

**National Aeronautics and Space Administration**

**Technology & Innovation Committee  
of the  
NASA Advisory Council**

**NASA Headquarters  
Washington, DC**

**April 18, 2013**

**Meeting Minutes**



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**G. M. Green, Executive Secretary**



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**William F. Ballhaus, Jr., Chair**

**NASA Advisory Council (NAC) Technology and Innovation Committee  
NASA Headquarters  
Washington, DC  
April 18, 2013**

**Meeting Minutes**

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

**NAC Technology and Innovation Committee Meeting  
April 18, 2013  
NASA Headquarters  
Washington, D.C.  
6Z43**

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 committee members that other people may be attending the meeting via teleconference. Logistics for the meeting were reviewed by Mr. Green and he announced that that next meeting will be held in June or July 2013.

Opening Remarks

Mr. Green introduced Dr. William Ballhaus, Chair, NAC T&I Committee, who welcomed everyone to the meeting. At the request of Dr. Ballhaus, the committee members and meeting visitors introduced themselves. Minutes from the last meeting were reviewed. Dr. Ballhaus clarified that the minutes at page 9 should indicate that there is not “yet” a demonstrated capability among the new commercial entrants, and they will not launch high-value assets for the National Reconnaissance Office until that capability is demonstrated. The minutes were approved subject to that revision.

Space Technology Mission Directorate Update

Dr. Ballhaus introduced Dr. Michael Gazarik, Associate Administrator, Space Technology Mission Directorate (STMD), who briefed the Committee on the Directorate’s status and its progress since the Committee’s meeting last November. He explained that STMD has three years to make definitive progress before the next election cycle. The areas where new technology is needed are well known. People from the Shuttle program are now working on new technology solutions. There is a greater push than ever to be more efficient with taxpayers’ dollars and great results are expected from people working together and sharing. Dr. Ballhaus stressed that is important to understand NASA’s long-term goal for moving the human presence into space in order to understand the technologies that will be needed. Dr. Gazarik noted that the question about the goal has been debated for over 25 years. The President has determined that NASA should visit an asteroid by 2025. NASA’s Deputy Administrator, Ms. Lori Garver, quoting from

Dr. Neil deGrasse Tyson, has indicated that this should be done for “fear, glory, and money.” Dr. Ballhaus cautioned against spinning wheels on something that has been pursued for 25 years. Dr. Gazarik reiterated that NASA’s direction is to go above low-earth orbit (LEO), and that NASA now has a focus on an asteroid mission and a future mission to Mars. Dr. Ballhaus explained that a consensus is needed within the government on what the long-term goals should be. Dr. Dava Newman suggested that NASA differentiate between the technology needed for a Mars mission and the technology needed for an asteroid mission. Dr. Gazarik reported that private companies believe profits can be earned from asteroid visits. NASA's Associate Administrator for Human Exploration and Operations, Mr. William H. Gerstenmaier, has promoted the “flexible path,” which Dr. Gazarik believes is sufficient to drive the STMD forward. A three to five year stable mission framework is needed for developing new technology. The high priority now is solar electric propulsion.

Dr. Gazarik presented a chart showing nine challenges for deep space exploration: communication; radiation mitigation; navigation; environmental control and life support systems; manufacturing in space; power generation and storage; propulsion; logistics; and entry, descent, and landing. Several recent accomplishments were described. The Inflatable Reentry Vehicle Experiment (IRVE)-3 demonstrated the feasibility of inflatable heat shields. A 2.4 meter cryogenic propellant tank was successfully fabricated. The Mars Science Laboratory Entry, Descent and Landing Instrument (MEDLI) suite was on board the Mars rover Curiosity. Small Business Innovation Research (SBIR) companies have provided technologies that enhanced Curiosity’s primary mission.

The FY 2014 President’s Budget for STMD was reviewed. The Space Technology FY 2014 strategy and key budget drivers were discussed. STMD will prioritize expenses based on the Strategic Space Technology Investment Plan (SSTIP) and the National Research Council (NRC) Report on the NASA Space Technology Roadmaps. STMD will align with and support the proposed asteroid retrieval and redirect mission. The budget will allow work on the high-powered Solar Electric Propulsion Demonstration Mission to be accelerated. STMD will support the congressionally mandated increases in the SBIR and Small Business Technology Transfer Programs. Charts were presented to show details on STMD’s funding increases and budget distribution across NASA’s Centers. Dr. Ballhaus advised that the budget has to be built to a level that is equivalent to an associate administrator, and that the funds need to be protected. Support for doing this is needed from the other mission directorates.

The funding for the asteroid capture mission was discussed. Dr. Gazarik explained that the mission was focused on bringing a small five-ton asteroid within Earth orbit. Dr. Randall Correll advised that it is important to start focusing on small objects, which are hard to find, and that it is important to find them before they find us. Dr. Ballhaus asked whether NASA is the federal agency responsible for planetary defense. Dr. Gazarik advised that there is a notification system

that involves the Department of Defense (DoD). He added that NASA does not have dedicated assets for this and leverages private telescopes. Dr. Newman suggested that more needs to be done to justify human missions to asteroids. Dr. Gazarik explained that the asteroid mission leverages other work throughout the Agency, and that the STMD's role is developing the solar propulsion system.

Dr. Gazarik described the division of authority between the STMD and the Office of the Chief Technologist (OCT). Charts were presented showing the STMD organization, its senior leadership, and its program executives. Dr. Gazarik explained that the organization is a flat structure with no divisions. Exploration technology development and its infusion were discussed. Charts showing the "Big Nine" missions and planned major events and milestones for STMD were reviewed. Dr. Gazarik noted that there would be a gap in 2016, where no missions are planned due to constraints related to sequestration. Dr. Erik Antonsson suggested that the gap is a good thing because it demonstrates that sequestration has had a real effect, notwithstanding the public's perception to the contrary.

Dr. Ballhaus noted that some organizations are working on the cube satellites, and he recommended that a white paper be developed to identify the market for cube satellites across the Agency. The white paper is desirable because it is important to know what the market "pull" is when developing a technology base. Dr. Antonsson concurred. Mr. David Neyland asked whether cube satellites launched by universities will create debris and interfere with other spacecraft. Dr. Gazarik advised that that would not be a problem because most do not have propulsion systems and would reside in low altitudes, where they would eventually de-orbit and burn up.

Dr. Newman expressed appreciation for the Space Technology Research Grant Program. She explained that graduate students are now once again becoming interested in working at NASA. She explained that it is important to encourage mentorships between NASA employees and graduate students.

Dr. Ballhaus asked whether Dr. Gazarik had any suggestions for Committee recommendations to the NAC. Dr. Gazarik suggested recognition for STMD's progress and for the fellowship grant program. Concern was expressed that STMD's fellowship grants might be consolidated into other grant programs. Dr. Ballhaus emphasized that mentorship is key and would be lost if STMD's fellowship grants were consolidated. Dr. Antonsson expressed a concern that hazards to the STMD may arise from mission failures that lead to the institution of safety assurance and layers of bureaucracy. Dr. Gazarik explained that this was unlikely and noted that the NASA Administrator, Mr. Charles Bolden, is writing a blog to the entire Agency, saying that it is acceptable to take more risk.

Dr. Ballhaus thanked Dr. Gazarik for his presentation.

### Sunjammer Solar Sail Project Overview

Dr. Ballhaus introduced Mr. Nathan Barnes, President, L'Garde Inc. Mr. Barnes explained that L'Garde is a private contractor and is leading the solar sail project. The company is not a French company; its name is an acronym derived from the founders' names. The word "Sunjammer" comes from an Arthur C. Clarke short story and is used with permission, although permission is not legally required. A solar sail is a spacecraft that harnesses the pressure provided by sunlight. It is basically a large area of reflective material that is held in the "wind" of sunlight and joined to the spacecraft bus. The project's next step is to develop a 1200 square meter sail that will be deployed through centrifugal force. The sail material is incredibly thin; 1200 square meters weighing only 8.5 kilograms. The solar sail spacecraft will be flown as a secondary mission on DISCOVER in 2014. The payload will measure 28 inches by 28 inches by 38 inches and weigh 153 kilograms. Once the sail is fully inflated, the carrier in which the sail is packed will be jettisoned to reduce mass. In response to a question from Dr. Antonsson, Mr. Barnes explained that the sail would be used to counteract the Sun's gravity and will transfer momentum from the Sun's photons. It can travel approximately 3,000,000 kilometers from the sun. The mission is already infused. NOAA is a prime infusion partner. Celestis is a commercial partner; for a fee it will send a portion of cremated human remains into space, a procedure known as a space burial. Mr. Barnes explained that L'Garde is a "greedy capitalist" and is looking at how to get people to use its technology in the future. Other infusion opportunities are orbit debris removal and a galactic cup hosted by entertainment groups. The solar sail is intended for robotic uses, not for humans, and will provide propellant-less propulsion to enable travel to places that cannot be reached with propulsion. The sail has been designed to be scalable to larger geometries. The cold of space is used to rigidize it. A truss system is used to convert bending loads into compression loads. Dr. Ballhaus asked how something that is intended to deploy in zero gravity is tested on land. Mr. Barnes explained that testing gossamer structures is difficult. The booms will be deployed and tested one time before being shipped to the payload facility.

Dr. Ballhaus thanked Mr. Barnes for his presentation.

Annual Ethics Briefing

Dr. Ballhaus introduced Mr. James A. Reistrup, Esq., Office of General Counsel (OGC), NASA Headquarters. Mr. Reistrup 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. Mr. Reistrup 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. Mr. Reistrup can be reached at [ethicsteam@hq.nasa.gov](mailto:ethicsteam@hq.nasa.gov).

Dr. Ballhaus thanked Mr. Reistrup for his presentation.

Chief Technologist Update and Basic Research in Engineering Science Discussion

Dr. Ballhaus introduced Dr. Mason Peck, Chief Technologist at NASA. Dr. Peck described how his role at the Agency has evolved since the STMD was established as a separate directorate. He serves as the voice for technology across the agency, integrates technology investments, and is the technology advisor to the Administrator. He leads technology transfers, partnerships, and commercialization activities across the Agency. Technology can be defined 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. Correll asked whether OCT has any focus on innovation. Dr. Peck responded that OCT addresses innovation through its partnership development and prizes and challenges programs, which incentivize technology development through innovative methods. He asserted that the Space Technology Program's elevation to mission directorate status demonstrates the Agency's direction and gives him better penetration into the other mission directorates. Incorporating technology programs into OCT had led to mistrust, which is now dissipating. He is now better able to advocate for technology because he has no budget to spend on technology. In response to a question from Dr. Ballhaus, Dr. Peck concurred that the Administrator looks to him as the "technology conscience," and noted that that is the role he plays on NASA's Executive Council.

Dr. Peck described a concept for a new Basic Research in Engineering program within NASA to advocate and develop basic research. He noted that the previous weak link at NASA had been technology, which now has been fixed; the next weak link is basic research. Basic research is the precursor to new technology. Foundational engineering science provides the raw material for innovation, inventions, and discoveries. It leads to new and unexpected solutions to major technical and cost barriers. It combines basic engineering science (BES) with research in engineering methods (REM). Investments in engineering science have continued to diminish due to unrelenting budget pressures. According to a 2010 NRC Assessment Report, the fundamental research community that is supported by NASA, both internally and externally, has been

severely impacted by these budget reductions. This puts the ability to achieve future NASA goals in serious jeopardy. The NAC has recommended that NASA manage the Agency's space-based research portfolio as a pilot activity funded separately from STMD. A foundational engineering sciences program would develop the strategy to provide foundational engineering knowledge and tools across the Agency. NASA has unique needs for research in areas that do not show up elsewhere. Potential investment areas include: materials for NASA's future; engineering; biology in exploration and space science; advanced communication science; underlying physics of advanced energy in the space environment; astrodynamics, celestial mechanics, and navigation; and modeling and simulation methods unique to exploration and space science. Mr. Neyland agreed and noted that many things are not being developed because other agencies think the job is being done by NASA, but NASA is not doing it. Dr. Antonsson declared that he is an enthusiastic supporter of the proposal. In response to a question from Dr. Ballhaus, Dr. Peck reported that there has been no determination on a source for funding this new program.

Dr. Correll addressed the asteroid capture mission and asserted that it would use many cross-cutting technologies that would be applicable to larger asteroids and planetary defense. Dr. Peck agreed that it is a planetary defense strategy as well as an asteroid strategy. It would leverage other resources and, in addition, it would help break down walls and stovepipes at NASA and around the world. Dr. Newman counseled that the mission could be accomplished with robots. Dr. Peck responded that sending humans would be a small additional investment and makes more sense than sending people around the moon.

Dr. Peck discussed the impact from the recent continuing resolution and sequestration. The Science Mission Directorate suffered the least impact. Next were the Aeronautics Mission Directorate and the Human Exploration and Operations Mission Directorate. STMD lost the most, relative to the other directorates. As a result, space technology and basic research have been significantly impacted by sequestration. Dr. Antonsson noted that funding in technology is not being preserved. Dr. Correll asserted that the priority for technology at NASA is slipping. Dr. Peck acknowledged partial responsibility for this since his role is to advocate for technology. Dr. Ballhaus asked Dr. Peck to comment on how NASA centers were handling the eight to nine percent institutional cuts from sequestration. Dr. Peck responded that employees at some centers have to empty their own trash bins, and that the Glenn Research Center has no money for research and development.

Dr. Antonsson acknowledged Dr. Peck for his work in redirecting the conversation. Dr. Ballhaus complemented Dr. Peck on his choice for a definition of technology, and noted that it sets up the opportunity for the new research program, how it will be funded, and how it will be managed.

Dr. Ballhaus thanked Dr. Peck for his presentation.



### NASA Robotics Technologies and National Robotics Initiative Update

Dr. Ballhaus introduced Dr. Rob Ambrose, Principal Investigator (PI) for Robotics & Autonomous Systems, NASA Johnson Space Center (JSC). Dr. Ambrose explained that future human exploration space missions will include teams of crew and robots, working with highly autonomous spacecraft. Systems will provide crew independence from Earth as they travel into deep space. Systems will also work separate from crew, providing unique capabilities. Robots' roles will include precursors that go before humans; assistance robots and systems that work with crew; and caretakers that work on "crew-tended" vehicles. He emphasized that this should be viewed not as humans versus machines, but rather as humans with machines. While there may always be some fear of robots, it is something that cannot be afforded. Dr. Ambrose discussed NASA's robotics and autonomous systems approach, and presented a slide showing where NASA's labs and partners for robotic activities are located. He reviewed a chart on the Robotics, Tele-Robotics, and Autonomous Systems Roadmap. Key challenges were discussed. These include: new approaches for extreme terrain; dealing with time delay for teleoperation; dexterous manipulation; system autonomy to reduce crew time and support from the ground; and improved systems performance with respect to mass, power, volume, and radiation tolerance. Dr. Ambrose noted that over 300,000 commands are sent per year to the International Space Station (ISS). He explained that that number would be unworkable in systems beyond LEO when distances are much greater. The National Robotics Initiative (NRI) was described. Under this initiative, the National Science Foundation (NSF), NASA and other federal agencies are partners in a joint solicitation to provide grants for research in new aspects of robotics technology. A chart was presented showing recent NRI awards. The NSF has been given the lead in making these awards. This year, the number of government agencies participating will increase from four to 10. NASA is looking for new partnerships with private companies that have independent research programs and share an aligned vision for the products and capabilities sought by NASA. One example is the Robonaut partnership with General Motors.

Dr. Ballhaus thanked Dr. Ambrose for his presentation.

### Space Technology Research Grants Update

Dr. Ballhaus introduced Ms. Claudia Meyer, Space Technology Research Grants (STRG) Program Executive. Ms. Meyer had presented a briefing to the Committee at its last meeting and was brought back to discuss plans to consolidate NASA's Science, Technology, Engineering, and Mathematics (STEM) grant program. She described the fellowships that are on the list for consolidation. Ms. Meyer noted that the consolidation is a presidential initiative and explained that there is concern over what will happen next year to this year's exemptions for STMD's grants. The basis for the exemption has been that STMD does not view its grants to be a NASA educational program.

Discussion and Recommendations

Dr. Ballhaus invited the committee members to discuss possible specific findings and recommendations for Dr. Ballhaus' presentation to the NAC at its upcoming meeting.

Dr. Antonsson noted that he is very impressed by the STMD's accomplishment in establishing strong leadership, developing a portfolio, and maintaining its budget. He would support a statement acknowledging those achievements. Dr. Weber recalled that the Committee at its last meeting had issued a finding that complemented its progress. She suggested that a further finding at this time would be appropriate to indicate the Committee's pleasure with STMD's results. Dr. Randall suggested that the finding also state that the STMD is going in the right direction.

Mr. Green advised the committee members that the Agency's budget planning efforts for FY 2015 will be debated over the summer, prior to the Committee's next meeting. Dr. Weber opined that the STMD has borne a disproportionate share of recent cuts and explained that science programs traditionally suffer when there is a need to make up for operational deficits. Dr. Ballhaus explained that it costs less to defer work in small missions than it does in large missions, like the James Webb Space Telescope. Mr. Green noted that STMD's budget has done well compared to other divisions.

Dr. Randall observed that renewed NASA funding initiatives have generated a great deal of positive response in the academic community. Dr. Weber advised it is important to stress that research is very important and that research grants should not be considered an educational program to be consolidated with other grants.

Dr. Neyland explained that there is an enormous push on space technology in Europe, and that NASA may want to consider using funds to leverage that. He acknowledged, however, that Congress likely is not very keen on seeing NASA spend its appropriation in Paris.

Adjournment

Dr. Ballhaus thanked the committee members for their participation and adjourned the meeting at 2:45 PM.

**Agenda**

**NAC Technology and Innovation Committee Meeting  
April 18, 2013  
NASA Headquarters  
Room 6Z43**

**April 18, 2013**

- 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. Space Technology Mission Directorate Update  
Dr. Michael Gazarik, Associate Administrator, STMD
- 9:15 a.m. Break
- 9:30 a.m. Solar Sail Project Overview  
Mr. Nathan Barnes, President, L’Garde Inc.  
Mr. Randy Lillard, Technology Demonstration Missions Program Executive,  
STMD
- 10:30 a.m. Ethics Training  
Ms. Kathleen Teale, Staff Attorney, NASA OGC
- 11:30 a.m. Working Lunch
- 12:00 p.m. Chief Technology Update and Basic Research in Engineering Science Discussion  
Dr. Mason Peck, NASA Chief Technologist
- 1:15 p.m. NASA Robotics Technologies and National Robotics Initiative Update  
Dr. Rob Ambrose, Principal Investigator, NASA JSC
- 2:00 p.m. Discussion and Recommendations
- 3:15 p.m. Adjournment

**NAC Technology and Innovation Committee Membership  
[Updated 11/1/12]**

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| 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                             |

**NAC Technology and Innovation Committee  
NASA Headquarters  
Washington, DC  
April 18, 2013**

**MEETING ATTENDEES**

***Committee Members:***

|  |                                       |
|--|---------------------------------------|
| Ballhaus, William (Bill) – Chair         | <i>[Retired – not affiliated]</i>     |
| Green, G.M. (Mike) – Executive Secretary | NASA Headquarters                     |
| Antonsson, Erik                          | Northrup Grumman Aerospace Systems    |
| Correll, Randall                         | <i>[Consultant – not affiliated]</i>  |
| Newman, Dava (attended via telecom)      | Massachusetts Institute of Technology |
| Neyland, David                           | Office of Naval Research – Global     |
| Weber, Mary                              | STELLAR Strategies, LLC               |

***NASA Attendees:***

|                  |          |
|------------------|----------|
| Ambrose, Rob     | NASA JSC |
| Dembling, Anyah  | NASA HQ  |
| Gazarik, Michael | NASA HQ  |
| Meyer, Claudia   | NASA HQ  |
| Peck, Mason      | NASA HQ  |
| Raslo, Dorothy   | NASA HQ  |
| Reistrup, J.A.   | NASA HQ  |
| Sambruna, Rita   | NASA HQ  |
| Silcox, Brett    | NASA HQ  |
| Simms, Natalie   | NASA HQ  |

***Other Attendees:***

|                 |                 |
|-----------------|-----------------|
| Barnes, Nathan  | L'Garde, Inc.   |
| Engola, Mary    | Ball            |
| Frankel, David  | P B Frankel LLC |
| Kruplarz, Chris | JHU/APL         |
| Nadir, Waseem   | Raytheon        |

**NAC Technology and Innovation Committee  
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**LIST OF PRESENTATION MATERIAL**

- 1) FY 14 Space Technology Mission Directorate Briefing [Gazarik]
- 2) Sunjammer Solar Sail Project Overview [L'Garde]
- 3) Sunjammer Technology Demonstration Mission (brochure)
- 4) NASA Technology Programs [Peck]
- 5) Robotics and Autonomous Systems [Ambrose]
- 6) NASA Strategic Space Technology Investment Plan – December 5, 2012