National Aeronautics and Space Administration

Technology & Innovation Committee
of the
NASA Advisory Council

NASA Headquarters
Washington, DC

March 6, 2012

MEETING MINUTES

G. M. Green, Executive Secretary

William F. Ballhaus, Jr., Chair

NASA Advisory Council (NAC) Technology and Innovation Committee
NASA Headquarters
Washington, DC
March 6, 2012

MEETING MINUTES
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Meeting Report prepared by
David J. Frankel, consultant
Zantech/ P B Frankel, LLC

NAC Technology and Innovation Committee Meeting
March 6, 2012
NASA Headquarters
Washington, D.C.
MIC 6A – 6H65

Welcome

The NASA Advisory Council (NAC) Technology and Innovation (T&I) Committee meeting was convened by Mr. G. M. (Mike) Green, Executive Secretary. He announced that the meeting was a Federal Advisory Committee Act (FACA) meeting open to the public, and he reviewed the planned agenda for the meeting. He informed the members that Dr. Dava Newman would be participating in the meeting via telecom.

Dr. Alain Rappaport's term has expired and he will be rotating off the Committee. Three new members, and possibly a fourth, will join the Committee by the next meeting. Reappointment letters were distributed to current members.

Opening Remarks

Mr. Green introduced Dr. William Ballhaus, Chair, NAC T&I Committee, who welcomed everyone to the meeting. Minutes from the last meeting were reviewed, corrected, and approved.

Office of Chief Technologist Update

Dr. Ballhaus introduced Dr. Mason Peck, NASA's new Chief Technologist. Dr. Peck described his background. He is a faculty member at Cornell University, where his work focuses on spacecraft dynamics, control, and mission architecture. The International Space Station (ISS) currently hosts his research group's flight experiment in microchip-size spacecraft. Formerly, he was a principal fellow at Honeywell Defense and Space Electronic Systems, where he led advanced-technology programs, helped direct patent and intellectual-property investments, and worked in business development. He has a passion for NASA's work.

Dr. Peck explained that as NASA's Chief Technologist, he has a number of roles. One is to coordinate technology across the Agency to ensure that NASA is investing wisely and in a non-duplicative manner. He is responsible for explaining why technology is important. Technology is about the future and here at NASA, the present. He applauded the architecture utilized in the Space Technology Program (STP) and its scope. Taking the long-range view, the Program is investing in Technology Readiness Levels one through six (TRLs 1–6). We can't get to Mars or the asteroids without that investment. The challenge is in getting people to hear that message. Technology is not sought just for technology's sake. New technologies must infuse into NASA's future missions. Dr. Peck stated that his job is to make sure that there is an infusion path and an infusion partner. Another goal is to make sure the Agency recognizes the role for a technology program separate from the missions. Technology funding at NASA has been separated from the Mission Directorates to prevent funds from being "raided."

Dr. Peck informed the Committee that Deputy Chief Technologist Mr. Joseph Parrish is returning to the Jet Propulsion Laboratory (JPL) and will be replaced by Mr. W. James Adams, formerly of the Science Mission Directorate.

Dr. Peck discussed recent innovative trends in aerospace. Several Federal agencies have become interested in "small space" using very small satellites commonly referred to as CubeSats. These typically use commercial off-the-shelf electronic components. The small satellite world is evolving with unprecedented speed. Small satellites have different physics that may allow them to survive re-entry. They can be used for demonstrating high risk technology concepts. Accordingly, even though small satellites are more likely to

fail, they have lower risk due to lower costs, which range from $100,000 to $150,000. A new commercial industry is springing up around them, and this is an opportunity to get in on the ground floor. Universities and private students are launching their own spacecraft. This is different from the "mission-pull" that is common at NASA. These small satellites are not intended to serve known science goals.

Dr. Peck also explained how NASA should work synergistically with other agencies. It should engage with the Department of Defense (DoD). Prizes and challenges are being used across the government and are encouraged by the Office of Science and Technology Policy (OSTP). The T&I Committee can help ensure that the technology funding is preserved for technology. Astute administrators have understood that if technology funds are distributed among the Mission Directorates, the money is likely to be diverted to cover project cost overruns. It is helpful to provide examples where technology "push" has enabled new technology that would not otherwise have been developed. Dr. Ballhaus noted that one example would be computational fluid, dynamics. Dr. Susan Ying suggested that a great example is ion propulsion. Dr. Raymond Colladay offered that another good example is the development of the heavy lift engine, which became necessary for the manned mission to the Moon. He also cautioned that the U.S. House and Senate staff members are focused on solving budget problems and perceive technology-push expenditures as being discretionary. Dr. Ballhaus explained that when new technology needs to be invented for a mission already underway, it is most often on the project's critical path, resulting in substantial unanticipated cost growth. Dr. Colladay counseled that "what we know how to do is not good enough." Dr. Peck suggested that this describes the science community and leads them to be more inclined to accept risk than the space community. Since Galileo, he added, science has always been enabled by new technology. Mr. Gordon Eichhorst asserted that it is wasteful to keep reinventing the same technology and asked whether there is a better way to capture system knowledge. Dr. Peck responded that systems are becoming more complicated, and that there is a need to maintain core technology competency. The problem is managing complexity. Dr. Ballhaus explained that corporate memory exists in the people and the core competencies. He advised that NASA should protect its franchise competencies and technologies and should identify who in the Agency is accountable for ensuring that NASA's key core competencies are maintained. Dr. Peck asserted that the need to maintain core competencies is taken seriously by the Agency.

Dr. Ballhaus thanked Dr. Peck for his presentation.

Update on NASA Space Technology Program

Dr. Ballhaus introduced Dr. Michael Gazarik, Director, STP, who briefed the Committee on the Program's status. Dr. Gazarik presented a chart comparing the $573.7 million FY 2012 Space Technology Appropriation with the $699 million FY 2013 President's Budget Request for Space Technology. No program elements have been decreased, and there has been an increase in Crosscutting Space Technology Development. In response to a question from Dr. Ballhaus, Dr. Gazarik explained that projects would be de-scoped or stretched out if lower funding levels were appropriated than had been requested. Dr. Ballhaus advised that a brief "elevator speech" be prepared to articulate the clear consequences or impact on the Agency from a reduction in funding. This is a "rubber on the ramp" argument and difficult to win unless it is "projectized."

Dr. Gazarik showed the Space Technology budget horizon through FY 2017 and the anticipated FY 2013 funding by state for Crosscutting Space Technology Development and for Exploration Technology Development. Dr. Charles Mountain opined that the appropriations committee chair would not be impressed by the state funding chart. Dr. Gazarik discussed the FY 2011 competitive and protest-free selections. In response to a question from Dr. Ying, Dr. Peck explained that he has been meeting with his counterparts in other agencies to compare roadmaps and identify where it would help to enter into a partnership or avoid duplication. His priority at this time is bilateral coordination rather than multi-level consortiums.

Dr. Gazarik noted that Space Technology was included in the NASA Authorization Act of 2010, and that a Space Technology Program account (STPX) was created and appropriated in FY 2012 at approximately $575 million. Five Space Technology Solicitations were released from December 2011 through February 2012. Over 1000 projects are being executed. Accomplishments and milestones were described for the

Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) programs. They are working with the Small Business Administration (SBA) to assess new requirements. Accomplishments and milestones in the Space Technology Research Grant program were discussed, and Dr. Gazarik showed a pictorial of the 80 Fellows in the inaugural class of persons receiving NASA Space Technology Research Fellowships (NSTRF). The Center Innovation Fund and NASA Innovative Advanced Concepts (NIAC) program was reviewed and Dr. Gazarik described how NIAC is funding innovation across the nation. He noted accomplishments and milestones achieved in the Centennial Challenges Program (CCP), the Game Changing Development (GCD) Program, Technology Demonstration Missions (TDM), and the Edison Small Satellite Demonstration Missions and Flight Opportunities Program. Dr. Peck noted that the return on investment for NASA from prizes awarded under the CCP is huge. Dr. Gazarik briefly reviewed the "Big Nine Projects," which include Laser Communications, Cryogenic Propellant Storage and Transfer, Deep Space Atomic Clock, Large-Scale Solar Sail, Low Density Supersonic Decelerators, Human Exploration Telerobotics and Human-Robotic Systems, Composite Cryogenic Propellant Tanks, the Hypersonic Inflatable Aerodynamic Decelerator (HIAD), and Robotic Satellite Servicing.

Dr. Ballhaus complimented Dr. Gazarik on the progress that has been made within the Space Technology Program in a brief time. Dr. Gazarik thanked the Committee for its assistance. Dr. Ballhaus addressed intellectual property development and noted that half of NASA's production comes from JPL, which is due to JPL's affiliation with the California Institute of Technology. He explained that this production comes from leadership, and he asked how intellectual property development is progressing now that NASA has technology leaders at each NASA Center. Mr. Adams responded that he is beginning to work on this. Dr. Gazarik added that NASA's Inspector General recently released an audit with findings and recommendations. Mr. Green added that the audit also covered the need for training and funding. Mr. Adams explained that the audit was being treated as an opportunity for the Agency.

Dr. Ballhaus thanked Dr. Gazarik for his presentation.

National Research Council (NRC) Technology Roadmap Report

Dr. Ballhaus introduced Dr. Raymond Colladay, Chair, Committee on the NASA Technology Roadmap, NRC Space Studies Board and Aeronautics and Space Engineering Board (hereinafter referred to as "the NRC"). Dr. Colladay briefed the Committee on the final report and recommendations on NASA's technology roadmap (the "Report") that was released by the NRC. Dr. Colladay noted that the Report had been prepared similarly to an NRC Decadal Study, but in one year rather than the normal two years. He explained that the study could not have been performed without the Office of the Chief Technologist's (OCT's) 14 draft technology roadmaps, which were used by the NRC as a point of departure. The OCT roadmaps are based on a layered Technology Area Breakdown Structure (TABS), with 14 technology areas containing 320 technologies. The NRC's task, as commissioned by NASA, was to prioritize the technologies from all 14 roadmaps. The NRC defined and prioritized a modified TABS with 295 technologies. The NRC was asked by NASA to evaluate technologies that address the needs of NASA's exploration systems, Earth and space science, and space operations mission areas, as well as those technologies that contribute to critical national and commercial needs in space technology. Dr. Colladay noted that NASA's success will depend on advanced technology developments that already should be underway and that NASA's technology base is largely depleted. Future U.S. leadership in space requires a foundation of sustained technology advances. Current technology is insufficient to accomplish many intended space missions in Earth orbit and to the Moon, Mars, and beyond. The technologies prioritized in the Report represent a foundation for the strategic goals outlined in the 2011 NASA Strategic Plan.

The Report is designed to give the Agency feedback on the draft roadmaps that were submitted in 2010 and to help the Agency prioritize its research. The NRC took into account NASA's "likely" level of funding for new technology--approximately $500 million to $1 billion per year. Dr. Colladay described the process that was used to prioritize the technologies, and he identified the staff, panels, steering committee, and panel members who participated in the work. A public workshop was held for each roadmap, and community input was solicited through a public website. The technology evaluation criteria called for the NRC to analyze each technology for benefit, alignment with needs and goals, and technical risk and challenge. The

roadmaps include "mission pull" technologies that contribute to specific future missions and are based on recognized needs. The roadmaps also include emerging "push" technologies that can shape future missions, influence future requirements, and foster new centers of expertise and talent. Dr. Colladay described the deliberative process used to build consensus. Three technology objectives or themes were defined by the steering committee: (1) extend and sustain human activities beyond LEO (Technology Objective A); (2) explore the evolution of the solar system and the potential for life elsewhere (Technology Objective B); and (3) expand our understanding of Earth and the universe in which we live (Technology Objective C). Following this process, the NRC identified 16 different technologies as having the highest priority and on which the NRC suggests that NASA focus in the next five years. This does not mean that the remaining technologies lack value or importance or that NASA shouldn't do them. The 16 highest priority technologies identified by the NRC, in no particular order, are: Electric Propulsion; (Nuclear) Thermal Propulsion; Solar Power Generation (Photovoltaic and Thermal); Fission (Power); Extreme Terrain Mobility; Long-Duration Health (Crew); Detectors and Focal Planes; (Instrument and Sensor) Optical Systems; High-Contrast Imaging and Spectroscopy Technologies; In Situ (Instruments and Sensor); Active Thermal Control of Cryogenic Systems; Radiation Mitigation for Human Spaceflight; Lightweight and Multifunctional Materials and Structures; Environmental Control and Life Support System; Guidance, Navigation and Control; and Entry, Descent, and Landing Thermal Protection Systems. Dr. Colladay noted that almost all the 16 technologies are cross-cutting, and he recommended that NASA assign someone to have cross-cutting responsibility, recognizing that each roadmap would be under a particular person's purview.

Dr. Colladay reviewed the Report's recommendations. During the next five years, NASA technology development efforts should focus on the following: (1) the 16 identified high-priority technologies and associated top technical challenges; (2) a modest but significant investment in low-TRL technology (on the order of ten percent of NASA's technology development budget); and (3) flight demonstrations for technologies that are at a high-TRL when there is sufficient interest and cost sharing by the intended user. OCT should use disciplined system analysis for the ongoing management and decision support of the space technology portfolio. OCT should establish a rigorous process to down-select among competing technologies at appropriate milestones to ensure that only the most promising technologies proceed to the next TRL. OCT should pursue both evolutionary and revolutionary advances in technology capabilities as well as cooperative development of high-priority technologies. OCT should collaborate in defining, advocating, and funding flight demonstrations of technologies. NASA should perform on-orbit flight testing for reduced gravity cryogenic storage and handling technology. OCT should work with the Science Mission Directorate and the Department Of Energy to bring Advanced Sterling Radioisotope Generator technology to flight demonstration on a mission beyond LEO. Pu-238 production must be restarted if the U.S. is to conduct certain planned, critical deep-space missions after this decade. OCT should make data from space missions and technology development more readily available to U.S. industry and should propose changes to NASA procedures so that programs are required to archive data in a readily accessible format. OCT should collaborate with the U.S. commercial space industry. OCT should assure effective ownership responsibility for crosscutting technologies in each of the roadmaps.

In response to a question from Dr. Ballhaus, Dr. Colladay recommended that NASA invest ten percent of its total budget in advanced technology development. Dr. Ballhaus reported that private industry invests three and one half to four percent, and that the Air Force had three percent as a goal. He recommended that NASA obtain an accounting on the amount that it invests. Ms. Faith Chandler, Acting Director, Strategic Integration, OCT, advised that a full accounting across the Agency is in process and should be completed by September 30, 2012. Dr. Colladay noted that one of the most difficult tasks at the Defense Advanced Research Projects Agency (DARPA) was to terminate work on some projects in order to allow other projects to move forward. Dr. Ballhaus concurred and advised that early "mercy-killing" is a best practice. He reported that some organizations target twenty percent of their portfolios for termination. Dr. Colladay recommended that the Report's technology prioritization be reviewed in five years. Dr. Ballhaus expressed concern that no one at NASA appeared to be accountable for assuring that core competencies are maintained. In response to a question from Dr. Mountain, Dr. Colladay reported that an economic analysis on the benefits from space technology had been performed; it did not suggest a large overall effect on the national economy attributable to space technology.

Dr. Ballhaus acknowledged Dr. Colladay for providing tremendous leadership to the NRC in producing the Report and thanked him for his presentation.

NASA Response Plan to NRC Report

Dr. Ballhaus reintroduced Dr. Peck, who briefed the Committee on NASA's plan for acting on the NRC's recommendations. It is acknowledged that success in executing future NASA space missions will depend on advanced technology developments. NASA intends to create a Strategic Technology-Investment Plan (STIP). The STIP will be developed using input from the NASA Strategic Plan, the NASA Space Technology Roadmaps, the NRC Roadmap Report, other government agencies and partnership opportunities, and NASA's Mission Directorates. The STIP will be a set of strategically-linked technology investments planned and managed collectively to (1) ensure high-priority goals are achieved, (2) avoid unnecessary duplication, and (3) optimize the overall return and infusion while maintaining allowable risk, schedule, and resource allotments. The STIP will guide the calls for technology proposals in FY 2013 as well as Agency technology partnering activities. The plan will be created by OCT with support from the Mission Directorates and Centers. Every two years, the T&I Committee will provide an independent "sanity" check on the STIP. Every four years, the 20-year Technology Roadmap will be evaluated by the NRC and updated. In creating the STIP, OCT will finalize Mission Directorate technology priorities, identify current Agency technologies in development, identify budget constraints, identify Center technology capabilities and facilities, and identify gap areas and potential partners for those areas. Dr. Peck showed the schedule for producing the STIP, which he suggested should include an independent assessment by the T&I Committee. After discussion, the tentative date for that assessment was changed to September 10, 2012. The meeting date was later amended to July 24, 2012.

Dr. Peck noted that the STIP may diverge from the NRC's technology recommendations. Also, the OCT needs to develop trust within the Mission Directorates. This is a cultural issue within the Agency. Dr. Ballhaus advised that real control requires some control over the budget, and he expressed concern over whether OCT has actual, documented authority to control or influence NASA's technology development budget. Ms. Chandler stated that the authority existed in the documentation for NASA's Executive Council and agreed to make that document available to the Committee. Mr. Eichhorst suggested selecting five technologies on which to focus from the NRC's 16 recommendations. He asserted that OCT does not need to "own" all technology development, but should assert leadership in driving it and should keep the rest of the Agency focused. Dr. Ying recommended establishing a methodology to measure success. Dr. Mountain suggested using a "fever chart." Dr. Ballhaus emphasized the importance in establishing trust and advised that this could be accomplished by committing to and delivering results on five top projects. Dr. Peck agreed that focusing on all 16 technologies may be too ambitious, and he would give serious consideration to reducing the list to five technologies. Dr. Mountain concurred with the need to reduce the number. He explained that enough roadmaps have been seen over the last two years, and that what is needed now is activity. Mr. Green advised that a reduced group of technologies already has been identified and is referred to as the "Big Nine."

Dr. Ballhaus thanked Dr. Peck for his presentation.

Update on Human Architecture Team (HAT) Technology Planning

Dr. Ballhaus introduced Mr. Christopher Culbert, Manager, NASA Exploration Missions and Systems Office, and Mr. Scott Vangen, Lead, HAT technology assessment team. They briefed the Committee on HAT technology planning. HAT is a cross-Agency, multi-disciplinary study team that conducts strategic analyses to assess integrated development approaches for architectures, systems, and mission scenarios for human and related robotic space exploration. HAT prepares design reference mission (DRM) definitions to inform integrated, capability-driven approaches for systems planning within a multi-destination framework. HAT does not build or design systems; it only engages at the concept level. In FY 2011, HAT prepared DRMs for NASA's Space Launch Services (SLS) and Orion Multi-Purpose Crew Vehicle (MPCV). Mr. Culbert used a graphical chart to illustrate capability-driven exploration. He explained that the capabilities required at each destination are determined by the mission. These capabilities are packaged into a logical progression of common elements to embrace incremental development. For SLS performance, it has been

determined that the ability to lift 105 tons into LEO will capture the majority of DRMs. He emphasized that activities at the destination will need as much attention as the transportation components. Dr. Ballhaus asked what the consequences would be if NASA were constrained to use the Delta IV Heavy rocket. Mr. Culbert responded that more frequent launches would be required and, therefore, the launch infrastructure would need to be examined. In addition, fuel would need to remain in orbit longer, necessitating new cryogenic technologies.

A sample "bat chart"—where the destinations are shown hanging down from the top—was shown. Mr. Vangen discussed the Global Exploration Roadmap (GER) for an extended lunar stay with emphasis on service mobility. He also discussed the new technology elements required for various destinations beyond LEO. The International Space Exploration Coordination Group (ISECG) GER enhances international coordination and cooperation in human exploration by enabling discussions on goals and objectives, technically feasible mission scenarios, and near-term opportunities. The NASA technical contributions to the GER are developed by the HAT team. Forward work issues and concerns for HAT include space propulsion, technology and capability priorities, an Earth Moon Lagrange Point 2 mission, and a Mars mission. Mr. Vangen described the HAT technology development assessment process and products and discussed HAT's role in influencing human spaceflight technology dialogues and decisions. He briefly reviewed the product benefactors. Mr. Vangen also described the HAT technology development assessment on the technology development data capture process. With proprietary data deleted, he showed a sample "one-pager" technology development sheet on regenerative fuel cells. To qualify for a "one-pager," an advocate who is the source for funds must be identified. Charts on technology development summaries and technology development element mapping were presented and explained. A superset of approximately 300 technologies will be included in a portfolio that will communicate possible duplicative efforts and potential partnerships.

HAT's future steps were described. Technology development alignments will be identified between Advanced Exploration Systems (AES) projects and HAT-identified technologies. OCT mapping and Human Research Program (HRP) mapping, without ranking, will be considered in the HAT mapping spreadsheet. Dr. Ballhaus expressed concern over leadership and governance issues that may have arisen because the Vice President no longer chairs the National Space Council. Ms. Chandler responded that OSTP is required by law to establish a cross-agency plan that is supposed to include all NASA programs.

Dr. Ballhaus thanked Mr. Culbert and Mr. Vangen for their presentation.

Technology and the James Webb Space Telescope (JWST) Program

Dr. Ballhaus introduced Mr. Rick Howard, Program Director, JWST, who briefed the Committee on the program's status. The JWST is the scientific and technological successor to the Hubble Space Telescope (HST). JWST will have more than six times HST's collecting area, and be 100 times more sensitive. It will operate in deep space, about one million miles from Earth, or four times further than the Moon. It will be cooled by a deployed sunshade the size of a tennis court. Mr. Howard described several technology inventions and advances attributable to the program: segmented beryllium primary mirror; composite structure to hold members and instruments; cryogenic application-specific integrated circuit (ASIC); micro-shutters; sunshield membranes; advanced near infrared detectors; advanced mid-infrared detectors; cryo-cooler for mid-infrared instrument; mirror phasing and control software; and heat switches. Eighteen mirror segments will be computer-controlled to operate as one mirror in space. The mirrors are gold coated because that is the best coating for infra-red. The total quantity of gold required for this is two ounces. NASA worked with the Air Force and the National Reconnaissance Office (NRO) to develop the mirrors. Mr. Howard showed the mirror development schedule. The development effort lasted over a decade, and four years were needed for the manufacturing process. The mirrors are so smooth that if stretched to the size of the continental U.S., the largest deviation from perfection would be less than 2 inches in height. There will be over 100,000 computer-controlled shutters, each the width of a human hair.

Mr. Howard described the mid-infrared instrument (MIRI) cryo-cooler and the process for manufacturing the sunshield. Each detector is able to see a single candle on the Moon from one million kilometers. He discussed a design flaw in the barrier layer of the pixel interconnect structure that has led to detector

degradation. This has been remedied and should not reoccur when the next generation of detectors is fabricated. Several technology spinoffs were discussed. The need to accurately measure the shape of the mirrors has led to new optical measurement devices with significant improvements in wavefront-sensing technology. This has enabled improvements in the technology for measuring human eyes, diagnosing ocular diseases, and potentially improving surgery. A low-noise, cryogenic ASIC to convert the analog signals from the near-IR detectors to digital had to be developed and is now being used with the Advanced Camera for Surveys on the HST. High-speed test devices have been developed that utilize pulsed lasers that freeze out the effects of vibration.

Mr. Howard reviewed the new master schedule for JWST and the hardware fabrication completion percentages. The planned launch date is October 2018. An additional $44 million for JWST was approved by Congress in FY 2011. JWST is fully funded and has adequate cost and schedule reserves.

Dr. Ballhaus thanked Mr. Howard for his presentation.

Annual Ethics Briefing

Dr. Ballhaus introduced Ms. Kathleen Teale, Esq., Office of General Counsel (OGC), NASA Headquarters. Ms. Teale briefed the Committee Members on the legal requirements pertaining to ethics. Each Committee Member is a Special Government Employee (SGE) and the government's ethics laws apply to all SGEs. Ms. Teale described the standards of conduct and the criminal statutes on ethics. Any Committee member having a specific issue should notify Mr. Green and obtain legal advice from the NASA OGC.

Dr. Ballhaus thanked Ms. Teale for her presentation.

Remarks by NAC Chair Dr. Steven Squyres

Mr. Green introduced Dr. Steven Squyres, Chair, NAC. Dr. Squyres had previously served as the NAC's Science Committee Chair when Mr. Green served as the NAC's Executive Director. Dr. Squyres noted that as the NAC Chair, he works for the NASA Administrator and for the NAC's committees. The committee chairs make up the NAC, and the "heavy lifting" is done at the committee level. He asked to be informed if anything is needed by the T&I Committee. He does not want the NAC to remand or serve as a high-density filter on committee advice to the Administrator; therefore, Committee advice should be focused at a level that is appropriate for the Administrator. The NAC's job is to convey information, not reject recommendations. Dr. Squyres does not intend to engage in "micro-management."

Dr. Ballhaus informed Dr. Squyres that there is an issue on maintaining governance over NASA's core competencies. The manner in which core competencies are managed has changed greatly over the last 25 years. In government, the ability to control is dependent upon authority to exercise budgetary control. The OCT's budgetary authority over technology development has yet to be tested and is dependent on NASA's governing structure. The Administrator needs to identify who is accountable for maintaining core competencies and to establish the metrics for measuring that accountability. Dr. Ballhaus advised that it is important to "fence off" the budget for "technology-push" and to segregate that funding from funds for technology required by missions. He observed that astute administrators have recognized that this is needed to maintain core competencies and fund technology development. The pendulum is moving back to a more appropriate balance. Many technologies are cross-cutting and are needed by more than one mission. OCT has a responsibility to look across the Agency for duplication. Dr. Mountain asked whether OCT has the authority to prevent duplication. Dr. Squyres explained that it is important to identify inefficiencies; at the same time, individual Mission Directorates need to be able to pursue technology that they don't believe is being developed elsewhere in the Agency. It comes down to adequate communications. OCT needs to know what the associate administrators and mission directors are doing. They may not be aware of technology linkage in other areas, and that is where OCT has a role for coordination.

Dr. Ballhaus noted that he concurs, as a rule of thumb, with the NRC Report's recommendation that ten percent of NASA's budget should go to technology development, and that ten percent of that ten percent should be applied to the more basic, low-TRL development. Dr. Ballhaus explained the need for an

accounting, which the Agency is currently performing, to identify what NASA is spending on technology development. Dr. Squyres noted that a recent Planetary Decadal Study had identified a shortcoming by the Agency in failing to pursue projects in the mid-TRL levels, which became known as the TRL "valley of death." Dr. Ballhaus responded that this has always been an issue. Dr. Squyres suggested that another role for the OCT could be to help identify future projects that should proceed as mid-TRL projects. Dr. Ballhaus concurred. Dr. Squyres requested that the Committee continue to give advice on these matters.

Dr. Ballhaus thanked Dr. Squyres for his comments.

Discussion and Recommendations

Members discussed possible subjects and specific observations, findings, and recommendations for Dr. Ballhaus' presentation to the NAC at its upcoming meeting. Mr. Eichhorst asserted that "adequate is the enemy of the future." He explained that mission directors may not see the value in fully developing a particular technology, whereas that technology, if fully developed, could be highly valuable elsewhere. For this reason, it would be important to have OCT share in controlling technology development. Dr. Mountain observed that science has fallen into the same trap and that nobody is b eing ambitious. Dr. Ballhaus explained that people have lowered their willingness to accept risk due to problems with JWST and the Mars Science Laboratory (MSL). He noted that these types of "grand" projects are exactly what NASA should undertake because nobody else can do them. Dr. Mountain recommended adopting the three themes from the NRC technology roadmap report. In his view, the three themes have equal priority. Dr. Ballhaus observed that the Committee's charter is broader than OCT; the Committee's purview extends to the entire Agency, and the Committee can advise across it. There is a need, therefore, for the accounting on technology development. Mr. Eichhorst recommended an effort to protect the core technologies for which there is consensus on the need to maintain. It was suggested that the Committee endorse the NRC's ten percent technology investment recommendation. Dr. Ballhaus agreed and explained that this would guarantee "seed corn" for NASA's future technology and innovations. Dr. Mountain recommended that OCT be an advocate for the technologies that should be included in that investment. Dr. Ballhaus recommended a finding on the importance in having a systems analysis capability to assess technology. Mr. Green noted that, according to the NRC Report, system analysis support tools are being developed in bits and pieces. Dr. Ballhaus advised that NASA should identify who is responsible for ensuring that NASA's core competencies, facilities and laboratories are maintained. He recommended additional training for each technology employee and suggested setting a standard equal to 40 hours per year.

Adjournment

Dr. Ballhaus adjourned the meeting at 4:15 PM.

Agenda

NAC Technology and Innovation Committee Meeting
March 6, 2012
NASA Headquarters
MIC 6A

March 6, 2012 –

8:00 a.m.	Welcome and overview of agenda/logistics (FACA Session) Mike Green, Executive Secretary
8:05 a.m.	Opening Remarks and Thoughts Dr. William Ballhaus, Chair
8:15 a.m.	Office of Chief Technologist Update Dr. Mason Peck, NASA Chief Technologist
8:45 a.m.	Update and Discussion of NASA 's FY 2013 Budget Request for Space Technology Program Dr. Michael Gazarik, Director, NASA Space Technology Program
9:45 a.m.	Break
10:00 a.m.	NRC's NASA Technology Roadmap Report Dr. Raymond Colladay, National Research Council
11:30 a.m.	NASA Response Plan to NRC Report and Discussion Dr. Mason Peck, NASA Chief Technologist
12:00 p.m.	Lunch (On own)
12:45 p.m.	Update on HAT Technology Planning Mr. Chris Culbert, NASA Johnson Space Center
1:45 p.m.	Technology and the JWST program Mr. Rick Howard, Program Director, JWST
2:30 p.m.	Annual Ethics Briefing Ms. Kathleen Teale, NASA OGC
3:30 p.m.	Remarks by NAC Chair Dr. Steve Squyres
3:45 p.m.	Discussion and Recommendations
4:15 p.m.	Adjournment

NAC Technology and Innovation Committee Membership
[Updated February 2012]

Dr. William (Bill) F. Ballhaus, Jr., Chair	[retired]
Mr. G.M. (Mike) Green, Executive Secretary	NASA Headquarters
Mr. Gordon Eichhorst	Aperios Partners LLP
Dr. Charles (Matt) Mountain	Space Telescope Science Institute
Dr. Dava Newman	Massachusetts Institute of Technology
Dr. Susan X. Ying	The Boeing Company

NAC Technology and Innovation Committee
NASA Headquarters
Washington, DC
March 6, 2012

MEETING ATTENDEES

Committee Members:

Ballhaus, William (Bill) – Chair	*[Retired – not affiliated]*
Green, G.M. (Mike) – Executive Secretary	NASA Headquarters
Eichhorst, Gordon	Aperios Partners LLP
Mountain, Charles (Matt)	Space Telescope Science Institute
Newman, Dava (attended via telecon)	Massachusetts Institute of Technology
Ying, Susan X.	The Boeing Company

NASA Attendees:

Adams, Jim	NASA HQ
Chandler, Faith	NASA HQ
Dembling, Anyah	NASA HQ
Gazarik, Michael	NASA HQ
Komar, George	NASA HQ
Parrish, Joe	NASA HQ
Peck, Mason	NASA HQ

Other Attendees:

Colladay, Ray	NRC
Frankel, David	Zantech/P B Frankel LLC
Mellody, Maureen	NRC
Squyres, Steve	NAC/Cornell University
Terrell, Kim	Katt International Management Solutions

NAC Technology and Innovation Committee
NASA Headquarters
Washington, DC
March 6, 2012

LIST OF PRESENTATION MATERIAL

1) Space Technology FY 2013 [Gazarik]
2) NASA Space Technology Roadmaps and Priorities [Colladay]
3) Restoring NASA's Technological Edge and Paving the Way for a New Era in Space [Aeronautics & Space Engineering Board, NRC]
4) NASA Response Plan to NRC Report and Discussion [Peck]
5) Human Spaceflight Architecture Team (HAT) Technology Planning [Culbert/Vangen]
6) James Webb Space Telescope [Howard]