National Aeronautics and Space Administration

NASA Advisory Council

Technology and Innovation Committee

NASA Headquarters

Washington, DC

November 15, 2012

MEETING MINUTES

G. M. Green, Executive Secretary

William F. Ballhaus, Jr., Chair

NAC Technology and Innovation Committee Meeting
November 15, 2012
NASA Headquarters
Room 2E39

MEETING MINUTES
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Meeting Report prepared by:
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NASA ADVISORY COUNCIL
TECHNOLOGY AND INNOVATION COMMITTEE
NASA Headquarters
Room 2E39
Washington, DC 20546-0001

PUBLIC MEETING
NOVEMBER 15, 2012

November 15, 2012

Welcome and Overview of Agenda

The NASA Advisory Council (NAC) Technology and Innovation (T&I) Committee meeting was convened by Mr. G. M. (Mike) Green, Executive Secretary. He welcomed everyone to the multipurpose room at NASA Headquarters and announced that the meeting was a Federal Advisory Committee Act (FACA) meeting open to the public. Meeting minutes will be taken by Mr. David Frankel and will be published. The agenda for the meeting was reviewed and the minutes from the last meeting were circulated to the members.

Opening Remarks and Thoughts

Mr. Green introduced Dr. William Ballhaus, Chair, NAC T&I Committee. Dr. Ballhaus asked the members to be thinking about recommendations and findings for the full NAC. Mr. Green advised the members that a response to the Committee's earlier recommendation to establish a space basic research program had been issued by NASA's Chief Engineer and had been transmitted to the NAC Chair, Dr. Steven Squyres, under a cover letter from the Administrator. NASA concurred with the Committee's recommendation. The response was circulated to the members.

Update on NASA's Advanced Exploration Systems Program

Dr. Ballhaus introduced Mr. Jason Crusan, Director, Advanced Exploration Systems (AES), NASA Human Exploration and Operations Mission Directorate (HEOMD), who briefed the Committee on the AES program. This is a new program that was formulated in FY 2012 when Exploration Technology Development (ETD) was transferred to the Space Technology Program (STP) from the HEOMD. The AES program stayed with HEOMD and ETD's remaining work was incorporated into two programs within STP: Game Changing Development (GCD) and Technology Demonstration Missions (TDM).

AES pioneers innovative approaches for affordably developing new capabilities and follows a "skunkworks-like" model. The program focuses on system-level integration work and prototype/design development to reduce the risk and cost of future exploration missions. Mr. Crusan contrasted the STP and AES objectives and presented a chart defining the combined

AES/STP portfolio. He explained that STP's efforts are more long-range, while AES measures progress by hardware. AES has no "paper milestones." AES' current investments are in crew mobility systems, deep space habitation systems, vehicle systems, operations, and robotic precursor activities.

A chart showing milestones for AES projects was presented. The AES portfolio is being realigned in FY 2013 to support two crewed missions in cislunar space, EM1 and EM2, later in this decade. An MOU was signed with the Science Mission Directorate (SMD) for Joint Robotic Precursor Activities. A Strategic Knowledge Gaps (SKGs) baseline to guide planning for robotic precursor missions has been developed and will be incorporated into the Global Exploration Roadmap. A flight project planning office has been established at Ames Research Center (ARC) to manage the RESOLVE lunar ice prospecting mission.

AES accomplishments in FY 2012 were described and include the following:

- Assessed mobility of Z-1 spacesuit in partial gravity aircraft flight tests. This is the first new design in 25 years. The suit will fit a wider range of sizes than the current suit.
- Tested electrodialysis metathesis system to remove calcium from urine.
- Conducted differential pressure tests for two suitport concepts.
- Designed prototype Portable Life-Support System for advanced spacesuit.
- Demonstrated Heat Melt Compactor for processing trash.
- Demonstrated miniature radiation environment monitor.
- Simulated asteroid exploration mission operations in NEEMO 16 underwater test.
- Conducted RESOLVE field test in Hawaii of lunar ice prospecting experiment in partnership with the Canadian Space Agency.
- Acquired radiation data during Mars Science Laboratory's (MSL) interplanetary cruise and on Mars' surface.
- Completed 20 tethered flight tests of the Morpheus lander. Morpheus is a vertical test bed vehicle demonstrating new green propellant propulsion systems and autonomous landing and hazard detection technology. Morpheus was lost during its second free flight attempt due to a hardware failure, caused by excessive vibration levels at liftoff, in the Inertial Measurement Unit (IMU) that supplies navigation updates to the flight computer. Two new landers are being assembled, and flight tests will resume in early 2013.

In response to Dr. Matt Mountain's query on how AES avoids the "not invented here" syndrome at the NASA Centers, Mr. Crusan explained that all AES projects are required to be multi-Center projects. Dr. Ballhaus counseled that development should not be attempted at organizations that have not done development for a long time and have lost the requisite expertise. Mr. Crusan explained that AES is bringing back the ability to do development. It maintains critical competencies at the NASA Centers, and provides NASA personnel with opportunities to learn new skills and gain hands-on experience. Through NASA's Center of Excellence for Collaborative Innovation (COECI), AES explores new models for problem solving using open innovation and crowd sourcing. The NASA Tournament Lab, with the enabling capabilities of the TopCoder community, sponsors competitions to engage the public in developing software to solve NASA challenges. The lab is an operational virtual facility developed jointly by Harvard University and NASA. COECI is working with the Office of Science and Technology Policy (OSTP) to implement collaborative innovation across the government. NASA's CubeSat Launch initiative (CSLI) provides opportunities for CubeSat payloads to fly on rockets planned for upcoming launches. Over 25 universities are collaborating with AES on projects to develop radiation protection, life-support systems, logistics reduction technologies, and nuclear thermal propulsion. The NASA Lunar Science Institute funds four university-led teams to conduct research on the moon and small bodies.

Mr. Crusan discussed the AES planning strategy for FY 2013. Several projects will be refocused to support crewed missions in cislunar space in this decade. New crosscutting projects that consolidate similar elements from existing AES projects will be started. Activities that are extensible to multiple destinations in the longer term will be continued. Slides were presented showing changes being made to existing projects, new projects for FY 2013, and major milestones in FY 2013 for AES. Regular, periodic coordination and review of STP and AES activities ensure that activities and developments are coordinated and complementary. Both programs are aligned with the highest priority technology needs identified in mission architecture studies. The Human Architecture Team (HAT) and SKGs are used to create an integrated set of time-phased technology priorities and design reference mission concepts. In response to a question from Dr. Ballhaus, Mr. Crusan explained that NASA's investment in AES for FY 2012 is $140 million and is expected to be $160 million for FY 2013, subject to the Continuing Resolution and possible sequestration. Any budgetary diminution would be applied 100 percent to procurements.

Dr. Erik Antonsson noted that radiation detection is critically important and does not appear significantly in AES's program. Mr. Crusan explained that there is a large suite of sensor development in the program, covering the full radiation spectrum. With respect to mitigation strategies, however, their work has been largely layout-based, focusing on getting the most material between humans and the radiation source. Ideas for solutions are still currently being researched.

Dr. Ballhaus thanked Mr. Crusan for his presentation.

Space Technology Program Update

Dr. Ballhaus introduced Dr. Michael Gazarik, Director, Space Technology Program (STP). Dr. Gazarik described the nine STP programs: GCD; TDM; the Small Spacecraft Technology Program; Space Technology Research Grants; the NASA Innovative Advanced Concepts (NIAC); the Center Innovation Fund; Centennial Challenges; Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR); and Flight Opportunities. The President's FY 2013 Space Technology Budget Request was discussed. The amount requested for FY 2013 is $699 million, reflecting an increase over the $573.7 million FY 2012 appropriation. Dr. Gazarik noted that the Program is enjoying support from both sides on Pennsylvania Avenue. In response to a question from Dr. Susan Ying, he indicated that STP's primary customers are SMD and HEOMD. The upcoming NASA Technology Days in Cleveland, Ohio, was described. Mr. Green indicated that 500 people were currently registered and 600 are expected. Industry sponsorship is limited due to new restrictions in place on conferences. The event is being planned on a very austere budget and only 100 civil servants can travel to the event. Dr. Erik Antonsson opined that the key results are infusions and transitions, and he recommended that a record in some form be kept on results. Dr. Gazarik explained that one word he focuses on is "traceability." Mr. Gordon Eichhorst counseled that there is a need to go beyond the easy audience and a need to get people from beyond the science realm to appreciate the Program's work. Dr. Mary Ellen Weber opined that people care about space because they want to realize a destiny where their children and grandchildren have an opportunity to fly in space. She advised that the Program's title does not capture the work that is being done, which is developing future technologies. Communications that focus on enabling the dream and vision will capture Congress and the public. Without these investments, NASA's future is imperiled. That is the reason the Administration bought into Space Technology: it is about the future and the dream. Dr. Antonsson expressed distress over how far NASA has retreated from technology development. He explained that there was a time when NASA's technology played a key role in global politics. The STP reestablishes the centrality of that role. He recommended that the Agency establish a guideline for each mission to require new technology that has not flown previously, requiring an amount equal to four percent, by budget or mass. That would be consistent with the current requirement for each mission to spend two percent on education and public outreach. Dr. Ballhaus counseled that the proposed guideline would not be popular with project managers who are responsible for mission success, and is not likely to be viewed favorably by NASA. He suggested beginning by asserting that there are things that NASA has to do because no one else can do them.

Slides were presented showing recent accomplishments and awards. Two patent applications are pending. Forty-eight students were selected as new Space Technology Research Fellows. The Inflatable Reentry Vehicle Experiment-3 (IRVE-3) was successfully launched at the Wallops Flight Facility in Virginia, demonstrating the feasibility of Hypersonic Inflatable Aerodynamic Decelerators (HIAD) as inflatable heat shields. Thirty-eight advanced space technology payloads were selected for parabolic and suborbital flight. The Mars Curiosity Rover mission carried the MSL Entry, Descent and Landing Instruments (MEDLI) on board. MEDLI streamed atmospheric data in real-time from the shield sensors, which will help engineers design safer, more efficient entry systems for future missions. Other accomplishments and awards were also discussed.

Charts were presented on milestones in FY 2012 and FY 2013 for STP's "Big 9" projects: Composite Cyrotank Technology and Demonstration, HIAD, Human Robotic Systems, Low Density Supersonic Decelerators, Deep Space Atomic Clock, Mission Capable Solar Sail, Cyrogenic Propellant Storage and Transfer, Laser Communications Relay Demonstrator, and Robotic Satellite Servicing. Charts were presented on technology areas for GCD, TDM, and SST. A chart was presented on major TDM events and milestones. The Space Technology Research Grant Program (STRGP) was discussed. Space Technology Early Career Faculty Awards and Space Technology Faculty Awards were described. A pie chart was presented showing the universities represented by the 128 graduate students who are conducting space technology research as Space Technology fellows.

Dr. Ballhaus thanked Dr. Gazarik for his presentation.

Space Technology Research Grants Update

Dr. Ballhaus introduced Ms. Claudia Meyer, Space Technology Research Grants (STRG) Program Executive. Ms. Meyer discussed the Program's accomplishments over the past year. The inaugural Space Technology Research Opportunities for Early Career Faculty (STRO-ECF) have been awarded and have a typical award amount equal to $200,000 per year. The inaugural Space Technology Research Opportunities Early-Stage Innovations (STRO-ESI) solicitation is ready to be awarded. The Program's acquisition strategy and objectives were described. The NASA Space Technology Research Fellowship (NSTRF) program had 80 fellows in its inaugural class and an additional 48 fellows have been added in 2012. Ms. Meyer explained that the STRG motivation is to tap into the Nation's university talent base, challenging faculty and graduate students to examine the theoretical feasibility of ideas and approaches that are critical to making science, space travel, and exploration more effective, affordable, and sustainable. A chart showing STRG's portfolio across the Nation was presented. The Program has made 148 awards involving 57 universities in 29 states. The technical considerations for STRO solicitations were described. The technologies that are investigated must be between Technology Readiness Level (TRL) 1 and 3, and must investigate a unique, disruptive, or transformational space technology or concept.

STRO-ECF research projects must be led by a single Principal Investigator (PI), who must be an untenured Assistant Professor. Co-investigators are not permitted; however, collaborators are permitted. STRO-ESI solicitations for FY 2012, were released May 31, 2012, and have a typical award amount equal to $250,000 per year. Only universities may submit proposals, and co-investigators and collaborators are permitted. The technology areas and topics for these solicitations are: communication and navigation systems; human health; life support and habitation systems; human exploration destination systems; materials, structures, mechanical systems, and manufacturing; space radiation; thermal management systems; and optical systems. Charts showing the portfolios for STRO-ECF and STRO-ESI were presented. The application components and evaluation criteria for 2013 were described. The annual award value for NSTRF 13 is up to $68,000 and includes a $9,000 faculty advisor allowance. Ms. Meyer explained that NSTRF relies on faculty advisors and NASA mentors. In response to a question from Dr. Antonsson, Ms. Myers reported that the program has been well received internally at NASA, and that NASA researchers are eager to serve as mentors. Excerpts from selected on-site experience reports were presented. Dr. Ballhaus asked whether NASA had slots to hire the fellows once they completed their degrees. Ms. Meyer responded that the number of slots available "could not be predicted."

The Committee received a briefing from Ms. Jaemi Herzberger, a University of Maryland NSTRF student fellow. She was introduced by Mr. Jean-Marie Denis, Goddard Spaceflight Center Parts Analysis Lab Operations Manager. He explained that the lab affords Ms. Herzberger the opportunity to use sophisticated laboratory equipment, including a Scanning Electron Microscopy and 3-D X-Ray. Ms. Herzberger described the research she has worked on in determining the failure mechanism attributable to electrochemical migration and dendrite growth in military and commercial ceramic capacitors.

Dr. Ballhaus thanked everyone for their presentations.

Update on Mars Science Lab and Overview of Technology's Role in Mission

Dr. Ballhaus introduced Mr. Doug McCuistion, Director, Mars Exploration Program, SMD. He described the history of Mars exploration missions. The purpose has been to determine whether life could have existed on Mars and the theme has been to follow the water. Mr. McCuistion introduced Dr. Dave Lavery, MSL Program Executive, SMD, who briefed the Committee. The Mars Exploration Program was described. A slide was presented showing the Curiosity Rover and rovers from earlier Mars missions. The Sojourner Rover from the 1997 mission is the size of a toaster and could fit within a wheel from Curiosity. Dr. Lavery explained that the MSL's primary scientific goal is to explore a landing site as a potential habitat for life and assess its potential for preservation of bio-signatures. Slides were presented showing the various stages involved in assembling the Curiosity Rover for launch.

The process for EDL was described. Curiosity's parachute was deployed at over 1,000 miles per hour. The landing site is named Gale crater and was selected from a few hundred potential landing sites. The crater is about the size of Connecticut and Rhode Island. It spans 96 miles in diameter and holds a mountain that rises 3 miles up from the crater floor, which is higher than Mount Rainier rises above Seattle. The rover used radar during its descent to measure speed and altitude in order to land safely. The hovering "Sky Crane" descent stage lowered the rover from 100 feet above the surface on a bridle of three nylon ropes. Electronics and communications cables also unspooled during the descent stage. When the Sky Crane sensed that Curiosity had six wheels on the surface, the cables were cut. The Sky Crane then flew a safe distance away from the rover before crash-landing.

Dr. Lavery described the MSL's early surface operations. A navigation camera image showed scour marks and bedrock that was exposed by the descent stage rockets. Pebbles that had been kicked up during descent can be seen on the rover's deck. One pebble damaged the Rover Environmental Monitoring Station (REMS). Fortunately, there is a redundant instrument for that purpose. Curiosity was able to image its undercarriage with its Mars Hand-Lens Imager. Curiosity will be able to send weather reports, using booms on the rover's mast that will monitor temperature, wind speed, direction, pressure, and ultraviolet light. Curiosity is progressing toward an area called "Glenelg," where three distinct terrain types come together. Slides showing the terrain and surrounding area were presented. The MSL science payload was described. It contains 10 instruments totaling 75 kg of mass. Curiosity uses a drill that was developed in the late 1990s. Three instruments perform rock analysis: the Alpha-Particle X-ray Spectrometer (APXS) identifies chemical elements in rocks; CheMin, short for chemistry and mineralogy, identifies minerals, including those formed in water; the Sample Analysis at Mars (SAM) instrument suite identifies organics, which are the chemical building blocks of life.

Technology advancements enabled by the MSL were discussed. A new power system enables significantly greater mobility, operational flexibility, and an enhanced science payload. The multi-mission radioisotope thermal generator provides 110 watts of electricity, using 10 point 6 pounds of uranium oxide. There are three modes for navigation, and hazards can be avoided autonomously. To enable visual audomotry, the rover's wheels have been carved at one point in their circumference to spell the letters "JPL" in Morse code and lay a visible track. The Mars

Reconnaissance Orbiter (MRO) is returning over three times as much data as five earlier missions combined. Curiosity averages .5 GB per day and on some days it approaches 1 GB. The main bottleneck is the link from Orbiter back to Earth. Spatial and spectral resolution has improved from 300-1000 m/pixel to 20 m/pixel. Dr. Antonsson expressed concern that the new technology shelf is rapidly emptying.

The public outreach for the mission was discussed. Dr. Lavery explained that there was a concerted effort to reach out to non-traditional venues. Toymakers approached the mission. Mattel included the rover in its "hot wheels" series. An "Angry Birds" space applications game was developed. Microsoft developed an Xbox game using the Xbox "Kinect." The game is distributed for free and is the most successful download program for the Xbox platform. In response to a question from Mr. Eichhorst, Dr. Lavery explained that there was no compensation paid by either party. Tens of thousands of people showed up in Times Square, New York, to watch the landing and people were shouting "NASA, NASA, NASA!"

Dr. Randall Correll congratulated Dr. Lavery on the MSL's success and asked what is done to identify requirements for new technology. Dr. Lavery responded that this is handled through the strategic Mars destination assessment, where the Mars program is strategically addressed; not just in terms of science, but also for technology. The Mars science community also helps answer the science investigation and exploration questions that get folded into a Mars exploration plan, which normally gets updated every two years. Now, however, due to the current budget situation, everything is being re-evaluated.

Dr. Ballhaus thanked Mr. McCuistion and Dr. Lavery for their presentation.

Chief Technologist Update

Dr. Ballhaus introduced Dr. Mason Peck, NASA Chief Technologist. Dr. Peck asserted that there are no opportunities in the future without new technology, and that technology can transform our way of thinking about space science and exploration. He noted that the National Research Council (NRC) has stated that "Half or more of the growth in the nation's gross domestic product in recent decades has been attributable to progress in technological innovation." NASA technology development addresses our national priorities by encouraging growth of a U.S. commercial space sector, maintaining a space technology base that aligns mission directorate investments, and directs technology investments to support robotic and human exploration missions. Transformative technologies are being sought from elsewhere in the economy. Charts were presented showing how NASA's technology portfolio is developed. There are 14 Space Technology Roadmaps that identify 320 technologies for development over a 20-year horizon. The NRC Study prioritized the technologies that need to be developed. Using the NRC Study and updated roadmaps, a Strategic Space Technology Investment Plan (SSTIP) has been developed. The SSTIP contemplates a four-year investment approach, where 70 percent is invested in eight core technologies that represent 12 of the NRC's top priority recommendations, 20 percent is invested in adjacent technologies, and 10 percent is invested in seeding innovation in technologies that were not part of the NRC's 83 high priorities. The SSTIP is undergoing review at the White House OSTP.

Dr. Peck reported that the STP will be spun from the Office of Chief Technologist (OCT) and act as its own mission directorate. He complimented the work that Dr. Gazarik has done with STP and explained that it will give STP the opportunity to talk directly to Congress and other stakeholders. Dr. Peck agreed with Dr. Ballhaus' assessment that the reorganization places STP in competition with other technology offices across the Agency and allows OCT to be a "fair broker" for taking objective actions. Dr. Antonsson stated it was good to see the momentum in the Agency for technology. Dr. Ballhaus counseled that many people do not understand the long lead time that is needed for technology. He expressed concern that the technology shelf is empty now due to the lack of technology investment over the last 10 years. Dr. Peck opined that establishing the STP as a directorate illustrates the seriousness of the problem. In response to a request from Dr. Ballhaus, Dr. Peck indicated that it would be helpful for the Committee to recommend that the NAC endorse the Agency's plan to make STP a directorate. Dr. Ballhaus concurred. Dr. Peck explained that the reorganization would not cause a change in personnel and that the Committee would have cognizance over both OCT and STP.

Dr. Correll asked Dr. Peck to discuss the implications for technology that might arise because the Agency is looking at possible mission destinations. Dr. Peck responded that the STP is focused on crosscutting technologies that can apply to any destination. There will always be the need for fundamental advances, for example, in radiation protection and launch propulsion. Dr. Ballhaus noted that, while new entrants may have lower costs, they do not have an adequate demonstrated reliability yet and, therefore, the Pentagon and the National Reconnaissance Office (NRO) will not use them for launching high-end satellites until they meet the EELV new entrant criteria. He asked Dr. Peck to describe the pressure to develop technology to improve launch reliability and affordability for launches. Dr. Peck responded that the NRC identified access to space as the number one technology that is needed. Access may be interpreted, however, to mean frequency, as well as low-cost. Dr. Ballhaus counseled that, while SpaceX and others thought the market would be elastic, the market has proven to be inelastic and there are actually fewer launches. Dr. Peck advised that there are two technologies that could change things dramatically, but are too expensive: one is nuclear propulsion and the other is hypersonic launch. Two to three billion dollars would need to be invested in each. Dr. Ballhaus asked for the status of an earlier proposal to create a program for basic research. Dr. Peck responded that the program has not been formulated to the point where it can be shared and that any program would have to reach across the nation and have broad national appeal.

The Innovative Partnerships Office (IPO) was discussed. It will remain within the OCT and has four programmatic elements: Technology Transfer, Strategic Partnerships, Prizes and Competitions, and an Emerging Space Office. NASA's successful track record with prizes was discussed. Dr. Peck noted that President Obama has stated "The federal government should…use high-risk, high-reward policy tools such as prizes and challenges to solve tough problems." Dr. Peck described "citizen space." He explained that people are already taking the development of space technology into their own hands. One example is CubeSat, a low-cost, spacecraft standard that is now one of the most commonly built types of spacecraft in the world. It was developed independent of government work at Stanford University and California Polytechnic University. NASA's CSLI will provide opportunities for small satellite payloads to fly on rockets as auxiliary payloads on previously planned missions. The CSLI web site can be found at: http://www.nasa.gov/directorates/heo/home/CubeSats_initiative.html. Another example of citizen space is the success of a spacecraft that has been crowd-funded on Kickstarter, which is a funding platform for creative projects. In response to a question from Dr. Ballhaus, Dr. Peck advised that the mission areas have not considered replacing current capabilities with CubeSats.

Dr. Ballhaus thanked Dr. Peck for his presentation.

HIAD Update

Dr. Ballhaus introduced Dr. F. McNeil Cheatwood, PI, NASA Langley Research Center, who briefed the Committee on the status of NASA's HIAD project. He began his presentation by describing the MEDLI suite. It is a set of sensors designed to measure the atmospheric conditions and performance of the MSL heat shield during entry and descent at Mars. Its purpose was to provide information to help design entry systems for future planetary missions. The MEDLI suite consists of seven MEDLI Integrated Sensor Plugs (MISP) and seven Mars Entry Atmospheric Data System (MEADS) pressure sensors, located on the heat shield of the spacecraft. MISP measured temperatures at different depths in the spacecraft's heat shield material. The measurements indicated that the heat shield had been overdesigned and weighed more than necessary. MEADS data allowed engineers to determine the orientation of the MSL aeroshell and how it changed with time during the descent. The instrumentation made MSL the first extensively instrumented heatshield ever sent to Mars. The EDL sequence was described. Several charts were presented on the measurements collected from the instruments. All MEDLI sensors worked extremely well and returned data. The MEDLI data identified differences between model predictions and measurements that will allow for improvement of models. Reconstructions show that the MSL Aerodynamic database predicted entry performance very well.

Dr. Cheatwood discussed the reason for the HIAD program. He explained that Mars has a thin atmosphere that makes it difficult to decelerate large masses and limits accessible surface altitudes. Future concepts for flexible thermal protection systems (TPS) and inflatable structures were discussed. A slide was presented on HIAD next generation subsystems. The IRVE-3 flight test was described and a slide was presented showing the IRVE-3 nominal mission. The test success assessments for separation, aeroshell inflation, flight performance, data set, body axis alignment, roll angle, aeroshell inflation maintenance, and reentry heating were discussed. Charts were presented on the IRVE-3 Best Estimated Trajectory (BET), flight dynamics, structural performance, aero performance comparison to BET, angle of attack, peak heat rate, and thermal protection system performance. Dr. Cheatwood described the status of IRVE-4. Hardware fabrication is complete and the inflation system is ready for avionics integration. The High Energy Atmospheric Reentry Test (HEART) was described. This is a design concept for a flight test that would demonstrate a larger HIAD with a TPS diameter of almost 30 feet or 8 meters. Slides were presented showing the HEART concept and the HEART concept of operations. Dr. Cheatwood concluded with slides about technology maturation from the HIAD project and HIAD future plans.

Dr. Ballhaus thanked Dr. Cheatwood for his presentation.

Discussion and Recommendations

Dr. Mountain was impressed by the innovations in thermal material and asserted that they were derived from earlier crosscutting investments. He recommended creating synergies across the Agency. Dr. Antonsson recommended that OCT should maintain an encyclopedia of investments that have led to insertion. It should include dates and investment levels. He commented that the Committee has not grappled with the serious problems affecting technology innovation. Dr. Ballhaus noted that the Administrator had asked the Committee to focus on technology, but that innovation remains in the Committee's charter. Dr. Correll concurred in having the Committee raise the profile on innovation. Mr. Eichhorst noted encouragement about the fellowship program. Dr. Gazarik explained that the reduction in the number of fellows was not budget driven; rather, it was due to a decrease in the number of applications. Mr. Eichhorst explained that the reason for the decrease is that the space program is not the only technology program. He advised that the high interest level in MSL presents an opportunity for attracting new fellows, and this opportunity should not be wasted.

Dr. Weber counseled that there is a need to get the word out that "NASA is not dead." She believes that establishing STP as a separate organization from OCT is a good way to get visibility. As a mission directorate, STP's name should be changed to reflect that it is engaged in pioneering or future space technology. She expressed concern that STP may be cannibalized because NASA's Space Launch Services (SLS) is being asked to do more with less funding. She suggested that STP work with Commercial Space, and noted that commercial companies have an advantage because they can suffer failures that are not as visible as NASA's failures. Dr. Ballhaus observed that commercial companies do a good job "controlling the message." Dr. Weber opined that when there is a NASA failure, the public attributes the failure to a bloated bureaucracy. Dr. Ballhaus noted that commercial companies are heavily subsidized by NASA.

Dr. Correll opined that the STP team has done well, but needs to do more. There is an opportunity, with the Administration's reelection, to reemphasize priorities. NASA should be emphasizing that a space technology portfolio is needed to enable science and other NASA missions. Dr. Antonsson explained that corporate technology development typically goes through a five year oscillation phase that is unhealthy and unproductive. The best way to prevent the oscillation is with overt leadership support.

The Committee discussed the presentation for the upcoming NAC meeting and reached a consensus on several findings and recommendations. The NAC should be advised that the Committee was impressed with the STP program maturity and momentum. The technology shelf is depleted and major missions flying now depend on technology investments made years ago. Technology should be included when NASA formulates a mission. The success in the fellowship program is encouraging; however, NASA lacks positions to offer the fellows upon graduation. The Committee supported the reorganization that established STP as a directorate and OCT as an independent crosscutting office.

Adjournment

The meeting was adjourned at 4:50 p.m.

Appendix A

Final Agenda

NAC Technology and Innovation Committee Meeting

November 15, 2012

NASA Headquarters

Room 2E39

Dial-in number: 866-804-6184 Pin Code: 3472886

Nov. 15, 2012 –

8:00 a.m.	Welcome and overview of agenda/logistics (FACA Session – public meeting)
	Mike Green, Executive Secretary
8:05 a.m.	Opening Remarks and Thoughts
	Dr. William Ballhaus, Chair
8:15 a.m.	Update on NASA's Advance Exploration Systems Program
	Mr. Jason Crusan, Director, Advanced Exploration Systems, HEOMD
9:15 a.m.	Space Technology Program Update
	Dr. Michael Gazarik, Director, Space Technology Program
10:15 a.m.	Break
10:30 a.m.	Space Technology Research Grants Update
	Ms. Claudia Meyer, Program Executive
11:15 a.m.	Update on Mars Science Lab and overview of technology's role in mission
	Dr. Dave Lavery, Program Executive, MSL
12:15 p.m.	Lunch (on own)
1:15 p.m.	Chief Technologist Update
	Dr. Mason Peck, NASA Chief Technologist
2:00 p.m.	HIAD Update
	Dr. Neil Cheatwood, IRVE 3 Principal Investigator, NASA Langley Research Center
3:00 p.m.	Discussion and Recommendations
4:00 p.m.	Adjournment

Appendix B

NAC Technology and Innovation Committee Meeting
November 15, 2012
NASA Headquarters

NAC Technology and Innovation Committee Membership
Updated 11/1/12

Dr. William (Bill) F. Ballhaus, Jr., *Chair*	*[retired]*
Mr. G.M. (Mike) Green, *Executive Secretary*	NASA Headquarters
Dr. Erik Antonsson	Northrop Grumman Aerospace Systems Corporation
Dr. Randall Correll	Consultant
Mr. Gordon Eichhorst	Aperios Partners LLP
Dr. Charles (Matt) Mountain	Space Telescope Science Institute
Dr. Dava Newman	Massachusetts Institute of Technology
Mr. David Neyland	Office of Naval Research – Global
Dr. Mary Ellen Weber	Stellar Strategies LLC
Dr. Susan X. Ying	The Boeing Company

Appendix C

NAC Technology and Innovation Committee Meeting
November 15, 2012
NASA Headquarters
Washington, DC

MEETING ATTENDEES

Committee Members:

Ballhaus, William (Bill) – *Chair*	*[Retired – not affiliated]*
Green, G.M. (Mike) – *Executive Secretary*	NASA Headquarters
Antonsson, Erik A.	Northrup Grumman Aerospace
Correll, Randall	Ball Aerospace & Technologies
Eichhorst, Gordon	Aperios Partners LLP
Mountain, Charles (Matt)	Space Telescope Science Institute
Newman, Dava (via telecom)	Massachusetts Institute of Technology
Weber, Mary Ellen	Stellar Strategies LLC
Ying, Susan	The Boeing Company

NASA Attendees:

Balint, Tibor	NASA Headquarters
Crusan, Jason	NASA Headquarters
Dembling, Anyah	NASA Headquarters
Denis, Jean M.	NASA GSFC
Gezarik, Michael	NASA Headquarters
Herzberger, Jaemi	NASA GSFC
Hughes, Peter	NASA GSFC
Lavery, Dave	NASA Headquarters
McCuistion, Doug	NASA Headquarters
Meyer, Claudia	NASA Headquarters
Peck, Mason	NASA Headquarters

Other Attendees:

Claybaugh, Bill	Orbital Sciences
Flanagan, Kathryn	STScI
Frankel, David	P B Frankel, LLC
Mackey, Bill	CSA
Peterson, Brad	Ohio State U

Appendix D

NAC Technology and Innovation Committee Meeting
July 24, 2012
NASA Goddard Space Flight Center

LIST OF PRESENTATION MATERIAL

1) Advanced Exploration Systems [Crusan]
2) Space Technology FY 2013 [Gazarik]
3) An Overview: NASA OCT Space Technology Research Grants Program [Meyer]
4) Mars Science Laboratory [Lavery]
5) Office of the Chief Technologist Update [Peck]
6) Space Technology Program Recent Successes [Cheatwood]

Other Material Distributed at the Meeting:

1) NASA response to recommendation 2012-02-01 (TIC-01) Space Basic Research (Engineering Science) Program, November 12, 2012
2) Technology and Innovation Committee Draft Meeting Minutes, July 24, 2012