- Better serve groups historically under-represented in STEM fields;
- Design graduate education for tomorrow's STEM workforce;
- Build new models for leveraging assets and expertise; and
- Build and use evidence-based approaches.

He presented charts showing NASA Strategic Goal 2 and Education Objective 2.4, NASA's Education Vision, and the NASA Education Mission. Strategic Goal 2 states: "Advance understanding of Earth and develop technologies to improve the quality of life on our home planet." Objective 2.4 asks NASA to "Advance the Nation's STEM education and workforce pipeline by working collaboratively with other agencies to engage students, teachers, and faculty in NASA's missions and unique assets." The NASA Education Vision is: "To advance high quality STEM education using NASA's unique capabilities." The NASA Education Mission is to:

- Align efforts to national priorities and NASA's mission and vision;
- Involve students, educators, and institutions in NASA's missions; and
- Impact the public using NASA's unique content, people and facilities.

Mr. Stofan concluded his presentation with a video demonstrating a NASA education success story. The video showed how students at the Nicholson Elementary School in Picayune, Mississippi, with assistance from NASA and the local high school robotics club, had designed an engineering solution to help solve a drainage problem in the city. The video can be found at the following link:

<http://www.samsung.com/us/solvefortomorrow/project/mississippi-robotic-storm-drain-expedition.html>.

Dr. Squyres remarked that the video had filled the empty spot in the Council's agenda from not having a presentation from a NASA early career engineer or scientist. He commented that when NASA restructured the Council and the Council lost the Education and Public Outreach Committee, it was determined that critical aspects of the Committee needed to be preserved. That led to the formation of the Ad Hoc Task Force on STEM Education, and it was designed to report directly to the Council, rather than through one of five NAC standing committees. It is expected that presentations from the Task Force would be a regular feature of Council meetings over the next two years. Dr. Squyres stressed, and asked Mr. Stofan to stress to his Task Force members, that they are empowered to come to the Council with findings and recommendations to pass on to the NASA Administrator.

Dr. Squyres thanked Mr. Stofan for his presentation.

Council Discussion and Final Wrap-up

Dr. Squyres presented a proposed Council finding that funds for the ARM should be reallocated to a mission that would use the new SEP stage for a round trip to a Mars orbit, with a return to a lunar DRO. After discussion, the Council approved the finding unanimously. The approved finding states:

High-performance solar electric propulsion (SEP) will likely be an important part of an architecture to send humans to Mars. NASA's current plan is to demonstrate a large SEP stage by using it to maneuver a boulder that has been lifted from the surface of a small asteroid, and to move the boulder to cis-lunar space.

Maneuvering a large test mass is not necessary to provide a valid in-space test of a new SEP stage. We therefore find that a SEP mission will contribute more directly to the goal of sending humans to Mars if the mission is focused entirely on development and validation of the SEP stage. We also find that other possible motivations for acquiring and maneuvering a boulder (e.g., asteroid science, planetary defense) do not have value commensurate with their probable cost.

Instead of relocating a boulder from an asteroid, we suggest that a more important and exciting first use of this new SEP stage would be a round trip mission to Mars, flying it to Mars orbit and then back to the Earth-Moon system and into a distant retrograde lunar orbit.

Dr. Hubbard presented a proposed Council finding on the need for an executable exploration strategy. Dr. Squyres noted that the proposed finding, as well as the previous finding, reflects NAC opinions that are counter to Administration policy. For that reason, a recommendation would not be appropriate because Mr. Bolden could not act on it. Dr. Austin suggested revising the proposed finding to reflect that the Council is waiting for NASA to lay out options for a longer-term plan. Mr. Bowersox suggested using a term other than “strategy.” After further discussion, Dr. Squyres requested that Mr. Bowersox and Dr. Hubbard develop revised language for the finding.

Dr. McComas presented to the Council for its consideration a revision to the travel recommendation considered by the Council earlier in the meeting. At Mr. Borghese’s suggestion, employee morale was included in the recommendation’s language. The revised recommendation was approved by the Council unanimously. The approved recommendation states:

The Council finds that there continues to be a major problem with travel restrictions on science contractors and recommends NASA reconsider Recommendation 2015-01-02 (SC-01) and stop including science programs funded through contracts with the travel restrictions externally mandated for Civil Servants.

Dr. Ballhaus presented a proposed Council finding that the current human exploration technology plans being implemented by STMD and HEOMD are inadequately funded to make the necessary progress in the near term to have a credible humans-to-Mars program. Dr. Squyres noted that it was a “pretty damning statement.” Dr. McComas stated that he had “grave concerns” over the proposed finding because it implied that funds should be shifted from SMD to STMD. He contended that many areas of NASA are underfunded. Dr. Spergel asserted that the whole Agency needs more funding. Mr. Young added that the funding shortfall compromises the U.S. civilian space strategy. Dr. Squyres counseled that the strength of the NAC lies in unanimous consensus for its findings and recommendations. At his suggestion, the proposed finding was tabled until a finding could be developed that the entire Council would support.

Dr. Hubbard presented a proposed Council finding on the Humans to Mars program and the Evolvable Mars Campaign, with modifications made pursuant to earlier Council discussions. After further discussion, the finding was approved unanimously, and states as follows:

The Council finds that developing an executable exploration strategy with plausible costs leading to humans on Mars in the 2030's would help NASA build the consensus necessary for such a program. In addition, creating a well articulated and costed plan will allow independent assessment of progress toward landing humans on Mars and create a framework for international and commercial partners to participate.

The horizon goal of sending humans to Mars has been well established by many studies, including the 2014 National Research Council report Pathways to Exploration. Several Administrations have adopted this goal. The Council finds that setting a goal is necessary but insufficient. A long term strategy and corresponding plans must also be developed. By this statement, the Council means a set of notional milestones, launches and hardware developments that are sufficiently defined so as to allow a cost assessment.

NASA has articulated their near term approach (~5 years) for development of plans to land humans on Mars with the Evolvable Mars Campaign (EMC) study. The Council is concerned that waiting to lay out

the options for the longer term plan for humans on Mars will miss the current opportunity of emerging public enthusiasm and create uncertainty in decision makers as well as potential partners.

Mr. Bowersox presented a proposed revised Council recommendation on radiation risks in sending humans to Mars, with modifications made pursuant to earlier Council discussions. After further discussion and revision, the recommendation was approved unanimously, with the language to be finalized into the Council's standard format by Mr. Bowersox and Ms. Rausch. The finding provides:

The Council recommends that NASA openly communicate the radiation risks while proceeding with preparations to send humans to Mars in the 2030s. As part of the mission development process, NASA should continue its work to mitigate radiation risks through improved knowledge and technology. In particular, there may be additional means of investigating the full extent of the radiation problem (for example, stellar observations, geologic record, further understanding of the heliospheric environment). Synthesizing expertise from both human exploration and science is essential to achieving this goal. Furthermore, we encourage NASA to initiate a long-term medical care program for astronauts which includes long-term astronaut health monitoring to mitigate long duration exposure health consequences, and build a baseline for future long-term health and engineering decisions.

Dr. Squyres gave the Council members an opportunity for final remarks before the meeting closed. Dr. Austin commented that the presentation by Mr. Gerstenmaier was "terrific." She noted that a question on governance by NASA Center Directors remained to be resolved. Dr. Hubbard requested more discussion time at the next meeting. Dr. Squyres concurred and indicated that the NAC's next meeting at NASA's Jet Propulsion Laboratory (JPL) would be a full two day meeting. Dr. Hubbard suggested that NASA be requested to avoid submitting its responses to Council recommendations at the last minute. Dr. McComas noted that he very much appreciated Dr. Squyres' emphasis on having the Council reach a consensus. He remarked that he has appreciated his opportunity to serve on the Council.

In closing, Dr. Squyres expressed the Council's appreciation to the staff at NASA Headquarters, specifically the audio-visual staff and Ms. Rausch, Ms. King, and Ms. Floyd, for their excellent assistance in supporting the meeting.

Adjournment

The Council meeting was adjourned at 12:09 pm.

NASA ADVISORY COUNCIL

**NASA Headquarters
Program Review Center, Room 9H40
300 E Street, SW
Washington, DC 20546**

PUBLIC MEETING**April 9-10, 2015****Thursday, April 9, 2015**

9:00 – 9:03 am	Call to Order, Announcements	Ms. Diane Rausch Executive Director NASA Advisory Council NASA Headquarters
9:03 – 9:10 am	Opening Remarks by Council Chair	Dr. Steven W. Squyres Chair, NASA Advisory Council
9:10 – 10:00 am	Remarks by NASA Administrator	Mr. Charles F. Bolden, Jr. NASA Administrator
10:00 – 11:00 am	The President's FY 2016 Budget Request for NASA	Mr. Andrew Hunter Deputy Chief Financial Officer Budget and Performance NASA Headquarters
11:00 – 11:45 am	NASA Human Exploration Strategy	Mr. William Gerstenmaier Associate Administrator for Human Exploration and Operations Mission Directorate NASA Headquarters
11:45 am – 12:00 noon	Group Photograph	
12:00 noon – 1:00 pm	Lunch	
1:00 – 1:45 pm	Discussion on NASA Space Flight Program and Management Requirements (NPR 7120.5E) and Program Affordability/Sustainability	Mr. Robert Lightfoot NASA Associate Administrator Mr. Ralph Roe NASA Chief Engineer Ms. Sandra Smalley Science Mission Directorate NASA Headquarters
1:45 – 2:30 pm	Human Exploration and Operations Committee Report	Mr. Kenneth Bowersox, Chair
2:30 – 4:00 pm	Council Discussion	
4:00 – 4:30 pm	Institutional Committee Report	Ms. Kathryn Schmoll, Chair

4:30 – 5:15 pm	Technology, Innovation and Engineering Committee Report	Dr. William Ballhaus, Chair
5:15 – 6:00 pm	Aeronautics Committee Report	Mr. John Borghese, Vice Chair (for Ms. Marion Blakey, Chair)
6:00 pm	Adjourn	

Friday, April 10, 2015

9:00 – 9:01 am	Call to Order, Announcements	Ms. Diane Rausch Executive Director NASA Advisory Council NASA Headquarters
9:01 – 9:03 am	Remarks by Council Chair	Dr. Steven W. Squyres Chair, NASA Advisory Council
9:03 – 9:10 am	Public Input	
9:10 – 10:00 am	Science Committee Report	Dr. David McComas, Chair
10:00 – 10:30 am	James Webb Space Telescope (JWST) Project Status	Mr. William Ochs JWST Project Manager NASA Goddard Space Flight Center
10:30 – 11:00 am	Ad Hoc Task Force on STEM Education Report	Mr. James Stofan, Chair (via telecon)
11:00 am – 12:00 noon	Council Discussion and Final Wrap-up	
12:00 noon	Adjourn	

NASA ADVISORY COUNCIL

Membership – April 2015

Role	Council Members
Chair – NASA Advisory Council	Dr. Steven Squyres , <i>James A Weeks Professor of Astronomy, Cornell University</i>
Member at Large	Dr. Wanda M. Austin , <i>President and CEO, The Aerospace Corporation</i>
Member at Large	Mr. N. Wayne Hale , <i>Consultant, Special Aerospace Services of Boulder, Colorado; NASA (Ret.)</i>
Member at Large	Prof. G. Scott Hubbard , <i>Department of Aeronautics and Astronautics, Stanford University</i>
Member at Large	Mr. Miles O’Brien , <i>Independent Journalist</i>
Member at Large	Mr. A. Thomas Young , <i>Executive Vice President, Lockheed Martin (Ret.); former Director, NASA Goddard Space Flight Center</i>
Chair – Aeronautics Committee	The Honorable Marion Blakey , <i>President and CEO, Aerospace Industries Association</i>
Chair – Human Exploration and Operations Committee	Mr. Kenneth Bowersox , <i>U.S. Naval Aviator (Ret); Former NASA Astronaut</i>
Chair – Institutional Committee	Ms. Kathryn Schmoll , <i>Vice President, Finance and Administration, University Corporation for Atmospheric Research</i>
Chair – Science Committee	Dr. David J. McComas , <i>Assistant Vice President., Space Science and Engineering Division, Southwest Research Institute</i>
Chair – Technology, Innovation and Engineering Committee	Dr. William F. Ballhaus Jr. , <i>President and Chief Executive Officer (Ret.), The Aerospace Corporation</i>
Ex Officio Members	<p>Gen. Lester Lyles, <i>Chair, Aeronautics and Space Engineering Board, National Academy of Engineering; USAF (Ret.)</i></p> <p>Dr. David Spergel, <i>Chair, Space Studies Board, National Academy of Sciences, Princeton University</i></p>

**NASA ADVISORY COUNCIL
NASA Headquarters
Washington, DC
April 9-10, 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. Kenneth Bowersox	U.S. Navy (<i>Ret.</i>)
Mr. N. Wayne Hale	Special Aerospace Services
Prof. G. Scott Hubbard	Stanford University
Gen. Lester Lyles	ASEB/National Research Council
Dr. David McComas	Southwest Research Institute
Mr. Miles O'Brien	Independent Journalist
Ms. Kathryn Schmoll	University Corp. for Atmospheric Research
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:

Andplick, Dennis	NASA Headquarters
Broadwell, Marguerite	NASA Headquarters
Comstock, Doug	NASA Headquarters
Craig, Doug	NASA Headquarters
Davison, Steve	NASA Headquarters
Deinhurst, Brian	NASA Headquarters
Denning, Elaine	NASA Headquarters
Durning, John	NASA/Goddard Space Flight Center
French, Mike	NASA Headquarters
Gerstenmaier, William	NASA Headquarters
Girton, Bev	NASA Headquarters
Guerra, Lisa	NASA Headquarters
Guidi, John	NASA Headquarters
Hasan, Hashima	NASA Headquarters
Hirshorn, Steven	NASA Headquarters
Jackson, Keegan	NASA Headquarters
James, Donald	NASA Headquarters
Jones, W. Vernon	NASA Headquarters
Kaminski, Amy	NASA Headquarters
Kelly, Allison	NASA Headquarters
King, Marla	NASA Headquarters
Lialtkoy, Robert	NASA Headquarters

Menzel, Michael	NASA/Goddard Space Flight Center
Metrocavague, Kevin	NASA Headquarters
Mullins, Todd	NASA Headquarters
Ochs, Bill	NASA/Goddard Space Flight Center
Rinkley, Robert	NASA Headquarters
Roe, Ralph	NASA Headquarters
Rose, Howard	NASA Headquarters
Siegel, Bette	NASA Headquarters
Smith, Eric	NASA Headquarters
Smith, Larry	NASA Headquarters
Sonally, Sandra	NASA Headquarters
Stofan, James	NASA Headquarters
Thomas, Allyson	NASA Headquarters
Thomas, Don	NASA Headquarters

Other Attendees:

Bordi, Francesco	Aerospace Corporation
Delton, May Lynn	Center for the Advancement of Science in Space (CASIS)
Frankel, David	P B Frankel, LLC
Li, Allen	SS&T Committee, U.S. House of Representatives
Obermann, Richard	SS&T Committee, U.S. House of Representatives
Tercell, Kim	KIMS
Ward, Steve	Exelis

**NASA ADVISORY COUNCIL
NASA Headquarters
April 9-10, 2015**

LIST OF PRESENTATION MATERIAL

- 1) The President's FY 2016 Budget Request for NASA [Hunter]
- 2) NASA Human Exploration Strategy [Gerstenmaier]
- 3) Managing NASA Spaceflight Programs and Projects – NPR 7120.5E [Roe]
- 4) Human Exploration and Operations Committee Report [Bowersox]
- 5) Institutional Committee Report [Schmoll]
- 6) Technology, Innovation and Engineering Committee Report [Ballhaus]
- 7) Aeronautics Committee Report [Borghese]
- 8) Science Committee Report [McComas]
- 9) James Webb Space Telescope Mission Status [Ochs]
- 10) Ad Hoc Task Force on STEM Education [Stofan]

Other material distributed at the meeting:

NACA NASA: Celebrating a Century of Innovation, Exploration, and Discovery in Flight and Space, 1915 - 2015