National Aeronautics and Space Administration

Technology & Innovation Committee

of the

NASA Advisory Council

Goddard Space Flight Center

Greenbelt, MD

July 24, 2012

MEETING MINUTES

G. M. Green, Executive Secretary

William F. Ballhaus, Jr., Chair

NAC Technology and Innovation Committee Meeting
July 24, 2012
NASA Goddard Space Flight Center
Bldg. 8 Management Conference Center

MEETING MINUTES
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Meeting Report prepared by:
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Welcome and Opening Remarks

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. Meeting minutes will be taken by Mr. David Frankel. The meeting is being broadcast over WebEx, and people can also listen to the meeting over a dial-in telephone line. The Committee members introduced themselves. Mr. Green reviewed the planned agenda for the meeting and noted that the Committee's primary task would be to consider the new NASA Draft Strategic Space Technology Investment Plan (SSTIP).

Mr. Greene introduced Dr. William Ballhaus, Chair, who thanked everyone for coming to the meeting. He noted that four new Committee members were in attendance: Dr. Erik Antonsson, Dr. Randall Correll, Mr. David Neyland, and Dr. Mary Ellen Weber. He thanked Dr. Mason Peck, NASA Chief Technologist, for doing an excellent job in selecting the new members. He noted that NASA Administrator, Mr. Charles F. Bolden, Jr., has requested that the Committee focus on technology issues.

Welcome to GSFC and Q&A

Dr. Ballhaus introduced Mr. Arthur F. "Rick" Obenschain, Deputy Director, NASA Goddard Space Flight Center (GSFC or Goddard). Mr. Obenschain welcomed the Council members to GSFC, which he explained was NASA's first field center. Goddard's primary focus is on Earth and space science. They have had over 300 missions, the vast majority of which have been successful. In addition to the Center located in Greenbelt, Maryland, Goddard operates the Wallops Flight Facility in Virginia, the Institute for Space Studies in New York City, ground stations at the White Sands Complex in New Mexico, and the Independent Verification and Validation Facility in West Virginia. Goddard employs across its facilities 3,400 civil servants and 6,400 contractors, of whom 61percent are scientists and engineers. In response to a question from Mr. Correll, Mr. Obenschain explained that Goddard is an applications Center, and that its technologies are generally mission directed. Dr. Ballhaus noted that NASA has developed critical core competencies over several decades, and that future budgets are going to be flat at best. He asked whether NASA is paying attention to those core competencies and investing in them. Mr. Obenschain responded that everyone knows there is a need to make investments, and that trades have to be made. He explained NASA will not be able to take the next step without establishing the enabling of technology today. Goddard does not need much support from the Office of Chief Technologist (OCT) because it is a mission center working on existing programs. The work performed at Goddard cannot be obtained from private industry. Dr. Ballhaus inquired as to the individual accountable for identifying the core competencies that might be lost. Mr. Obenschain explained that it would be the Center Director, Mr. Christopher Scolese, and Ms. Christyl Johnson, Deputy Director for Technology and Research Investments. Dr. Peck advised that NASA Associate Administrator Mr. Robert M. Lightfoot Jr., also has this responsibility and engages with the Centers directly. Dr. Charles (Matt) Mountain expressed a need for a coherent program to maintain core competencies and a need for integration between the science mission and the technology vision. Dr. Ballhaus counseled that it will be hard to maintain competencies in areas where there is no mission. Mr. Obenschain estimated that the number of people at Goddard who are working on technology is a little less than 10 percent of the workforce.

Dr. Ballhaus thanked Mr. Obenschain for his time.

Update and Discussion of Space Technology Program

Dr. Ballhaus introduced Dr. James Reuther, Deputy Director, NASA Space Technology Program (STP), who briefed the Committee on the program. He described the OCT and noted that the Chief Technologist's primary interface is with the NASA Administrator. The mission directorates are focused on supporting mission profiles, while OCT is engaged in pushing NASA more towards cutting edge technologies. OCT nurtures "push" technologies. A

technology "pull" arises where a mission requests a specific technology, whereas a technology push is not on the radar. Dr. Antonsson counseled that a mix of push and pull is critical. Dr. Reuther described the nine STP programs: the Game Changing Development (GCD) Program; the Technology Demonstration Missions (TDM) Program; the Small Spacecraft Technologies Program; the Space Technology Research Grant Program; the NASA Innovative Advanced Concepts (NIAC) Program; the Center Innovation Fund Program; the Centennial Challenges Prize Program; the Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) Program; and the Flight Opportunities Program. Technology Demonstration Missions involve in-space demonstrations of large systems and are the most visible elements among the nine programs. For these demonstrations, there must be an infusion customer--somebody who is going to do a space mission in the future who is willing to pick up the demonstration. Dr. Reuther described two failure modes. The first arises due to a technical problem or programmatic problem. That is acceptable. The second arises when a technology demonstration is successful but goes on the shelf because nobody uses it. That is unacceptable. The STP's guiding principles were discussed. A chart was presented on the Space Technology FY 2013 President's Budget Request. The notional budgets through FY 2017 for SBIR/STTR increase pursuant to congressional mandate, while the budgets for the remaining line items are flat-lined. In response to a question from Dr. Ballhaus, Dr. Reuther explained that only approximately $100 million of the $699 million budget is discretionary. The status of the current "Big Nine" projects was reviewed. Three are in GCD: Hypersonic Inflatable Aerodynamic Decelerators (HIAD), Composite Cryotank Technologies and Demonstration (CCTD), and Human Robotics Systems (HRS). The remaining six are in TDM: Cryogenic Propellant Storage and Transfer (CPST); Solar Sail Demonstration (SSD); Low Density Supersonic Decelerator (LDSD); Deep Space Atomic Clock (DSAC); Laser Communications Relay Demonstration (LCRD); and Human Exploration Telerobotics (HET).

Dr. Ballhaus thanked Dr. Reuther for his presentation.

Office of Chief Technologist Update

Dr. Ballhaus introduced Dr. Mason Peck, NASA Chief Technologist. Dr. Peck noted that the STP is a flagship program, and that his office has responsibility for giving strategic guidance. He discussed the distinction between basic research and technology development. NASA works on fundamental disciplines that do not constitute technology, but are fundamentally important and deserve to be nurtured. Basic research is not included in the Technology Readiness Level (TRL) spectrum and is not recognized or covered in the SSTIP. OCT is charged with ensuring that NASA supports a culture for innovation. Everything that NASA builds includes innovation. Empowering NASA's employees to innovate is an OCT responsibility. Dr. Ballhaus cautioned that there are two cultures that should be maintained separately: one is the highly innovative culture dedicated to research; the other is the culture, which is more disciplined and must avoid freelancing. Processes are used there to execute projects to generate predictable repeatable results. Ms. Faith Chandler, Acting Director, Program Management and Integration Office, asserted that there are two kinds of processes: one is for general safety, where it is important to not deviate; the other is the process for developing and testing ideas, where there is more capacity for tailoring, particularly at low TRLs. Dr. Ballhaus cautioned that this has to be handled very carefully and in a controlled way. Dr. Susan X. Ying asked what structure is used to quickly identify failure. Dr. Reuther explained that milestones, schedules, and budgets are laid out in advance, and if these are not met then NASA will call a termination meeting. Dr. Peck explained that having a portfolio approach gives NASA the freedom to terminate individual projects. In response to a question from Dr. Ying, Dr. Reuther responded that several projects in low TRL had been terminated early. Dr. Ballhaus advised that it is critical to make sure that a mission is properly scoped, and he cautioned that there is no tolerance for high profile missions to fail in a billion-dollar program. Portfolio management fails when projects are allowed to go on for too long, so an early termination mode is the best way to go. Dr. Peck noted that there is broad support for OCT in NASA, the Hill, and the White House. Dr. Antonsson expressed concern that some technologies, such as optical communications, might be canceled if a portfolio is not balanced to permit some speculative concepts that take a long time to mature. Dr. Reuther noted that there are three to four hundred SBIR projects in the low TRLs for which there is no insistence on infusion; however, a large demonstration mission has to be run in a very controlled way. Dr. Ballhaus explained that in private enterprise only a small percentage of patents make money for a company; NASA can afford to be more patient in looking at payoff for capital investment, whereas the private sector has to be interested in return on investment. Dr. Antonsson agreed that that is the precise role for government, which gives rise to his concern over the appetite for early termination. He suggested contemplating whether Robert Goddard's projects that would have survived funding cuts. Dr. Peck surmised that Dr. Goddard would have received a NIAC award, whereas there probably would not have been any funding for the Jules Verne

project. It is important to ensure that the technology budget cannot be "raided," Dr. Peck asserted, which is why Congress created the space technology account. Now, for the first time, funds for technology development have been set aside and protected.

Dr. Ballhaus thanked Dr. Peck for his presentation.

Review of NASA's Draft Strategic Space Technology Investment Plan

Dr. Peck informed the Committee that the Office of Management and Budget (OMB) had requested that the SSTIP be reviewed by a "deliberative" panel. The Committee is being asked to serve as that panel and to recommend whether the SSTIP should be adopted by the Administrator. The SSTIP defines technology as "a solution that arises from applying the disciplines of engineering science to synthesize a device, process, or subsystem, to enable a specific capability." Dr. Neyland expressed concern that the definition may exclude technologies that are not yet identified. Dr. Peck agreed and explained that the concept is intended to establish a connection to the world of applications and readiness. In response to a question from Dr. Ballhaus about the need for a separate research program, Dr. Peck advised that he cannot publicly discuss pre-decisional matters that are going to be presented to OMB and OSTP. The draft SSTIP is a strategic document that will serve as a single voice for technology development at NASA. It was put together by Ms. Chandler and her staff after the National Research Council (NRC) released its study. The SSTIP will be governed by the NASA Technology Executive Council (NTEC), which will make decisions on rebalancing the technology portfolio. In response to a question from Dr. Ying, Dr. Peck explained that the Center Chief Technologists have their own council, the Center Technologists Council (CTC), and would not have a seat on the NTEC. Ms. Chandler noted that the CTC would be expected to bring recommendations to the NTEC and, therefore, the individual chief technologists would have a conflict of interest. Dr. Peck explained that NASA technology is aligned with the nation's technology priorities, and he described how NASA's technology portfolio is developed. Dr. Ballhaus asked whether anything could have been done in the technology area to drive down costs for the James Webb Space Telescope (JWST) and the weather satellites. Dr. Peck responded affirmatively. He described how the SSTIP was prepared. It began with the OCT's 14 technology roadmaps. The NRC then prioritized the technologies in those roadmaps and identified the 16 highest priority technologies. The SSTIP updates the roadmaps to incorporate the feedback from the NRC study. In response to a question from Dr. Mountain, Dr. Peck explained that the NRC's goals are NASA's goals. In response to a question from Dr. Ballhaus, Dr. Peck opined that the NRC study adds credibility to NASA's choices, and that the NRC is advising, not redirecting NASA. He added that the community that advised the NRC is the same community that advised NASA in developing the roadmaps. In response to a question from Dr. Ballhaus, Dr. Peck explained that the percentage of the overall NASA budget that goes to technology is unknown. Dr. Antonsson noted that Jet Propulsion Laboratory's (JPL's) accounting system previously did not have a code or flag to identify technology development; the only way to develop the information was by hand, which was onerous and not sustainable. Dr. Ballhaus, noting that the Air Force budget had a three percent target for technology development funding, explained that the Committee may advise the Administration on the percentage that should be used for technology throughout the Agency and the percentage that should be set aside for OCT. He reported that Dr. Dava Newman is concerned that simply balancing the technology investment evenly like "spreading peanut butter" will produce minimal results over time.

Ms. Chandler described the SSTIP's contents. It does not cover aeronautics, which is covered by the National Aeronautics Research Plan. The SSTIP is based on four pillars, with each pillar having a strategic investment goal, capability objectives, and technical challenges. Some objectives cut across different pillars. The SSTIP's framework is based upon the NASA Space Technology Roadmaps, the NRC Study, U.S. National Space Policy, OMB Science and Technology Priorities for the FY 2014 Budget, NASA technology portfolio assessments, and a survey of stakeholder needs. The pillars' four goals are: (1) extend and sustain human presence and activities in space; (2) explore the structure, origin and evolution of the solar system and search for life past and present; (3) expand understanding of the Earth and the universe, and; (4) energize domestic space enterprise and extend benefits of space for the Nation. The investments will have three levels: core, adjacent, and complementary. Core investments will focus on mission specific technologies and eight critical pioneering and crosscutting areas; these will receive 70 percent of technology funds. Adjacent investments are not core technologies, but are part of the NRC's 83 high priorities; these will receive 20 percent. Complementary investments do not include core or adjacent and will receive 10 percent. Ms. Chandler noted that these allocations are industry standard. There are six guiding principles: balance investment across all 14 space technology areas in the roadmaps; balance investment across all technology readiness levels (TRLs); ensure that developed technologies are infused into Agency missions; pursue partnerships; use a

systems engineering approach; and reach out to the public. Dr. Ying observed that the only "push side" person on the NTEC is the Chief Technologist. Dr. Correll asked whether anyone in the NTEC addresses relevance to industry needs. Ms. Chandler advised that the commercial sector had provided input to the NRC, and that it would be inappropriate for NASA to include people from the commercial sector on the NTEC. Dr. Ballhaus felt that the pillar chart appeared redundant due to duplications in the capabilities. Dr. Antonsson felt that the plan was too complex and would benefit from greater simplicity. Dr. Mountain opined that Congress would not understand the plan. Dr. Ballhaus counseled that it was not an actionable investment plan because it does not show where the money will be spent. Dr. Neyland advised that users need to be able to determine where they fit in the plan's framework. Dr. Weber commented that the quality of work that went into developing the plan is outstanding. She advised that the most useful part of the plan was in the appendix, where the different entities that manage the projects are discussed. She recommended that that section be brought forward, and that the discussion in the plan on how it was developed be moved into an appendix. Dr. Antonsson commented that the plan did not provide sufficient direction and had too much vagueness. Dr. Weber noted that the plan contained references to items like "Game Changing," without explaining what those terms mean. Dr. Ballhaus observed that the plan is a tremendous improvement from where things were a few years ago. Dr. Neyland advised that the plan should paint a picture that gets people excited and interested in entering the fields discussed in the plan. Dr. Ballhaus suggested that the plan begin by describing exciting projects that NASA will be working on in the future. Dr. Randall suggested more focus on the infrastructure found at NASA Centers. He explained that the Centers are the incubators, that people in different regions want to work with the Centers, and that the plan should describe the Centers' role in technology development. Dr. Ballhaus summarized that the Committee's key inputs were to simplify the plan, explain where we are and where we are going, and reorganize the plan.

Dr. Ballhaus thanked Dr. Peck and Ms. Chandler for their presentation.

Discussion on Draft NASA Advisory Council Recommendations

A proposed Recommendation approving the draft SSTIP was presented for the Committee's consideration. With the caveat that the language be revised off-line by Dr. Ballhaus and the full NAC as needed, the Recommendation was approved as follows:

The Council recommends the NASA Administrator adopt a revised version of the Strategic Space Technology Investment Plan (SSTIP) as the Agency's space technology strategic plan moving forward, with the following input:

- *The Council agrees with the content and strategy of the SSTIP.*
- *The Council offered two suggestions to a) simplify the description of the plan in the SSTIP and b) re-organize the SSTIP to emphasize what the plan is, and de-emphasize how it was derived.*

The Committee was asked to consider a proposed Recommendation to establish formal guidance and seek funding for basic research in engineering science, and to begin this by having OCT manage the Agency's research portfolio. Ms. Chandler explained that TRL 1 is the first step into the application world. When something can be measured by a readiness level, it is technology that is being measured; anything below TRL 1 is basic research. Dr. Ballhaus counseled that the proposed research activity could develop into an activity parallel to the STP. Dr. Mountain noted that basic research is an element that is missing from the SSTIP's definition for technology. After further discussion, the Committee approved the Recommendation as follows:

The Council recommends that NASA establish a basic research (engineering science) program relevant to its long-term needs and goals.

- *The Council suggests that the Chief Technologist collaborate with the Chief Scientist and the Chief Engineer to establish formal guidance and seek funding for basic research in engineering science. The Council further suggests that NASA begin by managing the agency's basic research portfolio as a pilot activity that is funded separately from the Space Technology Program, similar to how OCT coordinates the agency's technology portfolio..*

Update on NASA Technology Transfer/Commercialization Activities

Due to time considerations, the Committee deferred its discussion on this matter to a later date.

GSFC Technology Programs

Dr. Ballhaus introduced Mr. Peter Hughes, GSFC Chief Technologist, OCT. He welcomed the Committee members to Goddard. The OCT's principal responsibility is managing the Internal Research and Development (IRAD) Program, which provides seed funding to develop concepts and reduce technology risk in order to enable future missions and increase the probability of external technology awards and mission funding. These investments are focused in technological areas that satisfy Goddard's principal business lines, which are Astrophysics, Communications and Navigation, Cross Cutting Technology and Capabilities, Earth Science, Heliophysics, Planetary and Lunar Science, and Suborbital Platforms. A chart showing how IRAD funds are allocated was presented. Approximately 40 percent of the IRAD portfolio is in early stage innovation projects. Twenty-five percent of IRAD efforts are led by Early Career technologists, who make up 11 percent of Goddard's workforce. In response to a question from Dr. Mountain, Mr. Hughes estimated that the IRAD budget was less than one percent of Goddard's overall budget. Ms. Chandler noted that in addition to IRAD funding, there is OCT technology development and mission technology development.

Mr. Hughes discussed technology development at Goddard. The Hubble Space Telescope (HST) has revolutionized astrophysics. Goddard is building the JWST. Construction progress on JWST may be followed through two webcams found at http://www.jwst.nasa.gov/webcam.html. Goddard provided the Sample Analysis at Mars (SAM) instrument suite on board the Mars Science Laboratory rover. The instrument suite includes a mass spectrometer, gas chromatograph, and tunable laser spectrometer that will search for carbon compounds that are associated with life. A mission called Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer, or OSIRIS-Rex, will be the first U.S. mission to carry samples from an asteroid back to Earth. The Solar TErrestrial RElations Observatory (STEREO) mission uses two nearly identical observatories, one ahead of Earth in its orbit, the other trailing behind, to trace the energy and matter that flows from the Sun to Earth. The Ice, Cloud, and land Elevation Satellite (ICESat) is the benchmark Earth Observing System mission for measuring ice sheet mass balance, cloud and aerosol heights, as well as land topography and vegetation characteristics. ICESat-2 is scheduled for launch in early 2016. Other projects discussed were the Gravity and Extreme Magnetism SMEX (GEMS) Mission, the Neuron Star Interior Composition Explorer (NICER), Micro-scale ElectroHydroDynamic (EHD) Thermal control, and nanotechnology development. Mr. Hughes described Goddard's role in a "big nine" NASA technology project, the Laser Communication Relay Demonstration (LCRD) mission, for which NASA OCT has awarded GSFC more than $160 million. Goddard engineers have won NIAC funding to investigate techniques for trapping and moving objects using laser light. A Goddard team is developing a new spectrometer with components that fit onto a silicon wafer and do not require moving parts to operate. Mr. Hughes concluded his presentation with a quote from Robert H. Goddard: "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow."

Dr. Ballhaus thanked Mr. Hughes for his presentation.

Adjournment

The meeting adjourned at 3:00 p.m.

Agenda
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July 24, 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
8:10 a.m.	Welcome to GSFC and Q&A Mr. Chris Scolese, Director, NASA GSFC
8:30 a.m.	Update and Discussion of Space Technology Program Dr. James Reuther, Deputy Director, NASA Space Technology Program
9:00 a.m.	Office of Chief Technologist Update Dr. Mason Peck, NASA Chief Technologist
9:30 a.m.	Break
9:45 a.m.	Review of NASA's Strategic Space Technology Investment Plan (SSTIP) Ms. Faith Chandler, Acting Director, Program Management and Integration Office Dr. Mason Peck, NASA Chief Technologist
12:00 p.m.	Lunch (On own)
12:45 p.m.	Update on NASA Technology Transfer/Commercialization activities Dr. Mason Peck, NASA Chief Technologist
1:15 p.m.	GSFC Technology programs Mr. Peter Hughes, GSFC Chief Technologist
1:45 p.m.	Discussion and Recommendations
2:50 p.m.	Adjournment
3:00 p.m.	NAC Committees All-Hands with NASA Administrator
~4:30 p.m.	Reception with other Committees and NASA Administrator

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NAC Technology and Innovation Committee Membership
[Updated July 2012]

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

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MEETING ATTENDEES

Committee Members:

Ballhaus, William (Bill) – *Chair*	*[Retired – not affiliated]*
Green, G.M. (Mike) – *Executive Secretary*	NASA Headquarters
Antonsson, Erik A.	Northrop Grumman Aerospace
Correll, Randall	Ball Aerospace & Technologies
Mountain, Charles (Matt)	Space Telescope Science Institute
Neyland, David	Office of Naval Research - Global
Weber, Mary Ellen	Stellar Strategies LLC

NASA Attendees:

Chandler, Faith	NASA Headquarters
Peck, Mason	NASA Headquarters
Reuther, James	NASA Headquarters
Obenschain, Rick	NASA Headquarters
Hughes, Peter	NASA/GSFC
Farrell, Kelly	NASA Headquarters
Anyah Dembling	Freedom Information Systems, Inc.

Other Attendees:

Winfield, Dan	RTI International
Butler, Leroy	Hamilton Sundstrand
Squyres, Steve (NAC Chair)	Cornell University

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LIST OF PRESENTATION MATERIAL

1. Technology & Innovation Committee [Ballhaus]
2. NASA Office of the Chief Technologist and Space Technology Program FY 2013 [Reuther]
3. Strategic Space Technology Investment Plan (SSTIP) Overview [Peck]
4. NASA Technology Transfer and Commercialization Update [Peck]
5. Statement of Dr. Mason Peck, Chief Technologist, NASA, before the Subcommittee on Space and Aeronautics, Committee on Science, Space and Technology, U.S. House of Representatives, July 12, 2012
6. NASA Space Flight Center: On the Cutting Edge [Hughes]
7. *Cutting Edge: Goddard's Emerging Technologies*, Vol. 8, Issue 3, Spring 2012
8. NASA Strategic Space Technology Investment Plan [draft]