

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

NASA ADVISORY COUNCIL

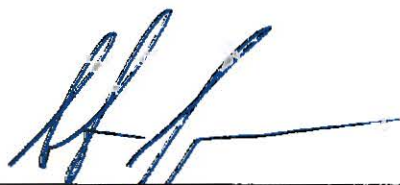
July 30-31, 2014

**NASA Langley Research Center
Hampton, VA**

MEETING MINUTES



P. Diane Rausch
Executive Director



Steven W. Squyres
Chair

**NASA ADVISORY COUNCIL
NASA Headquarters
Washington, DC
July 30-31, 2014**

**Public Meeting Minutes
Table of Contents**

Call to Order, Announcements.....2

Opening Remarks by Council Chair.....2

Welcome to NASA Langley Research Center.....2

Remarks by NASA Administrator.....3

NASA Human Exploration Strategy.....6

Council Discussion.....9

Public Input.....11

Council Discussion.....12

Aeronautics Committee Report.....12

Human Exploration and Operations Committee Report.....13

Council Discussion.....15

Institutional Committee Report.....15

Council Discussion.....16

Orbital Debris.....17

Council Discussion.....18

Technology, Innovation, and Engineering Committee Report.....18

Science Committee Report.....19

NASA Langley Research Center Early Career Employee Presentations.....21

Wrap-up and Final Acknowledgments.....21

Appendix A Agenda

Appendix B Council Membership

Appendix C Meeting Attendees

Appendix D List of Presentation Material

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

NASA ADVISORY COUNCIL MEETING**NASA Langley Research Center
Hampton, Virginia****Building 2101, Room 305****PUBLIC MEETING****July 30-31, 2014****Wednesday, July 30, 2014**Call to Order, Announcements

Ms. Diane Rausch, Executive Director, NASA Advisory Council (NAC or Council), called the meeting to order and welcomed the NAC members and attendees to the NASA Langley Research Center (LaRC or Langley) in Hampton, Virginia. 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 website, www.nasa.gov, soon after the meeting. Each NAC member has been appointed by the NASA Administrator, Mr. Charles F. Bolden, Jr., based on the member's individual subject matter expertise. All members are Special Government Employees (SGE), 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 at the end of the 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 and offered the opinion that it would be the most important Council meeting to take place since he became its Chair. The Council has been restructured, and three changes have been made to help it address the Agency's most important issues. The number of Council committees has been reduced to five. That will enable the Council to spend less time on committee business and more time on issues that cut across the Agency. He reminded Council members that the NAC reporting structure for findings and recommendations has been changed to a two-tier system. Recommendations and findings passed through the Council may now be directed to the Administrator or to a specific Associate Administrator, as appropriate. The third change is that the Council has added five new at-large members with no assigned committee responsibilities. That enables the Council to have "big thinkers" to help it grapple with strategic issues facing the Agency. He noted that the most important agenda items for this meeting are the ones that say "Council Discussion."

Welcome to NASA Langley Research Center

Dr. Squyres introduced Mr. Stephen Jurczyk, Director, NASA Langley Research Center, and thanked him for hosting the NAC meeting. Mr. Jurczyk welcomed the NAC members to NASA Langley. He presented Langley's vision:

We define, develop, and demonstrate breakthrough systems solutions that enable:

- *On Demand Air Transportation;*
- *Understanding, Adapting to, and Mitigating the Earth's Climate System; and*
- *Humans on Mars in the 2030s for the Benefit of Humanity.*

Mr. Jurczyk explained that Langley has seven product lines: atmospheric characterization; systems analysis and concepts; advanced material and structures research; aerospace sciences; entry, descent, and landing (EDL); measurement systems; and intelligent flight systems. The FY 2014 Budget for Langley is \$782 million (M). There are 1,900 civil servants and 1,700 contractors working at Langley or near the site. Langley has 166 buildings, with a replacement value of \$3.5 billion (B). Mr. Jurczyk described the Vibrant Transformation Plan to Advance Langley (VITAL). He noted that Langley's footprint will be 30 percent smaller when the plan is complete, and it will have a much more efficient and effective infrastructure. He added that Langley has placed an emphasis on Early Career hiring.

Mr. Scott Hubbard asked whether the structure of the NASA Centers is positioned to accomplish getting humans to Mars in the 2030s. Mr. Jurczyk responded that a Capabilities Manager is looking across the Centers to see what capabilities are duplicated or unique and how they can be best utilized. General Lester Lyles observed that the photos in Mr. Jurczyk's presentation materials did not reflect diversity. Mr. Jurczyk explained that Langley is reaching out to women and minorities in the technology fields and can do better. Dr. Wanda Austin asked Mr. Jurczyk for his advice on how the Agency can be more effective in working across the Centers. He responded that the Capabilities Assessment Program should be implemented. He noted that Centers are struggling to maintain capabilities and that there is a need to divest Centers from capabilities that are no longer needed. He added that Centers need to be less competitive with each other, and more collaborative.

Dr. Squyres thanked Mr. Jurczyk for his presentation.

Remarks by NASA Administrator

Dr. Squyres introduced Mr. Charles Bolden, Jr., NASA Administrator. Mr. Bolden thanked the NAC members for their willingness to serve on the Council and Dr. Squyres for his leadership. Mr. Bolden emphasized that he takes the NAC's recommendations very seriously. When NASA responds to NAC recommendations, he expects the Agency response to be substantive. He requested the Council members to let him know anytime they find that the Agency's response is insufficient.

Mr. Bolden gave a brief overview on developments at NASA since the last NAC meeting in April 2014. He began with the President's FY 2015 Budget Request for NASA. The first piece to consider is the Authorization process. The last time that NASA had an Authorization Act enacted was 2010. Mr. Bolden explained he is not optimistic that NASA will have an Authorization Act enacted for 2015. The other piece to consider is the Appropriations process. The President's FY 2015 Request was \$17.5B. The House Commerce, Justice, and Science Appropriations Bill funded NASA at \$17.896B, which was a very pleasant surprise because it added \$400M to the President's Request. The Agency was disappointed that the Bill did not fully fund the Commercial Crew Program. However, it provided \$786M, which was twice as much as NASA had ever received before for the Commercial Crew Program. NASA is also concerned that the Bill did not fund the full request for Space Technology, which is an area that remains in dire need. Dr. Michael Gazarik, NASA Associate Administrator for the Space Technology Mission Directorate, and his team have done a remarkable job with the funds they have been given. The Senate Appropriations Committee reported out its version of the Commerce, Justice, and Science Appropriations Bill in June 2014 and funded NASA at \$17.9B. The full Senate is the next to act on the Appropriations Bill; however, there is a strong possibility that the Federal Government could be funded under a Continuing Resolution (CR) for an extended period of time in FY 2015.

Mr. Bolden indicated that the President's \$17.5B Budget Request for NASA affirms bipartisan strategic exploration planning that had been agreed to with Congress under the 2010 Authorization Act and that ensures that the U.S. will remain the global leader in space exploration and scientific discovery for years to come. It is an investment that benefits the American people and the entire global community. The budget keeps NASA on a steady path, with a stepping stone approach to meet the President's challenge of sending humans to Mars in the 2030s.

On April 18, 2014, NASA witnessed another successful launch of a contracted cargo resupply mission by SpaceX. On that mission, the Dragon spacecraft delivered over 2.4 tons of cargo to support the more than 150 investigations in Expeditions 39 and 40 on the International Space Station (ISS). On July 19, 2014, Orbital Sciences conducted its second successful cargo mission flying to the ISS from NASA's Wallops Flight Facility, delivering over 3,000 pounds of cargo for the ISS, including science experiments, spare parts, and crew provisions. The European Space Agency launched an Ariane 5 sending the fifth and final Automated Transfer Vehicle (ATV) with supplies to the

ISS. Mr. Bolden commented that the value of commercial space has demonstrated itself repeatedly. It has been a good investment and is crucial to the path to Mars. Later this year, NASA will move forward on its Commercial Crew Program and award contracts to American companies to send astronauts to the ISS from American soil, ending sole reliance on Russia. NASA believes that can be accomplished by the end of 2017, if Congress fully funds the President's FY 2015 Budget Request for NASA.

Mr. Bolden reported that NASA is making steady progress on the path to Mars. On April 29, 2014, NASA held an Exploration Forum that covered the importance of the ISS in helping to move farther into the Solar System, working with industry partners, proving new technologies in space, an asteroid mission, and a human mission to Mars. In March, NASA held an Opportunities Forum, where NASA experts provided a status update on Asteroid Redirect Mission (ARM) concepts and summarized how responses from a FY 2013 Request for Information (RFI) are helping to inform planning for the ARM and the Asteroid Grand Challenge. The President's Budget Request also supports the next Mars 2020 rover mission. That mission will conduct geological assessments at the landing site, determine the habitability of the environment, search for signs of ancient Martian life, assess natural resources and hazards for future human explorers, and cache samples for subsequent return to Earth. In the coming days, NASA plans to announce the payload science and technology instruments that Mars 2020 will carry. Mr. Bolden explained that the programs that are in place today are all interlocking pieces in the strategy to get humans to Mars. NASA needs the Commercial Crew Program to free up NASA to move beyond low-Earth orbit (LEO). The Space Launch System (SLS) and Orion are needed to take NASA into deep space. NASA needs the ARM to advance its deep space exploration capabilities. With the FY 2015 President's Budget Request, NASA has a balanced portfolio that moves NASA ahead on the strategy. Mr. Bolden emphasized that all the pieces are important. Later this year, Exploration Flight Test-1 (EFT-1) with Orion will take a spacecraft meant for humans farther than humans have gone in 40 years. He noted that the U.S. has not built such a spacecraft for more than 40 years. That may not seem strange to some people, but he noted that it is strange and unbelievable for a nation as powerful as the U.S. to have taken 40 years to put in place another vehicle to take humans beyond LEO. Orion will launch on a Delta IV Heavy on a test flight by the end of the year. On June 10, engineers at NASA's Kennedy Space Station (KSC) began stacking the Orion crew module on top of the completed service module, the first step in moving the three primary Orion elements – crew module, service module, and launch abort system – into configuration for launch.

In April 2014, NASA announced Team Ares from the Governors School of Science and Technology in Hampton, Virginia, as the winner of the high school portion of NASA's Exploration Design Challenge. Working with Lockheed Martin and NASA's Office of Education, NASA issued an international call less than a year ago for ideas on how to protect astronauts flying in deep space against radiation. There were 30,000 responses. Five finalists were announced this past spring. Those teams will be taken to KSC to watch the launch of EFT-1. Team Ares' instrument will be flown in the Orion spacecraft, along with NASA-provided instrumentation to measure the effectiveness of their experiment to lessen the effect of radiation in humans. The Exploration Design Challenge was developed to inspire the next generation by engaging students in science, technology, engineering, and math (STEM), and inviting them to tackle one of the most significant dangers of human spaceflight, radiation exposure.

The ISS continues to be the springboard to the rest of the Solar System. NASA is preparing for Astronaut Scott Kelly and his Russian counterpart's one-year increment aboard the Space Station. The launch will be next spring 2015. NASA's Science program continues making critical observations of Earth and developing applications to benefit the nation and the world. There will be five Earth science launches this calendar year, including the Global Precipitation Measurement (GPM) Core Observatory, which launched from Japan in February. On July 1, NASA launched the Orbiting Carbon Observatory (OCO)-2, a replacement for OCO that was lost on launch about two years ago. OCO-2 is the first mission dedicated to studying atmospheric carbon dioxide. NASA is in the early stages of looking at a mission to Jupiter's moon, Europa. On July 15, NASA issued an Announcement of Opportunity for proposals for science instruments that could be carried aboard a future mission to Europa. The budget also maintains steady progress on the James Webb Space Telescope (JWST) for its 2018 launch. The telescope's mirrors have been delivered to NASA's Goddard Space Flight Center (GSFC). The sunshield was deployed in a test last week. The NASA Aeronautics Research program will continue to focus on reducing fuel consumption and noise to help make the Next Generation Air Transportation System, or NextGen a reality.

Mr. Bolden noted that NASA is working with the Federal Aviation Administration (FAA) to help air traffic controllers bring airplanes down more efficiently from cruising altitude, using less engine power and maintaining a safe distance from other planes. NASA is developing the precision departure and release capability (PDR) to

enable an aircraft to leave the gate at the precise moment it needs to make its slot in the overhead traffic, thereby reducing fuel and delays. NASA has trained U.S. Airways dispatchers on the software, and the dispatchers are now testing the system. In July, NASA released a tool called Terminal Sequencing and Spacing (TSS). TSS technology will enable air traffic controllers to better manage the spacing between aircraft, saving time and fuel and reducing emissions.

On June 28, the Space Technology Mission Directorate's (STMD) Low Density Supersonic Decelerator (LSD) Project passed its first flight test by flying a rocket-powered, saucer-shaped test vehicle into near space from the U.S. Navy's Pacific Missile Test Range facility in Hawaii. The LSD cross-cutting technology demonstration mission tested EDL technologies that will enable large payloads to safely land on the Mars surface or other planetary bodies with atmospheres, including Earth. The technology will not only enable landing larger payloads on Mars, but will also allow access to more of the planet's surface by enabling landings at higher-altitude sites and with more precision.

This month, the U.S. marked the 45th anniversary of the Apollo 11 Moon landing with a series of events, including renaming the Operations and Checkout Building at KSC in memory of Astronaut Neil Armstrong. The Apollo 11 Moon landing was a remarkable American accomplishment and a giant leap for humankind. Today, NASA is working on the next giant leap: a human mission to Mars, standing on the shoulders of those who went before.

Mr. Bolden noted that NASA does many things that have nothing to do with Mars. NASA's vision is to reach for new heights and reveal the unknown for the benefit of people on Earth. Some of what NASA does has societal value unrelated to Mars. Mars, however, is NASA's ultimate human endeavor, the horizon goal upon which NASA is focused. NASA has a lot on its plate, and to do everything effectively, NASA needs another \$3B a year. The alternative would impact the broad-based nature of NASA's portfolio.

Dr. Wanda Austin expressed concern that the public does not know about NASA's amazing accomplishments. Mr. Bolden acknowledged that NASA is not doing enough in education and public outreach. Regarding General Lyles' observation about diversity, Mr. Bolden acknowledged that NASA has not been effective in informing all communities about the space program. Over the last four years, NASA has become very good at using social media. For every launch, NASA has a "NASA Social." It is an opportunity for anybody who uses social media to spend a few days before the event getting briefed and looking at hardware," he said. The participants often are visited by an NASA Astronaut. Almost always, the NASA Center Director spends some time with them, and if Mr. Bolden is there, he always spends some time with them as well. Almost 75 percent of the attendees at a NASA Social have never seen a launch before. Mr. Bolden asks them to tell people how they feel and what the experience is like for them. Dr. Austin advised that NASA should figure out how to leverage the NASA Social experience and turn it into support.

Mr. Miles O'Brien commented that there is a huge potential stored up in the people across NASA's Centers. He observed that Mr. Bolden wants NASA to speak with one voice and doesn't want multiple messages going out; however, Mr. O'Brien advised that "unleashing the employees" and allowing them to share their enthusiasm would be good for NASA. Mr. Bolden explained that he asks NASA people to tell the public what they do.

Dr. Squyres noted that at the last NAC meeting in April 2014, Administrator Bolden gave the NAC an Annual Work Plan with five topics listed. He asked Mr. Bolden what other things are on his mind that he would like to see the Council address. Mr. Bolden responded that, while not an issue for the NAC, he wants his leadership team to become better leaders. He explained that there is a major distinction between managers and leaders. When NASA promotes people into the Senior Executive Service (SES) ranks, they are brought there to be leaders. He tells them that the days of being a "hands-on" engineer are gone. He needs them to take care of their people. The vast majority do that, but as long as there are some who do not, it takes away from the organization's cohesiveness. He noted that the NAC would be hearing shortly from Mr. Greg Williams, Deputy Associate Administrator for the Human Exploration and Operations Mission Directorate, who is doing briefings all the time on behalf of its Associate Administrator, Mr. Bill Gerstenmaier. That is leadership development. NASA prepares people to go out, give presentations, and take the "heat." Leadership development at NASA is his number-one worry and challenge. That cannot be improved by an outside organization. It must be improved by the team in place. He acknowledged that NASA, including himself, is not as good at leadership and caring for its people as it needs to be.

Mr. Bolden added one item to the NAC's Work Plan. He asked that the Council hold NASA accountable for answering the question: Is what you are doing affordable? He enjoined the Council to make NASA answer that question and explain what would it take to make what NASA is doing affordable. He recalled that at his Senate Confirmation Hearing on becoming NASA Administrator in July 2009, he told Congress that he would not do three things: he would not bring to the Administration and Congress anything that was unrealistic, he would not bring them anything that was unsustainable, and he would not bring them anything that was unaffordable. Unaffordable means that it does not fit within the budget. He noted that Mars always seems to be 30 years away. He would like to see Mars closer than 30 years away, and he thinks that it is. However, he needs the Council members to help people understand that if it is worth doing, there must be money to pay for it and a sustained commitment over many years.

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

NASA Human Exploration Strategy

Dr. Squyres introduced Mr. Greg Williams, Deputy Associate Administrator, Human Exploration and Operations Mission Directorate (HEOMD), NASA Headquarters (HQ). Mr. Williams briefed the Council on NASA's Human Exploration Strategy. He explained that NASA is guided by the U.S. National Space Policy and the 2010 NASA Authorization Act. These set the Executive and Legislative Policy Direction, and direct NASA, in part, as follows:

U.S. National Space Policy

- "Set far-reaching exploration milestones. By 2025, begin crewed missions beyond the moon, including sending humans to an asteroid. By the mid-2030s, send humans to orbit Mars and return them safely to Earth;"
- "Maintain a sustained robotic presence in the solar system to: conduct scientific investigations of other planetary bodies; demonstrate new technologies; and scout locations for future human missions;"

2010 NASA Authorization Act

- "The long term goal of the human space flight and exploration efforts of NASA shall be to expand permanent human presence beyond low-Earth orbit and to do so, where practical, in a manner involving international partners."
- "Finding (1) The extension of the human presence from low-Earth orbit to other regions of space beyond low-Earth orbit will enable missions to the surface of the Moon and missions to deep space destinations such as near-Earth asteroids and Mars."
- "Finding (7) Human space flight and future exploration beyond low-Earth orbit should be based around a pay-as-you-go approach . . ."

Building from these two policy documents, the NASA Strategic Plan was developed to guide planning in the current policy and budget environment. The 2014 NASA Strategic Plan states, in part, the following goal and objectives:

- Goal 1: Expand the frontiers of knowledge, capability, and opportunity in space.
- Objective 1.1: Expand human presence into the solar system and to the surface of Mars to advance exploration, science, innovation, benefits to humanity, and international collaboration.
- Objective 1.2: Conduct research on the International Space Station (ISS) to enable future space exploration, facilitate a commercial space economy, and advance the fundamental biological and physical sciences for the benefit of humanity.
- Objective 1.3: Facilitate and utilize U.S. commercial capabilities to deliver cargo and crew to space.

Mr. Williams discussed the concept of "Pioneering Space," as the idea that captures this strategy of moving beyond LEO into the solar system with long term purpose and multiple partners. He reviewed six key strategic principles to provide a sustainable program:

- Implementable in the *near-term with the buying power of current budgets* and in the longer term with budgets commensurate with economic growth;
- 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 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 learned from the ISS logistics and crew market;
- *Multi-use, evolvable* space infrastructure; and
- Substantial *international and commercial participation*, leveraging current ISS partnerships.

Mr. Williams described the Evolvable Mars Campaign (EMC). The EMC's guiding philosophy:

- Leverages strong linkage to current investments in ISS, SLS, Orion, ARM, EAM, technology development investments, science investments;
- Develops Earth independence for long-term human presence leading to the surface of Mars, starting in the Proving Ground, through the cis-lunar environment, enabling science along the way, and providing infrastructure for human exploration missions beyond Mars;
- Accommodates the budget, both in escalation and peaks coupled with a cadence of missions;
- Emphasizes prepositioning and reuse/repurposing of systems when it makes sense;
- "Provides a basis for architecture development and identification and analysis of trade studies with our partners and stakeholders and incorporates the flexibility to adjust to changing priorities across the decades; from this work will emerge the roadmap we will follow through cis-lunar space to pioneer Mars" (from Pioneering Space paper); and
- Not to develop "the plan" but develop different options to provide a range of capability needs to be used as guidelines for near term activities and investments.

The different trades that must be considered for the EMC were reviewed. These trades take place in three domains: the Proving Ground (cis-lunar trades), Earth Independent (Mars vicinity trades); and trades that apply "across the board." A slide was presented showing the EMC's capability and mission extensibility from Earth Reliant, Proving Ground and Earth Independent. Slides depicting a Mars split mission concept were discussed. Solar Electric Propulsion (SEP) would be used for transporting cargo, and chemical propulsion would be used for more rapid crew transportation.

Mr. Williams reviewed the ARM. It has three components and is part of the Proving Ground: identify potential target asteroids, redirect the target asteroid to cis-lunar space using SEP, and explore the asteroid using crew launched on SLS/Orion to rendezvous with redirected asteroid, study and return samples to Earth. Mr. Williams discussed the ARM's objectives with a chart that stated:

- Conduct a human exploration mission to an asteroid in the mid-2020's, providing systems and operational experience required for human exploration of Mars.
- Demonstrate an advanced solar electric propulsion system, enabling future deep-space human and robotic exploration with applicability to the nation's public and private sector space needs.
- Enhance detection, tracking and characterization of Near Earth Asteroids, enabling an overall strategy to defend our home planet.
- Demonstrate basic planetary defense techniques that will inform threat mitigation strategies to defend our home planet.
- Pursue a target of opportunity that benefits scientific and partnership interests, expanding our knowledge of small celestial bodies and enabling the mining of asteroid resources for commercial and exploration needs.

He then explained how the ARM fits into NASA's Exploration Strategy, noting that ARM leverages ongoing activities across the Agency to implement a compelling and affordable human exploration mission in the "Proving Ground," providing systems and operational experience for human missions to Mars; and the ARM technologies, systems, and capabilities are part of a sustainable exploration strategy. He stated that NASA studies have determined that essentially the same flight system can support both robotic mission capture options A and B. Regardless of the capture option, the SEP spacecraft can make substantial asteroid mass available for crewed exploration and sampling in the mid-2020's. He described two alternatives being considered for the ARM's second segment. Option A calls for a small asteroid to be captured and brought back into cis-lunar space. Currently there are 9 potential asteroid candidates, three of which have been validated. Option B calls for landing on a large asteroid and removing

a small boulder to cis-lunar space. In this case, there are many potential asteroid candidates, three of which have been validated. Specific candidate asteroids for each option were further described. The development and risk reduction status for each option were discussed. Charts were presented to show STMD work in FY 2014 on solar array technology and electric propulsion. Mr. Williams described design and development work for the crewed mission segment. He presented a chart on ARM risk reduction for future Mars and deep space missions. One risk reduction issue listed in the chart stated: “Enhanced understanding of uncooperative, low-G targets as will be experienced with Mars moons.” Dr. Squyres and Dr. Hubbard disagreed with the characterization that Mars moons were “uncooperative,” noting that both have rotation states that are tidally “locked” to Mars, and Mr. Williams agreed that the chart should be corrected. Mr. Williams discussed a chart showing the use of ARM for SEP, and current status of ARM milestones leading up to the Mission Concept Review to be held in February 2015. The down-select between the Option A and Option B robotic mission concept is scheduled for mid-December 2014.

Dr. Squyres asked when a hard-nosed independent cost estimate of ARM would take place, and Mr. Williams replied that it would occur before the down-select. Mr. Thomas Young noted that NASA’s Origins Spectral Interpretation Resource Identification Security Regolith Explorer (OSIRIS-REx) mission had not been included in any of Mr. Williams’ presentation, and asked why, since its purpose is to return an asteroid sample to Earth in 2023. Mr. Scott Hubbard also noted this omission and asked whether HEOMD and SMD were coordinating on this mission. Mr. Williams explained that there had been some crosstalk regarding OSIRIS-REx between the NASA’s Office of Chief Technologist (OCT) and NASA’s Science Mission Directorate. He added that OCT had included OSIRIS-REx in a briefing on NASA’s Asteroid Grand Challenge.

Dr. William Ballhaus noted that the U.S. National Space Policy stated that the long-term goal was “orbiting Mars” and that the 2010 NASA Authorization Act stated the long-term goal as “landing on Mars” implying a much more ambitious, longer duration mission. Dr. Squyres asked about the cis-lunar space focus of ARM, specifically if the asteroid redirect component were not done, would the ARM mission still be worth it? Mr. Williams responded that yes, NASA wished to go to cis-lunar space as the next step.

Mr. Williams presented a slide showing Human Exploration pathways. A chart on EMC forward work was discussed. The chart lists “across the board” trades, cis-lunar trades, and Mars vicinity trades. Mr. Williams reviewed several charts that compared findings and recommendations from the 2009 Augustine Report, the 2014 National Research Council (NRC) Report, and the 2013 Global Exploration Roadmap (GER) on exploration philosophy, destinations, leveraging current assets, and science and technology development. Mr. Wayne Hale asked why more Mars trade studies were being planned by NASA, noting that these studies have been done for over 40 years. Mr. Williams acknowledged that many studies had already been done and would be used by NASA, but additional Mars maturation studies were needed to put all the pieces together in light of the new ARM mission. Ms. Marion Blakey noted that working with international partners was becoming rather “dicey” in view of the current geopolitical situation, and gave as an example NASA’s current partnership with Russia on the International Space Station. Mr. Williams responded that earlier this year, the U.S. had announced its planned extension of ISS through 2024, and that currently the other ISS Partners were working through their national and international bodies to obtain approvals for their continued participation in ISS, to obtain maximum research and utilization from their financial investments. NASA believed that our International Partners would continue their commitment to the highly successful long-term partnership, he said.

Mr. Hale commented that the recommended path to Mars should not be a fraud, noting that Mr. Bill Gerstenmaier of NASA told the NAC at their previous meeting in April 2014 that the Mars program would require a “modest increase” in NASA’s budget, but that the 2009 Augustine Committee Report had stated it would require an additional \$3B more, and the Congressional Budget Office had concluded an even higher number, \$6B. He advised that there cannot be a program without a price tag. Mr. Williams explained that NASA thinks it is too early to inform the Office of Management and Budget (OMB) about the cost to go to Mars, and that if the Agency did so, “the whole system will choke on it.”

Mr. Bolden then stated that NASA has to be honest with the American public, the Congress, and the Administration. At some point a decision has to be made as to whether going to Mars is something that the country really wants to do. This is the way that humanity ought to be going, but it cannot be done cheaply or without commitment. Neither Congress nor the Administration has made a decision yet. NASA’s job is to develop the strategy to recommend and that is what NASA has been doing for the last five years. NASA thinks it is doable and that it will require increase in

the budget, not a flat-line. Nobody knows what those increases need to be at this time. By December 2014, a final decision is expected to be made and communicated to Capitol Hill.

Dr. David McComas expressed concern that the problems posed by extragalactic cosmic radiation exposure to human crews are not being addressed in satisfactory manner, noting that this critical biological issue had not been mentioned in any of Mr. Williams' charts. This issue is extremely important, and that it could be the show-stopper for humans going to Mars, he said. Mr. Williams responded that NASA was addressing the radiation issue in pieces, noting the recent Institute of Medicine (IOM) report that had been provided to NASA's Chief Health and Medical Officer, Dr. Richard Williams. He suggested that NASA provide the Council with an integrated presentation on radiation at the next NAC meeting, to which the NAC members agreed. Ms Rausch was given the task of arranging the radiation presentation with the appropriate NASA speaker.

Mr. Hubbard asked what is NASA's rationale for ARM, and Mr. Williams responded that it was to advance our capability to ultimately take us to Mars. Mr. Hubbard suggested that NASA should stick to this main point. In particular, the planetary defense rationale seemed to confuse everyone. Mr. Bolden explained that saving the planet is not part of ARM, but is part of the White House initiative known as the Asteroid Grand Challenge. ARM, however, can help inform the people who are working on the Asteroid Grand Challenge. The Council members agreed that the references in two bullets that stated "to defend our home planet" as part of the ARM objectives contained in Mr. Williams' presentation (chart 14) were not helpful, and recommended their deletion.

Dr. Squyres thanked Mr. Williams for his presentation. He announced a short break, and reminded the Council that it was charged with providing "actionable advice" to NASA, and that a very important Council discussion would take place after the break. To that end, he had allowed a great deal of time on the agenda for it.

Council Discussion

Following the short break, Dr. Squyres opened the floor for comments from the Council. Mr. Young asserted that the most important problem in the U.S. human spaceflight program is the lack of an executable mission. He explained that at the current rate of spending in NASA's budget for human spaceflight, over the next two decades NASA will have spent approximately \$160B for human spaceflight. This is the equivalent of 20 James Webb Space Telescope missions, 60 Mars Curiosity missions, or 1,000 Discovery-class science missions. That would not bother him if it resulted in humans on Mars, however, he expects that by 2035, with \$160B spent, the Nation will not be closer to Mars than it is today. He advised that there are only two choices: fund the Mars strategy or adjust the scope to be consistent with available funding. He suggested that the Council make a strong statement calling for the leadership to address the situation. He noted that this is the greatest problem facing NASA, and he had never before seen a problem of this magnitude. Mr. Hubbard commented that Mr. Young had gone to the heart of the matter. Mr. Hubbard noted that it is "inconceivable that after 40 years of study that someone today could not pick a plausible path to Mars." He explained that what has been presented is not a program of record. Mr. Hubbard encouraged NASA Administrator Bolden to find someone to put together the Mars program of record for \$160B and see what is possible. Dr. Ballhaus noted that he concurred with Mr. Young and Dr. Hubbard, and asked, "What is the program, and what drops out? And if not Mars, he said, what should be the strategy and goal for other nations to follow us?" He suggested NASA use the "soft-power" argument to support international cooperation, and lamented that Mars "is always 30 years away."

Mr. Hale observed that NASA is hemmed in by the U.S. National Space Policy get to Mars by the 2030s and by the asteroid mission. He noted that he is passionate about human spaceflight, and reflected that he has a mixed mind on whether the U.S. should go to Mars or return to the Moon. In any event, he expressed the view that the future U.S. human spaceflight program "should not be about flags and footprints – it must be sustainable, and we must go there to stay this time." Mr. Hale opined that he is at loggerheads over how to fix the current situation, that NASA's current plan perhaps made sense because it touched all the bases, and the only question it begs is the funding aspect. He suggested that the Council should endorse the current plan, at least on an interim basis, as a framework for proceeding forward. Mr. Young stated that the U.S. top leaders need to be told, "The current strategy is not executable," and they should be forced to deal with it. Gen. Lyles noted that he served on both the 2009 Augustine Committee and the 2004 Aldridge Committee, and the Augustine Committee had noted that NASA needed an additional \$3B to execute the program. He added that the Augustine Committee had advocated "pay as you go" not "go as you can afford to pay." He opined that he wished it were possible to change the current U.S. National Space

Policy but NASA is locked into it, and it is not executable. He recommended taking incremental steps to get to Mars. Dr. Austin counseled that NASA should communicate what it can execute within the current budget, and what could be executed with additional funding, and then let people conclude what to do about it. Dr. McComas indicated that Mr. Young's earlier comments resonated with him also. He added that radiation is a major hurdle and could be a "go/no go" problem, hence this issue needs to be put on the table now and not pushed aside. He noted that he personally considers it unwise that the U.S. National Space Policy states the goal as "orbiting Mars, not "landing on Mars." He opined that perhaps the former is a way to make the current budget fit the goal. Mr. Bowersox agreed with the comments that NASA must have a Mars strategy in order to obtain funding. He asserted that based on history, it is a smart approach not to lay out the total budget all at one time. He advised that the Council should also identify what NASA is doing now that seems to be right.

Mr. O'Brien commented that NASA has a vehicle gap because there is a communications gap. Frankly, in his view the public is not engaged with NASA, and neither is Capitol Hill. The basic question, "why Mars?" has not been answered. He stated that he had not seen a clear articulation of the rationale for going to Mars to the American public. "We're operating in a bubble," he said, and NASA's messaging is not reaching most Americans. He suggested that one answer to the question, "why Mars?" might be international cooperation, as demonstrated by the ISS partnership. Mr. Young reported that the NRC panel had also considered this subject and did not identify a compelling rationale for going to Mars. Dr. Ballhaus suggested that the Moon would be as good as Mars for the purpose of international cooperation. Mr. O'Brien suggested discussing with the international partners the Moon as a destination. Mr. Hubbard opined that no one rationale for going to Mars captures everyone in America, one needs several rationales. Mr. O'Brien responded that the ISS deserves the Nobel Peace Prize for its international partnership, and that too much focus is given to "the United States going to Mars." Why not explore Mars as an international endeavor, and communicate it as such?

Ms. Blakey counseled that it is important to recognize that the NAC is not going to change U.S. National Space Policy, but it can still be effective under the existing circumstances. She asserted that it is incumbent on the NAC members to be strong advocates as individuals, separately as well as in this group. She observed it is not realistic to think that the NAC will be able to cause the President to change his mind and shift his policy. Dr. Squyres noted that he was inspired by Ms. Blakey's comments.

Dr. Squyres requested that the Council discuss the ARM. Mr. Hubbard advised that NASA obtain an independent cost review for the ARM if NASA wants Congress to fund it. He suggested that just one rationale, one bullet would suffice as the rationale for ARM: "Technology demonstration for the future exploration of Mars." He added that Mr. Williams' presentation should also have included OSIRIS-REx, and the impact of this asteroid mission on the ARM mission. He also suggested that the OSIRIS-REx mission returning samples from an asteroid back to Earth may present a better alternative to ARM.

Mr. Young noted that President Obama had directed NASA to "go to an asteroid" not "bring an asteroid to the Moon." NASA at the time should have spoken up and said that the asteroid mission was "too hard" and not allowed it to become the U.S. Space Policy. Mr. O'Brien agreed that ARM does not help the Mars narrative of the Agency. Mr. Young stated, "In my opinion, the ARM mission does not get us one inch closer to Mars, and as a technology demonstration, it doesn't do much either." He noted that Capitol Hill is more supportive of NASA going to an asteroid in its natural orbit than NASA bringing an asteroid to the Moon. Ms. Blakey queried him for his recommendation on the ARM, and Mr. Young responded, "Don't do it."

Mr. Hale noted that some opportunity is needed to develop and demonstrate the hardware that would be needed for going to Mars. Mr. Bowersox explained that it had taken him some time to warm up to the ARM mission, but that one beneficial element in the ARM is that it calls for operations in cis-lunar space. Mr. Hubbard reported that Dr. Richard Binzel, MIT Professor of Planetary Sciences, has noted there are several asteroids that could be visited in their native orbits with significantly greater ease than previously realized, and NASA should consider going to them. Dr. Ballhaus stated that he did not expect that President Obama would change his mind about the asteroid mission in the last 2.5 years of his Administration, so the only question for the Council at this point is: "Does ARM advance the path to Mars?" – for example, with the development of solar electric propulsion (SEP)?

Dr. Squyres summarized the Council's deliberations on the ARM. NASA is looking at an asteroid initiative that has three elements. The costs for the second element (redirect the asteroid to cis-lunar space) are poorly defined. The

other elements – searching for target asteroids and sending humans to cis-lunar space – make good sense. NASA should at the earliest opportunity obtain an independent cost estimate for the ARM and state the criteria for proceeding with the mission. The estimate should be obtained before the down-select. At Mr. Hubbard’s request, it was agreed to include a reference to the possibility that there may be asteroids that could be visited in their native orbits. The Council indicated its general consensus with Dr. Squyres’ summary.

Dr. Squyres noted that another topic arises from fact that the current budget-limited flight rate for the SLS is substantially below any previous human-rated flight system. NASA should examine the safety recommendations and determine what flight rate would be too low a flight rate. There also may be other uses for SLS that do not involve Human Exploration and Operations (HEO) requirements that could be used to increase the flight rate. Dr. McComas reported that the NAC Science Committee was exploring that possibility jointly with the NAC HEO Committee. Dr. Ballhaus noted that in his view and experience, a minimum flight rate of four per year is necessary and asked how is NASA going to mitigate this risk for SLS if it only flies once every two years? Mr. Young reported that the U.S. Air Force had decided that it could not afford to fly Delta-II rockets at the flight rate proposed for the SLS. Dr. Squyres added that NASA should also take a hard look at whether radiation exposure for crews could pose a significant threat to the horizon goal of getting humans to Mars. Dr. McComas advised that NASA needs to deal with this issue up-front, sooner rather than later, and not kick this can down the road – or accept the increased risk. Any statistical studies should include environments and systemic variability. Mr. Bowersox noted that radiation is a systems problem relating to the mass that can be carried. At Ms. Blakey’s suggestion, it was agreed that NASA would be asked to provide a briefing on this issue to the joint committees and to the Council as a whole. Ms. Rausch was given the task to arrange the NASA radiation briefing for the Council at its next meeting, and will follow up with the NASA Chief Health and Medical Officer, Dr. Richard Williams. The presentation should also include the results of the recent Institute of Medicine (IOM) study.

Dr. Squyres stated that the current mismatch between NASA’s aspirations and current budget is the largest problem facing the U.S. civil space program. He asked the Council if there should be a recommendation that the NASA Administrator identify the elements of the current Agency portfolio that should be sacrificed if the U.S. National Space Policy remains unchanged. Gen. Lyles cautioned that this could result in Aeronautics being chosen as an easy target. Mr. Young commented that the Augustine Committee had concluded in 2009 that NASA needed an additional \$3B, and the only two possible human spaceflight program candidates to be sacrificed are the ISS program or the Exploration program; all other Agency program budgets are too small to make to significant difference. He added that only one human spaceflight program can be afforded. Dr. Bowersox urged caution over stern wording in a NAC recommendation; it could cause turmoil at the lower levels of the Agency. Mr. O’Brien noted that such a recommendation might spark a larger debate. Mr. Hubbard said he worried that throwing the “\$3B” number into the debate – is it the right number? Dr. Squyres stated he wished to stimulate a serious conversation as to whether Mars is a long-term goal if we as a nation cannot afford it. In his view, the \$3B number has a questionable heritage at best. He added he wanted to identify “the low-hanging fruit” if a flat-level budget for NASA continues in the future. Another alternative would be to request NASA to establish priorities. Dr. Austin counseled that any managing enterprise must be able to say that there is no more money; this helps form a decision. Ms. Blakey cautioned that Congress might initiate its own cuts if NASA suggests areas that NASA would be willing to cut. Dr. Squyres stated he would develop the proposed wording for, at a minimum, a Council finding that states the obvious: “we can’t get there from here,” and would attempt to say more that would be actionable and hopefully help the U.S. civil space program.

Public Input

Dr. Squyres temporarily suspended Council discussions at 4:50 pm in order to invite comments from the public, as stated on the NAC agenda. A student from Purdue University spoke over the telephone line and introduced himself. He referred to NASA’s Exploration Design Challenge, where student teams are competing to design shielding to protect a sensor inside Orion from space radiation. The winning design will be flown in Orion during EFT-1. The speaker noted that the Orion is a large enough spacecraft to fly many experiments from many contestants. He suggested that expanding the program in that way would keep everyone engaged in working on the problem for the next 10-20 years until the problem is solved. He also suggested that NASA delegate costs other than the Orion service module to the Europeans and obtain additional lift capability from commercial space. He added that commercial space is a vital step in moving forward. Dr. Squyres thanked the student for his comments. There were no other comments from the public.

Council Discussion (continued)

Dr. Squyres asked Mr. Bowersox to prepare a draft recommendation on the SLS flight rate. Dr. Squyres assigned to himself a task to draft a finding on the affordability of Mars as a horizon goal. Mr. Young explained that he would oppose a finding on that topic without a recommendation. Dr. Squyres agreed to include a proposed recommendation with his draft finding. Dr. Squyres asked Dr. Hubbard to prepare a proposed recommendation on the ARM with assistance from Mr. Young.

Mr. Young suggested that another topic that the Council should consider is the James Webb Space Telescope (JWST) launch vehicle, Ariane 5. He noted that NASA is planning for the JWST to be launched on an Ariane 5 in 2018. Mr. Young explained that neither the U.S. Air Force, nor the National Reconnaissance Office (NRO) would fly a critical payload on that vehicle. Dr. Ballhaus reported that Ariane 5 has experienced 1 failure in 44 launches, and that when the NASA agreement was entered into, the estimated total cost for the JWST mission was only \$500M. That cost has now grown to almost \$8B, and JWST is a critical payload. The U.S. Air Force does independent verification of launch vehicles it contracts for to launch its payloads, but NASA has an international cooperative agreement in place for the Ariane 5 launch vehicle to launch JWST, not a contract. Hence, NASA is entitled to some insight, but does not have a mission assurance role. Dr. Ballhaus recommended that NASA think carefully about the national treasure it is about to launch and renegotiate the cooperative agreement to permit independent mission assurance for the Ariane 5 launch vehicle. He added that he had been in discussions with Jim Norman of HEOMD at NASA Headquarters on this issue. Dr. McComas noted that this issue calls for expertise that is not available in the NAC Science Committee. Dr. Austin agreed that the risk posture for JWST has changed significantly due to the significantly increased cost from \$500M to \$8B, and it is an issue for the NASA Administrator to reassess. At her suggestion, the Council agreed to request a briefing on the issue from NASA at its next meeting, preferably from Dr. John Grunsfeld, NASA Associate Administrator for the Science Mission Directorate. Ms. Rausch will follow up on this action to arrange the JWST briefing.

Adjournment

The meeting was adjourned for the day at 5:10 pm.

Thursday, July 31, 2014Call to Order, Announcements

Ms. Rausch called the NAC meeting to order and welcomed everyone to the second day of the meeting. She reminded Council members that the meeting was a public meeting and as such, 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

Dr. Squyres thanked the Council members for a productive first day, and indicated that the second day would focus on hearing reports from the five committees and Council deliberations on recommendations and findings.

Aeronautics Committee Report

Dr. Squyres introduced Ms. Blakey, Chair, Aeronautics Committee. Ms. Blakey reviewed the Committee's membership and the areas explored at its most recent meeting. She described the Aeronautics Research Mission Directorate's (ARMD) Strategic Implementation Plan, which represents the view for Aeronautics research over the next 20 years. The plan reflects a hierarchy of Strategic Thrusts, Outcomes, Research Themes, and Technical Challenges contained in ARMD's Analysis Framework. A chart was presented on ARMD's Planning Framework. It shows that ARMD research is organized into six Strategic Thrusts: Safe, Efficient Growth in Global Operation; Innovation in Commercial Supersonic Aircraft; Ultra-Efficient Commercial Vehicles; Transition to Low-Carbon

Propulsion; Real-Time System Wide Safety Assurance; and Assured Autonomy for Aviation Transformation. Another chart showing the outcomes for Strategic Thrusts in the near-term, mid-term, and far-term was discussed. Ms. Blakey reviewed reasons for low carbon propulsion. A chart was shown on jet fuel characterization research. She described how new propulsion concepts are being pioneered.

Ms. Blakey discussed the Advanced Composites Project (ACP) and its technical challenges. She explained that much duplicative testing in industry could be eliminated if there were agreement on general standards. NASA's partners in the ACP are industry, academia, and the FAA. The roles for each partner were explained. She described the Advanced Composites Consortium (ACC). Ms. Blakey presented for the Council's consideration a proposed Committee finding on the ACP for the ARMD Associate Administrator. The Council approved the finding, which reads as follows:

The Committee believes the Advanced Composites Project is a particularly high value initiative and endorses the approach that NASA ARMD is taking to establish a management and technical plan. The Committee feels that the research goal of reducing the development and certification timeline of composites is an important one that, if successful, will provide benefits to both the aerospace industry and the National economy. The Committee recognizes that there are challenges implementing collaboration aspects of the project (other government agencies - FAA and DoD, academia, industry, and the consortium implementation) that breaks new ground but finds that the approach by ARMD is well thought out. The Committee looks forward to continuing to work with ARMD to provide guidance and advice as the project continues to develop.

Ms. Blakey reviewed the previous NASA Advisory Council recommendation: Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Project Demonstration Mission [2013-01-02 (AC-01)]. NASA's response to the recommendation described a Capstone Demonstration in the design phase and a plan for it to be flown during FY 2016. There are three proposals and one is to be selected. A chart was presented describing the testing and evaluation planned for the demonstration. Ms. Blakey described the NRC's recent report on Autonomy Research for Civil Aviation. The NRC's vision for increasingly autonomous aircraft and ground systems was reviewed. The key challenge is assuring that advanced systems will enhance, rather than diminish, the safety and reliability of the NAS. The most urgent and most difficult high priority research projects identified by the NRC are: Behavior of Adaptive/Nondeterministic Systems; Operation without Continuous Human Oversight; Modeling and Simulation; and Verification, Validation, and Certification.

The NRC study found many substantial barriers to the increased use of autonomy in aircraft. The study also found several potential benefits to increased autonomy for civil aviation, including improved safety and reliability, reduced acquisition and operational costs, and expanded operational capabilities. The extent to which those benefits are realized will depend on the degree to which the barriers are overcome, the extent to which military expertise can be leveraged, and the extent to which government and nongovernment efforts are coordinated. The FAA will need to develop technical competency and issue new regulations to enable safe operations. Dr. Hubbard expressed doubt that the FAA would issue the necessary regulations. He observed that it is difficult to get the FAA and NASA to do anything together other than talk. Ms. Blakey explained that without new regulations, the FAA could risk losing control of the situation.

Mr. Young asked whether NASA should acquire an X-airplane for research into sonic booms and other matters. Ms. Blakey responded affirmatively and explained that those planes are very expensive. Dr. Squyres suggested that X-plane acquisition is an issue that the Committee could bring to the Council as an agenda item. Ms. Blakey agreed to do so.

Dr. Squyres thanked Mr. Blakey for her presentation.

Human Exploration and Operations Committee Report

Dr. Squyres introduced Mr. Bowersox, Chair, Human Exploration and Operations (HEO) Committee. Mr. Bowersox described the Committee's membership. He presented a chart showing HEOMD's organizational structure. The status of the ISS was discussed. A chart was presented on planned ISS port utilization. Mr. Bowersox noted that the international partners attend many of the launches and that Mr. William Gerstenmaier, Associate Administrator for HEOMD, uses the launches as an opportunity to build relationships among the internationals to

join NASA in the Exploration program. Mr. Bowersox noted that NASA's relationship with its international partners remains as good as ever, notwithstanding the current political turmoil. He suggested that that is a good reason for having international partnerships and that the international partners want to participate with NASA in Exploration. Photographs of the Expedition 38 and 39 Soyuz crews were shown. Mr. Bowersox described a recent micrometeoroid orbital debris (MMOD) strike on the ISS's P4 Photovoltaic Radiator (PVR). He described the first rodent research on ISS, Rodent Research-1, commenting that rodent research is exciting science.

Mr. Bowersox reviewed the ISS Top Program Risk Matrix. The highest risk continues to be lack of assured access to the ISS. The next highest risks are pension harmonization and operations budget reduction. Mr. Bowersox described a mishap investigation into what caused water to leak into an Extravehicular Mobility Unit (EMU) helmet during a spacewalk last year. The prime suspect is a filter that had not been properly cleaned. The investigation must be completed before nominal spacewalks can be resumed. He briefed the Council on the status of commercial spaceflight. The Commercial Orbital Transportation Services (COTS) contract has been successfully completed and regular resupply missions to the ISS are in progress. The Commercial Crew Program (CCP) is concluding the Commercial Crew Integrated Capability (CCiCap) Space Act Agreement (SAA) work. The Commercial Crew Transportation Capability (CCtCap) contract(s) for the final phase of Commercial Crew development are planned to be awarded in August or September. In August, NASA will award multiple no-exchange-of-funds SAAs for the Collaborations for Commercial Space Capabilities initiative. The CCP Level I Risk Matrix was reviewed. The top three risks are: NASA's costs may exceed NASA's budget, NASA-unique requirements may drive costs up, and there may be a lack of competition.

Mr. Bowersox described a presentation on HEOMD and Science Mission Directorate (SMD) joint activities. The presentation had been given by NASA's Planetary Science Division to a joint session of the NAC HEO and Science Committees. A chart was presented on radiation measurements on Mars obtained by the Curiosity rover. He noted that the chart reflects only a single data set. Dr. McComas explained that solar flares and extragalactic cosmic radiation are the two main sources of radiation. Solar flares are periodic and pass in a few days, while cosmic radiation is continuous. Dr. Squyres noted that the Council will be briefed by NASA about the radiation problem at its next meeting. Mr. Hale commented that radiation is a significant concern. The Mars 2020 rover was discussed. It will conduct rigorous *in situ* science and retain a returnable cache of samples. Mr. Bowersox described the ARM and its three segments: identify, redirect, and explore. An update was given on the SLS. The SLS will have a greater mass lift capability than any other launch vehicle in the world. It will have a larger payload fairing than any other launch vehicle, producing the greatest available volume. Its high departure energy will be available for missions throughout the solar system and beyond. Europa exploration is a possible use for the SLS. The SLS can provide direct injection to Jupiter, eliminating several years of planetary gravity assists, thereby reducing flight time to Europa from 6.3 years to 2.7 years. Additional benefits from using SLS for Europa exploration are reduced operational costs, reduced mission risk, and greater mass margin. A summary chart was shown on the SLS benefits in its 70-ton and 130-ton configurations. The 70-ton configuration will be used to launch the Exploration Mission-1 (EM-1) and EM-2 flight tests. SLS is currently on schedule for its first launch in December 2017.

Mr. Bowersox briefly reviewed a presentation that Mr. Greg Williams had given earlier in the week to the HEO Committee on the NASA Human Exploration Strategy. It was noted that the presentation was the same presentation that Mr. Williams had given to the Council earlier in the day. The EMC was described. Mr. Bowersox explained that NASA is developing plans that must be sustainable in the future, which is the reason for maintaining flexibility in the program. He discussed the Mars Split Mission concept.

Mr. Bowersox presented to the Council for its consideration a proposed NAC recommendation for NASA to determine a minimum launch rate for the SLS. Dr. McComas concurred with the recommendation and suggested that the consequences of no action include a reference to safety. Mr. Hale expressed concern that by including cost, cost becomes the driver. Dr. Austin explained that the recommendation provides motivation to look for science missions that could use the SLS. Dr. McComas noted that the Science Committee was unable to find a good reason to use the SLS for science missions. Dr. Ballhaus expressed doubt that either the science community or the defense community would want to contribute to the SLS's cost. Dr. Squyres explained that the SLS flight rate is an issue that the Council has been discussing and is concerned about. It would be worthwhile, therefore, to bring this concern to the NASA Administrator's attention and ask the Agency to address it. At Dr. Squyres' request, Mr. Bowersox agreed to redraft the section on consequences. The Council approved the recommendation as follows:

The NAC recommends that NASA conduct a trade study to determine a minimum launch rate for the SLS with respect to cost, safety, mission success, and performance.

Mr. Bowersox presented to the Council for its consideration a proposed NAC finding to endorse several aspects of NASA's Human Exploration Strategy. The aspects proposed to be endorsed were:

- Mars as a horizon goal for human space exploration;
- An intermediate exploration goal which is affordable and allows development of systems that can later be used for more distant exploration of the solar system;
- An approach that emphasizes affordability and allows re-use of system components;
- A flexible approach, which allows reassessment of goals and objectives as the U.S. economy and technical capability develop with time; and
- Potential areas of involvement for commercial and international partners.

Mr. Bowersox explained that the finding is intended to show NASA what the Council thinks is being done right. Mr. Hubbard noted that the proposal is inconsistent with the NRC finding that sending humans to Mars is unaffordable. Mr. Young concurred with Mr. Hubbard that the finding is at odds with NRC's assessment. He asserted that the item on flexible approach "picks a fight." Mr. Young explained that "go as you pay" make sense until a project is started; however, once a project is started, it is the most expensive way to implement the project. Ms. Blakey endorsed the concept of putting forward positive aspects of the program. Mr. Hale concurred with Ms. Blakey and noted that the finding does not completely endorse the plan. Dr. Squyres commented that the finding would provide a balance to the Council's other actions. He suggested removing the item on flexible approach. Dr. Hubbard concurred with Dr. Squyres' suggestion. Action on the finding was tabled for further consideration later in the meeting.

Council Discussion

The Council considered a possible recommendation concerning the ARM. The issue was whether NASA should conduct an independent cost and technical assessment of the mission. Mr. Bowersox noted that it would be good to ask for an independent cost estimate. He added that going to a cis-lunar destination may be less expensive than going to Mars. Dr. Squyres asked that Mr. Bowersox and Dr. Hubbard draft a proposed recommendation for the Council to consider later in the meeting.

Dr. Squyres presented for the Council's consideration a proposed recommendation addressing the "mismatch" between NASA's aspirations for human spaceflight to Mars and NASA's budget. He explained that this is the most serious problem facing the Agency. Mr. O'Brien noted that the recommendation appeared to be only a request for a briefing on costs. Mr. Young opined that the program should be abandoned if NASA would be only negligibly closer to getting to Mars after spending \$160B. Dr. Hubbard and Mr. Young requested a briefing by NASA on the costs for the EMC at the next Council meeting. Dr. McComas asserted that only the minimum path to Mars should be considered. Dr. Squyres agreed to rewrite the recommendation and present it to the Council for its consideration later in the meeting.

Institutional Committee Report

Dr. Squyres introduced Ms. Kathryn Schmoll, Chair, Institutional Committee. Dr. Squyres noted that this was the NAC's newest committee and that they had held their first meeting earlier in the week. Ms. Schmoll described the individuals who have been recruited and appointed to serve on her Committee. She provided an excerpt from the NAC Institutional Committee Terms of Reference that describe its broad scope:

The Institutional Committee is a standing committee of the NASA Advisory Council supporting the advisory needs of the NASA Administrator, the Mission Support Directorate, and the NASA Mission Directorates, as required. The scope of the Committee includes all NASA institution-related programs, projects, and activities – including human capital; finance; information technology; infrastructure; acquisitions; security; real and personal property; and business and administrative capabilities.

Ms. Schmoll provided an excerpt from the NAC 2014 Work Plan on two items that have been assigned to the Institutional Committee:

- *Overhauling NASA's Information Technology (IT) Governance Structure, and Ensuring the Security of NASA's IT Systems:* Review and assess Agency's plans to overhaul the current IT governance structure and ensure the security of NASA's IT systems.
- *Acquisition Reform, and Ensuring the Integrity of the Contracts and Grants Processes:* Review and access Agency plans for acquisition reform and ensuring the integrity of the NASA contracts and grant process.

Ms. Schmoll reviewed the topics discussed by the Committee at its first meeting. These included an overview of the Federal Advisory Committee Act (FACA) by Ms. Rausch; a discussion on the Committee's work plan; an overview of the NASA Mission Support Directorate; an ethics briefing; an overview on NASA IT; and an overview on NASA acquisition and contracts. Due to lack of time, there was no time to discuss NASA grants processing; this topic will be handled at the next Committee meeting. The Committee's next meeting has been tentatively scheduled for November 19-20, 2014, at NASA Headquarters. Detailed briefings will be requested on: NASA facilities, NASA workforce planning, the Technical Capability Assessment Team (TCAT), the Business Capability Assessment Team (BCAT), the NASA Shared Services Center (NSSC), IT security, grants processing, and NASA's budget structure and management.

Ms. Schmoll observed that NASA's infrastructure is aging, that some NASA facilities have to be phased out, and that the ones remaining need to be as good as they can be. Dr. McComas explained that in the IT security area it is important to draw a distinction between computers on one hand and the business of science and data on the other hand. He offered to work with the Institutional Committee on those issues. Ms. Schmoll suggested holding a joint session with the Science Committee.

Dr. Squyres expressed the Council's appreciation to the Institutional Committee for its willingness to take on a massive set of issues and to Ms. Schmoll for taking on the role of Committee Chair.

Council Discussion (cont'd)

The Council resumed its discussion on Dr. Squyres' proposed recommendation. A consensus was reached on the following language:

The mismatch between NASA's aspirations for human spaceflight and its budget for human spaceflight is the most serious problem facing the Agency. NASA should carefully consider what steps would have to be taken in the years ahead in order to meet the national goal of sending humans to Mars in the 2030s with a realistic budget. The Agency should be prepared to articulate these steps publicly.

Using the best available information for Humans to Mars selected from the past 40+ years of studies, NASA should identify the "minimum path" of only those technologies and capabilities absolutely required, and perform internal and independent cost estimates of this minimum path. The result should be compared to a notional 25-year budget that only grows with inflation. The resultant shortfall should be used to address what combination of budget increase, added partnerships, and/or adjustments to NASA portfolio scope would be necessary to attain that goal.

Addressing this important issue will be an ongoing process. We request that the Agency brief us regarding the implementation of this recommendation at our next meeting, and at subsequent ones.

The Council resumed discussion on the HEO Committee's proposed finding on NASA's Human Exploration Strategy. Dr. Austin recommended that the finding reference the Council's related findings from the current session. Dr. Squyres concurred. Mr. Young noted that the Strategy contains pages of additional elements, and he queried whether the proposed finding would mean that the Council does not endorse those additional elements. Dr. Hubbard counseled that "attaboy" findings generally mean nothing, and that the things that are paid attention to by managers are those specific things that you are told should be done better. Mr. Young explained that the two big issues for Mars are "getting a lot of stuff on the surface" and "the astronauts not dying from radiation." Mr. Hale expressed concern that the finding might confuse people into thinking that the NAC endorsed the ARM. Dr. Squyres observed that there was "grudging" agreement around the table. At Dr. Squyres' request, Mr. Bowersox agreed to rewrite the finding and present it to the Council for its further consideration later in the meeting.

Mr. O'Brien asked whether it would be appropriate for the NAC to be part of a campaign to engage the American public on the future of NASA's human spaceflight program. He suggested that the Council might consider being more forward-leaning in its public relations, and asked whether issuing a press release on the results of this NAC meeting would be beneficial, and perhaps doing some briefings. Mr. Young and Dr. Hubbard concurred. Dr. Squyres stated that perhaps a higher public profile for the NAC could help, not as destructive criticism but with "tough love" as the goal. Ms. Rausch was asked if there was any precedent for NAC press releases, and she responded that there had been several examples in the past. She cited as one example the press release announcing Dr. Squyres' appointment as the Council Chair several years ago. As a first step, Dr. Squyres agreed to consider drafting a NAC press release reporting on the Council findings and recommendations from this meeting. He asked Ms. Rausch to consult with the Office of Communications at NASA Headquarters on the potential news value of such a press release, and to keep him and Mr. O'Brien informed on her progress.

The Council agreed on dates and locations for its next three meetings. It will meet on December 8-9, 2014, at NASA Stennis Space Center in Mississippi; on April 8-9, 2015, at NASA Headquarters in Washington, DC; and July 27-31, 2015, at the Jet Propulsion Laboratory in Pasadena, California. The latter will be the NAC annual all-hands meeting.

Orbital Debris (via WebEx)

Dr. Squyres introduced Mr. Eugene Stansbery, Program Manager, Orbital Debris Program Office (ODPO), NASA Johnson Space Center (JSC). Mr. Stansbery briefed the Council on the ODPO goals and objectives. Its goals are to preserve the space environment in the area of orbital debris (OD) for the continued safe operation of both robotic and human crewed spacecraft and to raise global awareness of OD issues and effective mitigation strategies, standards, and requirements. The goals are intended to ensure that U.S. space industry has a "level playing field." The Program's objectives include OD environmental definition and measuring, space vehicle risk assessments, developing mitigation measures, and research and development. The ODPO research program and office interfaces were described. Mr. Stansbery described OD related tasks performed by other NASA groups. Collision avoidance for human crewed spacecraft is performed by JSC's Mission Operations Directorate (MOD). Collision avoidance for robotic spacecraft is performed by NASA Goddard Space Flight Center's Conjunction Assessment Risk Analysis (CARA). Spacecraft shielding and hyper velocity testing is performed by the Hyper Velocity Impact Technology Group (HVIT). Remediation related technology development is assigned to STMD and OCT at NASA Headquarters.

Mr. Stansbery explained that OD is defined as any object in Earth orbit that no longer serves a useful function. A chart on the amount of OD in space was presented. Mr. Stansbery discussed OD detection responsibilities and capabilities. The Department of Defense (DoD) is the lead for objects over 10 centimeters in LEO and over 1 meter in geosynchronous orbit (GEO). Charts were presented showing the growth of the satellite population, the number of fragments in orbit, the mass of objects in orbit, and OD spatial densities from LEO to GEO. A chart on orbital debris detectors and damage potential was shown. Mr. Stansbery provided an overview on U.S. OD mitigation policies. He described standard practices for OD mitigation. He reviewed international mitigation efforts. A chart was discussed on the effects of the Chinese anti-satellite test in 2007, and the collision between Iridium 33 and Cosmos 2251 in early 2009. Mr. Stansbery described the Ground Electrical Optical Deep Space Surveillance (GEODSS) network. He discussed DebrisSat, which was a satellite fabricated to be representative of modern payloads in LEO and used in a hypervelocity impact test with sufficient kinetic energy to break up the satellite. He described the Debris Resistive Acoustic Grid Orbital Navy-NASA Sensors (DRAGONS) test program, which is used to provide data on debris smaller than one millimeter.

Mr. Stansbery concluded his presentation by relating a success story on how the Space Shuttle STS-128 had been hardened with modifications based on orbital debris models and hyper velocity impact tests. A post flight inspection found micrometeoroid damage to a payload bay radiator located directly above a Freon cooling loop. Without the modifications, the impact could have forced an early termination of the mission and a landing with reduced avionics. Mr. Stansbery asserted that the cost saved in preventing an early termination of the mission justified all the money spent to date on the ODPO. In response to a question from Dr. Austin, Mr. Stansbery noted that the ISS has been moved 18 times in order to avoid micrometeoroid damage. He explained that 1 in 10,000 is the risk threshold for when a maneuver is triggered. In response to another question from Dr. Austin, Mr. Hale explained that there is a plan to deorbit the ISS at the end of its life span. Mr. Hale added that he sees no recommendations about OD for the

Council to give to NASA. In response to a question from Dr. McComas, Mr. Stansbery explained that OD travels at 10 to 11 kilometers per second. In response to a question from Dr. Ballhaus, Mr. Stansbery described the Kessler syndrome, which is where the density of objects in LEO is high enough that collisions could cascade, resulting in OD that could render space exploration unfeasible. Mr. Stansbery explained that the current prediction is for one satellite collision every 10 years. That would not prevent spaceflight; it would, however, double the risks. For people interested in learning more about OD, Mr. Stansbery suggested the website at: <http://orbitaldebris.jsc.nasa.gov>.

Dr. Squyres thanked Mr. Stansbery for an exceptionally helpful briefing. Dr. Squyres noted that this is a serious problem with no easy answers. He agreed with Mr. Hale's assessment that there is nothing for the Council to recommend. Mr. Hale commented that stabilizing the budget would be helpful.

Council Discussion (cont'd)

The Council resumed its discussion on the HEO Committee's proposed NAC finding to endorse aspects of NASA's Human Exploration Strategy. Mr. Bowersox presented language that had been revised to take into account the Council's earlier discussions. With minor additional language changes, the Council approved the finding as follows:

The Council has serious concerns with important aspects of NASA's human exploration plans, and has provided three specific recommendations to address those concerns. However, the Council would also like to endorse the following aspects of NASA's current approach to Human Exploration as presented by the Human Exploration and Operations Mission Directorate (HEOMD) Deputy Associate Administrator at the July 30, 2014 meeting of the Council:

- *Mars as a horizon goal for human space exploration.*
- *Intermediate missions to cis-lunar space that will allow development of systems that can later be used for more distant exploration of the solar system.*
- *An approach that emphasizes affordability and allows re-use of system components.*
- *Early investment in enabling technologies.*
- *Involvement of external partners to reduce the total amount of U.S. Government funding.*

Technology, Innovation, and Engineering Committee Report

Dr. Squyres introduced Dr. William Ballhaus, Chair, Technology, Innovation, and Engineering (TI&E) Committee. Dr. Ballhaus introduced Dr. Gazarik and Mr. Mike Green, the Committee's Executive Secretary. Dr. Ballhaus reviewed the Committee membership and the items covered by the Committee at its last meeting. He described Low Density Supersonic Decelerators (LDS) and presented a video showing a recent LDS test. The test involved the largest blunt-body aeroshell ever flown supersonically, the first ever supersonic pilot chute deployment, and the largest supersonic parachute ever deployed. He explained that LDS technology will serve as the foundation for supersonic decelerators over the next several decades. The LDS test infrastructure represents a critical NASA resource for understanding parachute dynamics and quantifying the risk for current and future planetary missions.

Dr. Ballhaus described STMD investments to advance future capabilities of the SLS and Orion and to advance human exploration of Mars. A chart showing major events and milestones through 2019 was presented. Dr. Ballhaus described the successful test of high-power solar arrays. He explained that there are two concepts for deployable solar arrays. The MegaFlex design deploys like a fan. The ROSA design rolls out and can be hooked together to increase power. Those technologies have an advanced TRL of five. The SEP project was discussed. Dr. Ballhaus described Game Changing Development's (GCD) flagship project: composite cryotank technologies. A 5.5-meter diameter composite cryotank has been fabricated and demonstrates a 30 percent mass savings and 25 percent cost reduction. The Green Propellant Infusion Mission (GPIM) project was described. It is much safer than hydrazine. Its reduced toxicity enables it to be handled and processed without having to wear a protective suit. He described a briefing the Committee received from NASA's Chief Technologist, Mr. David Miller, on how technology drives Exploration. A chart was presented on Agency investment for low TRL research.

Dr. Ballhaus discussed a presentation that the Committee received on small spacecraft technology markets. He reviewed a previous Committee recommendation to NASA on the small spacecraft market as additional background::

- *The T&I Committee recommends that STMD characterize the small spacecraft mission market pull.*
 - *Civil, military, intelligence, commercial, academia*
 - *What is the technology's potential utility and societal benefits?*
- *Identify what is NASA's particular role in developing capabilities for this market. How can NASA "move the needle"?*

Dr. Ballhaus presented a chart showing one of the tasks listed in NAC 2014 Work Plan relating to knowledge capture that had been assigned to his Committee. It stated:

Knowledge Capture: Offer suggestions on how to establish and the most useful approach for a Knowledge Capture program. Past NASA technology incarnations left no real knowledge behind for use in the future. NASA's Space Technology Mission Directorate and Human Exploration and Operations Mission Directorate want to be the places where others check first for what has been done, how to do it, and what was learned. These organizations want to be on the cutting-edge and a resource for others.

Dr. Ballhaus reported that STMD has made progress in this area, and he presented a slide showing how STMD captures knowledge.

Dr. Ballhaus then reviewed a previous Council recommendation that NASA establish a basic research (engineering science) program. He described a briefing from a member of NASA's Office of the Chief Engineer, Ms. Dawn Schaible, on Foundational Engineering Sciences (FES). He then presented a proposed joint recommendation from the TI&E Committee and the Science Committee for STMD and SMD to encourage new technologies for small to medium class missions. Dr. Hubbard commented that this is a good idea, but hard to implement. He suggested adding a requirement for an information policy. Dr. Ballhaus concurred. The Council approved the recommendation as follows:

The Council recommends that the Space Technology Mission Directorate (STMD) Associate Administrator and Science Mission Directorate (SMD) Associate Administrator engage with each other and their communities to determine how policies and procedures could be modified to allow the infusion of new mission-enabling and mission-enhancing technologies developed by Principal Investigators, STMD or others in small to medium class missions. Once appropriate policies and procedures have been defined, formulate an implementation plan that assures that the selection decision process is consistent with those policies and procedures.

Dr. Squyres thanked Dr. Ballhaus for his presentation.

Science Committee Report

Dr. Squyres introduced Dr. McComas, Chair, Science Committee. Dr. McComas reviewed the Committee's membership. He asserted that science is NASA's number one objective, and in support of that assertion he presented an excerpt from the National Aeronautics and Space Act of 1958, as amended. It states:

Objectives of Aeronautical and Space Activities.--The aeronautical and space activities of the United States shall be conducted so as to contribute materially to one or more of the following objectives:

(1) The expansion of human knowledge of the Earth and of phenomena in the atmosphere and space.

Dr. McComas discussed a chart showing SMD science as a percentage of worldwide science. He noted that science from extended SMD missions represents a significantly large percentage of all SMD science. He described a joint meeting of the NAC HEO Committee and Science Committee. At the joint meeting, a briefing was given by SMD. Dr. McComas commented that the briefing was intended to cover joint SMD and HEOMD activities, but focused primarily on planetary science. He noted that the two committees were also briefed by HEOMD on the SLS. Dr. McComas noted that committee members expressed concern about the SLS launch cadence, sustainability, and its costs to SMD missions. The committees agreed that an additional joint session is needed. They plan to meet at NASA Headquarters on December 2-3, 2014. Dr. McComas described a joint session held with the TI&E

Committee. The two committees discussed how current practice and policy discourages small and medium science mission proposals from including technology development. They agreed on the text for a joint recommendation.

Dr. McComas described recent science results. The Solar Terrestrial Relations Observatory (STEREO) has mapped a much larger solar atmosphere than previously observed. The Balloon Array for Radiation Belt Relativistic Electron Losses (BARREL) mission returned data from Antarctica. It measured precipitation of relativistic electrons from Earth's radiation belts. NASA-funded researchers have produced high-resolution global mapping of forest cover change from 2000 to 2012, using data from Landsat. The mystery of missing CO₂ was discussed. Dr. McComas explained that less than half of the CO₂ that has been added to the atmosphere by humans since 1958 has remained in the atmosphere. It is unknown where the sinks are that have absorbed the lost CO₂ or how the CO₂ sinks will respond to climate change. New spectral features on Mars' moons indicate the presence of bound hydroxide, which may provide a potential *in situ* resource for water and hydrogen. A new study has shown that stardust floating through the Solar System contains tiny pockets of water. Astronomers have observed that Jupiter's Great Red Spot, which has been shrinking for decades, is now at its smallest size ever and is shrinking at an unprecedented rate. The Spot's spin rate is increasing as it shrinks. Slides were presented showing radar imagery for a near-Earth asteroid, remnants from the Chandra Supernova, and Kepler 186f, the first Earth-size planet in the "habitable zone."

A chart showing FY 2014 program accomplishments in Heliophysics was reviewed. In Earth science, Dr. McComas described the July 2, 2014, Orbiting Carbon Observatory-2 (OCO-2) Delta II successful launch. It will be joining the "A-Train" of Earth science missions already in orbit. He described the upcoming launch of the Soil Moisture Active Passive (SMAP) mission in less than four months, and a briefing received from the Joint Agency Satellite Division (JASD). A chart showing JASD spacecraft and instruments was presented. Dr. McComas described the Mars Commercial Telecomm Request for Information (RFI). The RFI is seeking business models for data-relay services that could be used from orbiter to surface or orbiter to orbiter. Dr. McComas reported on current status of the Hubble Space Telescope, and noted that Spitzer telescope operations have been extended for two more years. He presented a chart on the Widefield Infrared Survey Telescope with Astrophysics Focused Telescope Assets (WFIRST/AFTA), which uses assets provided by the NRO. He reported that the President's Budget Request for FY 2015 proposes to end funding for the Stratospheric Observatory for Infrared Astronomy (SOFIA) and place it in storage. A chart was presented on the results of the Astrophysics 2014 Senior Review. A chart was also presented on JWST progress.

Dr. McComas presented for the Council's consideration a proposed Committee finding on the JWST funding wedge for consideration by the SMD Associate Administrator. Mr. Young stated that JWST is an Agency mission, and as such, its funding takes place outside of SMD's Astrophysics Division. Some elements of the U.S. Government think there is a better use for the money, he said. Dr. Squyres observed that the finding is a recommendation disguised as a finding. The finding was approved by the Council as follows:

The Science Committee encourages the Science Mission Directorate (SMD) Associate Administrator to review the history and evolution of the JWST funding wedge within SMD. The Science Committee believes it would be valuable for SMD to assess the relative contributions toward JWST from all of its divisions and their impacts in developing a Directorate-wide science strategy that optimizes post-JWST SMD science within the available resources, taking into account the relevant decadal surveys and a balanced portfolio.

Dr. McComas presented for the Council's consideration a proposed Committee finding on education and communications for consideration by the SMD Associate Administrator. In response to a question from Mr. O'Brien, Dr. McComas explained that a year ago much education money was taken from the Agency and used elsewhere for education. NASA scientists were very concerned and expressed strong reservations about this development, and, as a result, some of the funding has been reestablished. The finding was approved by the Council as follows:

The Science Committee commends SMD for the establishment of the new Education and Communications group within the SMD front office. The Science Committee continues to stress the absolute criticality of such activities as part of the ongoing work of Earth and space sciences at NASA. We look forward to tracking progress in this area, and in particular, learning how the program maintains a diversity of size of education and communications programs and how they couple with mission scientists, engineers and others.

Mr. Young asserted that the JWST “will make or break NASA.” He commented that he was unable to tell from the briefing how well JWST is really doing. Dr. McComas explained that the NAC Science Committee receives much of its information through its five subcommittees and that specific information about JWST comes through its Astrophysics Subcommittee. Dr. Squyres expressed concern over the JWST “falling between the cracks.”

Dr. Squyres thanked Dr. McComas for his presentation.

NASA Langley Research Center Early Career Employee Presentations

Dr. Squyres informed the Council members that it was time for them to enjoy as “dessert” a favorite part of every Council meeting at NASA’s Field Centers – the opportunity to hear from young, upcoming scientists and engineers to remind everyone about what attracted them to the space business. At Dr. Squyres’ request, Mr. Jurczyk introduced four early career employees from Langley and invited them to address the Council with three presentations:

- Ms. Lindsay M. Rogers, Assistant Program Manager, DEVELOP National Program, gave a talk entitled: “*Applied Earth Science: My NASA Opportunity to Serve Society.*”
- Ms. Christie J. Funk, Research Aerospace Engineer, Research Directorate, gave a talk entitled: “*Shaken Not Stirred: The Perfect Cocktail Needs “The Right Stuff.”*”
- Mr. Kevin Daugherty, Radiation Dosimetry Experiment (RaD-X) Project Manager, Systems Analysis and Concepts Directorate, and Ms. Amanda Cutright, RaD-X Chief Engineer, Engineering Directorate, jointly gave a talk entitled: “*Radiation Dosimetry Experiment (RaD-X).*”

One common thread among all the early career presenters was how their professional career development at NASA was greatly enhanced by the opportunity to have excellent mentors at LaRC who encouraged them.

Dr. Squyres thanked Ms. Rogers, Ms. Funk, Mr. Daugherty, and Ms. Cutright for their presentations. They were applauded by the Council members.

Wrap-up and Final Acknowledgments

Dr. Squyres invited each of the Council members to offer any final comments before the meeting adjourned.

Ms. Austin expressed appreciation for Dr. McComas’ presentation on science at NASA, and she commented that the science data being collected is amazing. She encouraged getting the word out at every opportunity. Dr. Ballhaus observed that there was more substance at this Council meeting compared to the Council meeting one year ago, and the Administrator Bolden’s reorganization of the NAC was an improvement. Mr. Bowersox noted that he had enjoyed working with the Council members at this meeting, and the various discussions held will be helpful. Mr. Hubbard thanked Dr. Squyres for a very substantive top-level meeting, and expressed the hope that the Council will make a difference. Mr. Young stated that it had been a good meeting, that the Council had discussed some very tough issues and had made a good start. He noted that there were great Science results taking place, but noticed some science will dropping off due to budget constraints. Ms. Schmoll expressed that the ISS presentation had been excellent and overwhelming, and regretted that most of the public did not see it. She noted that it had been a great meeting. Mr. Hale commented that the Council had developed good advice on some critical subjects, and believed that it would make a difference. He commended NASA Langley Research Center for many great programs and projects, and expressed appreciation for being a member of the Council.

Dr. Squyres expressed his pleasure with the meeting results. He explained that much thought had gone into the NAC reorganization and restructuring. It had been considered in depth by Mr. Bolden, himself, and NASA’s “three chiefs” (Chief Scientist, Chief Engineer, and Chief Technologist). The result was the current NAC membership and structure with which he was extremely pleased. This NAC meeting had been the first meeting of the full-strength Council. Dr. Squyres thanked Ms. Rausch, her support staff, and the five NAC Committee Executive Secretaries for their assistance. He thanked the NASA Langley staff for the meeting support, and the NASA Langley leadership for their hospitality.

Adjournment

The meeting was adjourned at 5:00 pm.

NASA ADVISORY COUNCIL

**NASA Langley Research Center
Building 2101, Room 305
Hampton, VA**

PUBLIC MEETING

July 30-31, 2014

Wednesday, July 30, 2014

1:00 – 1:03 pm	Call to Order, Announcements	Ms. Diane Rausch Executive Director NASA Advisory Council NASA Headquarters
1:03 – 1:10 pm	Opening Remarks by Council Chair	Dr. Steven W. Squyres Chair, NASA Advisory Council
1:10 – 1:40 pm	Welcome to NASA Langley Research Center	Mr. Stephen Jurczyk Director, NASA Langley Research Center
1:40 – 2:15 pm	Remarks by NASA Administrator	Mr. Charles F. Bolden, Jr. NASA Administrator
2:15 – 2:30 pm	Discussion	
2:30 – 3:15 pm	NASA Human Exploration Strategy	Mr. Gregory Williams Deputy Associate Administrator for Human Exploration and Operations Mission Directorate NASA Headquarters
3:15 – 4:50 pm	Discussion	
4:50 – 5:00 pm	Public Input	
5:00 pm	Adjourn	

Thursday, July 31, 2014

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 – 9:45 pm	Aeronautics Committee Report	Ms. Marion Blakey, Chair
9:45 – 10:30 am	Human Exploration and Operations Committee Report	Mr. Kenneth Bowersox, Chair
10:30 – 11:15 am	Discussion	
11:15 – 12:00 noon	Institutional Committee	Ms. Kathryn Schmoll, Chair
12:00 noon – 1:00 pm	Lunch	
1:00 – 2:00 pm	Orbital Debris (<i>via WebEx</i>)	Mr. Eugene Stansbery Program Manager Orbital Debris Program Office NASA Johnson Space Center
2:00 – 2:45 pm	Technology, Innovation and Engineering Committee Report	Dr. William Ballhaus, Chair
2:45 – 3:30 pm	Science Committee Report	Dr. David McComas, Chair
3:30 – 4:30 pm	NASA Langley Research Center Early Career Employee Presentations:	
	<i>Applied Earth Science: My NASA Opportunity to Serve Society</i>	Lindsay M. Rogers Assistant Program Manager DEVELOP National Program
	<i>Shaken Not Stirred: The Perfect Cocktail Needs “The Right Stuff”</i>	Christie J. Funk Research Aerospace Engineer Research Directorate
	<i>Radiation Dosimetry Experiment (RaD-X)</i>	Kevin Daugherty RaD-X Project Manager Systems Analysis and Concepts Directorate
		Amanda Cutright RaD-X Chief Engineer Engineering Directorate
4:30 – 5:00 pm	Wrapup and Final Acknowledgments	
5:00 pm	Adjourn	

NASA ADVISORY COUNCIL MEMBERSHIP – JULY 2014

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; Former Director, NASA Ames Research Center</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 – 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; Former Director, NASA Ames Research Center</i>
Chair, Institutional Committee	Ms. Kathryn Schmoll , <i>Vice President, Finance and Administration, University Corporation for Atmospheric Research</i>
Member at Large	Gen. Lester Lyles , <i>Chair, Aeronautics and Space Engineering Board, National Academy of Engineering; USAF (Ret.)</i>
Member at Large	Dr. David Spergel , <i>Chair, Space Studies Board, National Academy of Sciences, Princeton University</i>

**NASA ADVISORY COUNCIL
 NASA Headquarters
 Washington, DC
 July 30-31, 2014**

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 (Ret.)
Ms. Marion Blakey	Aerospace Industries Association
Mr. Ken Bowersox	U.S. Navy (Ret.)
Mr. N. Wayne Hale	Special Aerospace Services
Prof. G. Scott Hubbard	Stanford University
Gen. Lester Lyles	Aeronautics and Space Engineering Board
Dr. David McComas	Southwest Research Institute
Mr. Miles O'Brien	Independent Journalist
Ms. Kathryn Schmoll	University Corp. for Atmospheric Research
Mr. A. Thomas Young	Lockheed Martin (Ret.)
Ms. P. Diane Rausch, <i>Executive Director</i>	NASA Headquarters

NASA Attendees:

Applin, Junilla	NASA LaRC
Bales, Rebecca W.	NASA LaRC
Cole, Stan	NASA LaRC
Cutright, Amanda	NASA LaRC
Daugherty, Kevin	NASA LaRC
Feeley, T. Jens	NASA Headquarters
Funk, Christie	NASA LaRC
Green, Mike	NASA Headquarters
Greer, Mike	NASA Headquarters
King, Marla	NASA Headquarters
LaBar, Claire	NASA LaRC
McGowan, David	NASA LaRC
Mullins, Todd	NASA Headquarters
Obland, Mike	NASA LaRC
Rink, Chris	NASA LaRC
Robinson, Shawanda	NASA Headquarters
Rogers, Lindsay	NASA LaRC
Ruiz, Michael	NASA LaRC
Sandford, Steve	NASA Headquarters
Siegel, Bette	NASA Headquarters
Stansbery, Eugene	NASA JSC
Williams, Greg	NASA Headquarters
Wright, Ken	NASA LaRC
Wyman, Robert	NASA LaRC

Other Attendees:

Frankel, David	PB Frankel, LLC
----------------	-----------------

**NASA ADVISORY COUNCIL
NASA Langley Research Center
Hampton, VA
July 30-31, 2014**

LIST OF PRESENTATION MATERIAL

- 1) NASA Langley Research Center [Jurczyk]
- 2) NASA Human Exploration and Operations Mission Directorate [Williams]
- 3) NAC Human Exploration and Operations Committee Report [Bowersox]
- 4) NAC Aeronautics Committee Report [Blakey]
- 5) NAC Institutional Committee Committee Report [Schmoll]
- 6) NASA Orbital Debris Program Office [Stansbery]
- 7) NAC Technology, Innovation and Engineering Committee Report [Ballhaus]
- 8) NAC Science Committee Report [McComas]

Other Material Distributed at the Meeting:

- 1) Space Technology Game Changing Development Program – Winter 2013
- 2) Fact Sheet: SAGE III on ISS
- 3) Fact Sheet: NASA Successfully Demonstrates Inflatable Heat Shield
- 4) Fact Sheet: Game Changing Development—Rapid Technology Infusion
- 5) NASA Langley Research Center 2013
- 6) Autonomy Research for Civil Aviation: Toward a New Era of Flight [National Research Council]