National Aeronautics and Space Administration

Technology & Innovation Committee

of the

NASA Advisory Council

NASA Headquarters

Washington, DC

April 15, 2014

Meeting Minutes

Michael Green, Executive Secretary

William F. Ballhaus, Jr., Chair

Technology and Innovation Committee

NASA Advisory Council

NASA Headquarters

Washington, DC

April 15, 2014

Meeting Minutes

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Meeting Report prepared by

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Welcome and Overview of Agenda

Executive Secretary, Mr. Michael Green, welcomed everyone to the Technology & Innovation (T&I) Committee meeting and reminded everyone that the meeting was open to the public. He discussed the reorganization of the NASA Advisory Council (NAC) committees. The Committee has been realigned with the Space Technology Mission Directorate (STMD). Committee membership will be expanded in the coming months because the Committee's scope has been expanded to include fundamental engineering and science issues. Mr. Green introduced Dr. David Miller, the new NASA Chief Technologist. Mr. Green distributed the minutes from the previous meeting.

Opening Remarks and Thoughts

Mr. Green introduced the Committee Chair, Dr. William Ballhaus, and commended his article in *Space News*, which was written with Gen. Lester Lyles. Mr. Green noted that the last NAC meeting had resulted in no recommendations from the Committee.

Space Technology Mission Directorate Update

Mr. Green introduced Dr. Michael Gazarik, Associate Administrator (AA), STMD. Dr. Gazarik stated that NASA needs sustained and substantial investments in space technology and capabilities in order to conduct the Asteroid Retrieval Mission (ARM) and land on an asteroid. He highlighted several STMD projects. The 5.5-meter diameter composite cryotank is ready for testing. The Synchronized Position Hold Engage Reorient Experimental Satellites (SPHERES)-Slosh experiment on the International Space Station (ISS) is examining how liquids move around inside containers in microgravity. The PhoneSat 2.5 mission will use an Android smartphone to control a CubeSat satellite. It will be launched as a rideshare on a SpaceX vehicle. Solar Electric Propulsion (SEP) technology is being developed for future missions into deep space. The MegaFlex Solar Array is projected to provide ten times more power than the largest current satellite solar array technology. The Roll-Out Solar Array (ROSA) is a new innovative mission-enabling solar array system. The Green Propellant Infusion Mission is preparing for a test flight in 2015.

Dr. Ballhaus explained that he intended to share these technologies with the full NAC. Dr. Gazarik agreed to provide a chart that would be useful for that purpose. Dr. Ballhaus noted that the government invests in early Technology Readiness Level (TRL) projects and that industry only begins investing when technology is more mature. Dr. Gazarik concurred. Dr. Ballhaus rhetorically questioned the degree that NASA is expected to lay a foundation for the technology pipeline.

Dr. Gazarik described how STMD has been investigating the use of inflatable structures and parachutes to assist with landing on Mars. In the first week of June, the Low-Density Supersonic

Decelerator (LDSD) will be tested at the Pacific Missile Range Facility by dropping it from 180,000 feet. Dr. Gazarik commented that the Agency is determining whether to use the parachute that will be tested in Hawaii or a smaller parachute previously developed.

There was a discussion on how to manifest new technologies and integrate them into commercial space flight. Dr. Ballhaus posed the question, "To what extent should NASA be driving new technology?" Dr. Matt Mountain responded that NASA was originally designed to take risk, but now avoids risk. He suggested that proposers need to know that they will be marked up and not marked down if their projects include new technologies. Dr. Ballhaus recommended "fenced off" technology money to protect those projects. Dr. Randall Correll added that NASA takes more risks with new technology when the technology is absolutely needed for a mission.

Dr. Gazarik highlighted several new technologies that may be keys to future missions, including Deep Space Optical Communications, the Deep Space Atomic Clock, High Performance Space Computing, and Small Nuclear Fission/Sterling Power. He noted that STMD is working with senior leadership across the Agency, and STMD has joint investments with the Science Mission Directorate (SMD) and the Human Explorations and Operations Missions Directorate (HEOMD).

Dr. Mountain remarked that it is easier to get new technologies on big expensive missions than small- and medium-class missions, and he recommended that this should be changed. Dr. Miller explained that the reason for this may be because failure of new technology will not always cause the big mission to fail.

Dr. Gazarik described STMD investments in eight key thrust areas: High Power Solar Electric Propulsion; Space Optical Communication; Advanced Life Support and Resource Utilization; Mars Entry, Descent, and Landing (EDL) Systems; Space Robotic Systems; Lightweight Space Structures; Deep Space Navigation; and Space Observatory Systems. STMD is working closely with the Defense Advanced Research Projects Agency (DARPA) on the development of humanoid robots. Dr. Correll commented that biology should have a stronger presence in the program for life support, gene expression research, and pharmaceutical technology. Dr. Gazarik replied that biology is not a thrust area. He noted, however, that the Human Research Program (HRP) is doing research in radiation protection and that NASA-funded programs at the University of Colorado at Boulder involve biology.

Dr. Gazarik noted that STMD's budget is increasingly driven largely by investment in SEP. Early-stage work is 10 percent of the portfolio. Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs remain the largest programs in STMD. Crosscutting space technology development will be decreasing in future years; however Exploration technology development is increasing. Dr. Mountain observed that NASA's overall budget request is lower this year than last year, but the budget request for STMD has grown since last year.

Dr. Gazarik explained that deep space operations, including a mission to Mars and the ARM, are more imminent than many people realize, and there is an impetus is to get a number of technologies ready for deep space exploration. High power SEP will be able to do more than move asteroids; it could, for example, be used to move satellites into geosynchronous orbit. NASA may build its own SEP system or acquire it from industry. STMD is trying to avoid building a SEP system that can only be used by NASA. An example of this effort is planning to use four 10-kilowatt thrusters, rather than a single 50-kilowatt thruster, so that industry may benefit from having smaller thrusters. He described how STMD is aligned with other NASA Directorates. EDL, propulsion, power, communications, navigation, instruments, sensors, and thermal protection technologies are aligned with SMD goals. SEP, life support, resource utilization, and Space Launch System (SLS) technologies are aligned with the HEOMD. Aviation safety, fundamental aeronautics, airspace systems, and aeronautics test technologies are aligned with the Aeronautics Research Mission Directorate (ARMD).

There was a discussion about the risk associated with new technologies. Dr. Ballhaus asked what the Agency is willing to accept in terms of cost and mission success risk. Dr. Mountain expressed disappointment over seeing NASA grow more conservative about risk. Mr. David Neyland suggested that more money be set aside for manufacturing-readiness issues.

Office of Chief Engineer Overview and Discussion

Mr. Green introduced Mr. Ralph Roe, NASA Chief Engineer. Mr. Roe explained that the Chief Engineer's role is to advise Agency leadership on the technical readiness of programs and projects, maintain awareness of technical and programmatic issues, and participate in major milestone reviews. The Office of the Chief Engineer (OCE) also executes engineering Technical Authority. Delegation is driven to the lowest level that is closest to implementation, and disagreements are raised to the next level for resolution. He described the NASA Engineering and Safety Center (NESC). It was founded following the Columbia tragedy to provide a second perspective on difficult problems. NESC is chartered to work on specific issues. It has performed more than 500 safety and engineering assessments over the past 10 years and has demonstrated "value added."

The OCE administers Agency-level policy and standards for engineering and for program and project management. OCE also shares lessons learned, program and project management guidelines, and engineering best practices. Dr. Ballhaus remarked that because NASA has not had a significant failure since Columbia, new engineers are not sensitized to failures and need to be educated on lessons learned and the potential for failure. Mr. Roe noted that 40 percent of the engineers he has met at NASA were not working at NASA during the Columbia tragedy. He described a program developed with APPEL to share knowledge with the workforce as a part of mandatory training.

The Foundational Engineering Sciences program was described. NASA Technical Fellows make possible a bottom-up look that helps NASA decide where to invest in the future.

Mr. Roe observed that NASA is relying on 30-year-old research. Dr. Miller noted that he has seen the same thing in the U.S. Air Force. He added that making models perfect is impossible, but that inaccuracy is mitigated through a robust design. Dr. Ballhaus advised that it is important to reduce uncertainty in order to create less conservative designs. If one cannot "fly as you test and test as you fly," one needs to do more risk mitigation. He recommended integrated modeling and development from the start of a project. Mr. Roe stated that NASA did not do a good job of systems integration in preparing for the failed Space Shuttle Columbia mission, and he would expect systems integration to become the champions of modeling. The Vision for Foundational Engineering Sciences (FES) was described; it includes partnerships with industry, other government agencies, and technology and science communities. Mr. Roe stated that he thinks it is critical to recognize that NASA has not made investments like this in 30 years. If the Agency does not do this, it will continue to consider uncertainties and conservatisms, which make things cost and weigh more. Mr. Gordon Eichhorst advised that NASA must ask the question "when is the old technology too risky to fly?" Dr. Ballhaus explained that currently, the only "relief valve" is risk. In order to cap mission risk, a new relief valve is needed, for example, cost. This requires building a budget reserve to handle cost overruns.

Mr. Green thanked Mr. Roe for his presentation.

Update on NASA Advanced Manufacturing Activities

Mr. Green introduced Dr. LaNetra Tate, NASA Principal Investigator for Advanced Manufacturing, STMD. Dr. Tate explained that NASA's STMD Advanced Manufacturing Technology portfolio funds Game Changing Technologies. Manufacturing is a critical area that can advance the eight key thrust areas. NASA supports and benefits from manufacturing institutes. She described an internal technical change meeting and a two-day working group that resulted in a diversified portfolio containing additive manufacturing, composites, metals, digital materials and manufacturing, and in-space manufacturing, including the use of 3-D printers. She noted that a 3-D printer will fly on the ISS and that NASA is developing a modular SmallSat kit.

NASA is partnering with industry to develop and test rocket engine parts. The Agency is investing in "for space" and "in space" manufacturing. Additive manufacturing for space could save thousands of dollars and months of manufacturing time.

Dr. Tate discussed composites. They are a core capability and technology because 60 percent of a launch vehicle's dry mass is fuel. The composite cryotank project necessarily took on considerable risk because reducing fuel mass is very important. The composite cryotank was a two-phase effort. Phase one looked at different materials and systems. Tanks were tested at Marshall Space Flight Center (MSFC). The 5.5-meter tank will be tested soon; a 2.4-meter tank

has already been tested. The composite crew model is an example of NASA engineers working with industry, as The Boeing Company designed and manufactured the two aforementioned tanks. Lessons learned from this manufacturing project will be shared with the public. NASA is trying to maximize infusion of composite materials on launch vehicles such as the SLS. She described advanced metallic manufacturing work that NASA is funding at Langley Research Center (LaRC). Steel manufacturing technology that had been perfected in the automotive industry is being applied to aluminum to eliminate longitudinal welds, which are potential failure points. Bulk Metallic Glass (BMG) technology has been around for a long time; however, current manufacturing technologies are insufficient for developing advanced applications. NASA's Jet Propulsion Laboratory (JPL) is working on this problem. BMG may be used in next generation Mars rovers.

NASA digital materials and manufacturing is being used for the Modular Rapidly Manufactured Small Satellite (MRMSS). The SmallSat is being used as a demonstration, but the concept can be used in space for manufacturing large structures. Work has been funded to assemble large structures in orbit, called the Scalable Automated Lattice Structure Assembly System (SALSAS). This could potentially reduce launch mass.

Another area being funded is "living off the land" additive construction. Work is being done on this project at Kennedy Space Center's (KSC's) "Swampworks" and by Dr. Behrokh Khoshnevis at the University of Southern California. KSC has a 3-D printer that prints with regolith. The Army Corp of Engineers and the state of Hawaii have shown interest in this technology.

Printable electronics and additive manufacturing in orbit are being combined with the goal of printing spacecraft on demand in space. This program began with off-the-shelf printers, but the printers had to be modified to work in microgravity. The printer will use Acrylonitrile Butadiene Styrene (ABS) plastic and will be programmed with 21 prints. A 22nd print program will be sent from Earth.

Dr. Miller asked if NASA is working on recycling so that broken parts can be ground down and reworked. Dr. Tate responded that recycling is on the roadmap. There have been proposals submitted through SBIR, and at least one may be funded. She noted that much plastic and waste has to be returned to Earth, and NASA would like to reduce that by using old parts for feedstock in 3-D printing. STMD is also the Directorate behind the National Advanced Manufacturing Initiative. There are four manufacturing institutes. STMD will support members of these institutes through solicitation calls.

Mr. Green thanked Dr. Tate for her presentation.

Chief Technologist Introduction and Update

Mr. Green introduced Dr. Miller, NASA Chief Technologist. Dr. Miller explained that the Chief Technologist looks across all NASA directorates. Technology investment is about making new tools to help engineers effectively and efficiently build systems to answer scientific questions. He explained that the first challenge is that if NASA only prescribes technical solutions from the top down, the Agency misses game changers. NASA needs to have a healthy mix. How does NASA balance the investment between basic and applied technology research? When finances are tight, basic technology is often the first to go. NASA must find the opportunity to rigorously mature technologies despite risk and cost. Technologies can "whither on the vine" if they are not nurtured and matured. The ISS should be used more as a technology test bed because it is the most accessible place on orbit. Right now it is underutilized. He questioned why the SmallSat industry is booming and ISS is not.

Dr. Miller advised that NASA should do more to understand the technology developments occurring outside NASA so as to avoid duplication. This enables smarter choices between what NASA needs to develop, adapt, or watch and purchase later. NASA needs to track technology investment in a measurable way. This may help avoid surprises when technology is incorporated into a mission. NASA needs to be able to see when avenues of research should be stopped in favor of adopting a competing technology. NASA needs a clear way to measure success so that resources can be allocated elsewhere after success has been achieved. This is all a part of NASA's Strategic Space Technology Investment Plan. The OCT is currently engaged in road mapping exercises. The Office is trying to obtain clearer guidelines from the mission directorates on what their technology needs are. He asked, "At what point has NASA improved a technology to the point where it is no longer a driving level?" He explained that he wants to facilitate that discussion with the mission directorates so that OCT understands their needs. For near-term missions, the needed technical performance may be well thought out, but for farther-out missions, this is not the case and NASA must be careful. NASA needs to know what the mission capability needs to be for long-term missions and needs to create a robust investment in technology.

Dr. Ballhaus asked how the Chief Technologist balances ideas from outside sources with grand challenges and makes sure to invest in the right technologies. Dr. Miller responded that they look at what type of missions NASA wants to do and if a technology would be a game changer. Dr. Correll commented that many important technologies were not driven by mission requirements, but began as basic ideas. He asked whether there is a way technology can enable NASA to do what the Agency would like to do. Dr. Miller replied that in HEOMD and SMD, deep space communications are essential. The best way to grow that capability is to modularize it into a number of pieces that would help different communities, including industry. NASA's investment could enable new industries or set up an infrastructure that could be developed by other industries that are not space-related. It is important, he advised, to look at technologies related to missions and see what their other benefits might be.

Dr. Correll noted that some people in NASA think there is enough innovation for now. He asked whether Dr. Miller thinks NASA has had enough innovation. Dr. Miller responded that innovation is important and that he is trying to help with the messaging about the importance of a long-term sustained effort. He explained that NASA's technology transfer program is amazing, but it is not sufficient. It is possible, he noted, to show the correlation between setting a steady course and arising opportunity; when the course is turned on and off, opportunity stops.

Dr. Mary Ellen Weber advised that in the advocacy world, people believe that if they plead their case eloquently and the person they are talking to buys into it, they are done. In reality, however, one needs to "develop the ask," and devise very strategic requests and then follow through with selling them.

Dr. Ballhaus advised that there is a need to have an "urgency argument" that explains why something has to be right away. It is often based on a need or a threat, such as competition from another country. Dr. Mountain observed that people get excited when NASA does something different and challenging. He advised that NASA needs to send the message that the Agency is doing "cool things," and others will want to be a part of it.

Mr. Ballhaus thanked Dr. Miller for his presentation.

Update on NASA Small Spacecraft Technology Program

Mr. Green introduced Mr. Andrew Petro, Program Executive for the Small Spacecraft Technology Program (SSTP), STMD. Mr. Petro described the Program. Small spacecraft have lower cost, more rapid development, higher risk tolerance, and lower barriers to entry. To encourage development of small spacecraft, interfaces are standardized for rideshare launches. Co-satellite Orbital Deployers (P-PODS) are a standard way to put CubeSats into space from a launch vehicle. Many small spacecraft are launched to the ISS as cargo and then released into space through the ISS's airlock.

SSTP is one of the nine programs in the STMD portfolio. The Program's objectives include developing technologies for small spacecraft and demonstrating new technologies, capabilities, and applications. The Program develops technologies from TRL three to seven. There are five propulsion projects and one reentry project this year. The Program intends to do a flight demonstration of the miniaturized electrospray propulsion technology.

The PhoneSat team flew five satellites in under a year. They used a cell phone's camera to take pictures of Earth. The pictures were downloaded with assistance from amateur radio operators. PhoneSat 2.5 will test two-way communication. Dr. Ballhaus asked what new capability the mission will add. Mr. Petro explained that it will add three-axis orientation, two-way radio capability, and the ability to use commercial, off-the-shelf, consumer electronics as the main computer system on the satellite.

He described how a network of eight SmallSats will introduce a satellite bus that costs less than $10,000 and can be replicated many times. He noted that it might be cost effective to create a large swarm of satellites. Using consumer electronics means that the cell phone industry is doing the technology advancement for NASA. A private company is using a similar system to perform Earth surveillance. The satellites can provide multiple views of Earth or spacecraft.

Dr. Mountain remarked that the SmallSats program is a "hammer looking for a nail." He advised that if anyone creates a technology and says "the use will come," the program will be cut. Mr. Petro replied that the technology could be used in science missions that explore other planets. He described a new project in collaboration with The Aerospace Corporation to send two cubes one and a half times the size of the PhoneSat into space to demonstrate a laser link for communication to the ground. There are SmallSat technology partnerships with universities where NASA funding and one full-time NASA employee are provided for a project. The Program is conscious of the orbital debris issue, so there is an emphasis on developing propulsion systems for SmallSats. Developing more power is needed for propulsion. Deployment of the Maraia Earth Return Capsule has begun, and there will be a flight test later this year.

Mr. Neyland advised that there is an interest in things that would not be done with a big satellite, such as collecting data in the high atmosphere where a satellite cannot sustain orbit for a long time and would have to be sacrificed. He recommended looking for areas where the cost is too high with traditional satellites.

Mr. Petro explained that there has been no trouble getting proposals, but within STMD, SmallSats are competing with other programs. He emphasized that cost, schedule, and performance (in that order) are important for making the most with limited funds.

Dr. Correll asked if the satellites can be scaled to different configurations other than CubeSats. Mr. Petro clarified that CubeSats are used because they are easy to launch. Larger satellites have fewer launch opportunities. The CubeSats that are being launched at this time are being sent as pressurized cargo to the ISS and must meet safety requirements.

Mr. Green thanked Mr. Petro 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 requested a written opinion on a specific situation.

Discussion and Recommendations

Mr. Green reviewed the Committee's past recommendations. He explained that there are now two levels for recommendations--those intended for the Administrator and those for the AA.

The purpose of the Small Spacecraft Technology Program was discussed. There was a desire for further clarification as to the "mission pull" for these technologies.

There was a discussion about the effect that the SBIR and STTR programs have on the overall STMD budget. The SBIR currently functions as a type of "non-discretionary" spending and resides entirely in STMD's budget. In the past, those programs were funded from other mission directorates. Dr. Weber suggested recommending that the SBIR budget be considered separately from the rest of the STMD budget. Mr. Green cautioned that a recommendation on this matter could be a "double-edged sword" and the Committee should avoid any implication that SBIR and STTR should not be funded. It was decided not to make a recommendation on the SBIR/STTR budget issue at this time.

The infusion of new technologies into science missions was discussed. There was a question as to whether to focus on small and medium missions, or all missions. Dr. Ballhaus noted that large missions already use new technologies because that is the only way to accomplish the mission.

The following recommendations and findings were agreed upon:

Finding for STMD AA:

Findings:

- There may be real potential in developing capability to improve space mission effectiveness by using small satellites.
- The market pull associated with small satellites has not been well characterized for the NAC T&I Committee.

Recommendations:

- The T&I Committee recommends that STMD characterize the small spacecraft mission market pull.
  - Civil, military, intelligence, commercial, academia
  - What is the technology's potential utility and societal benefits?

Identify what is NASA's particular role in developing capabilities for this market. How can NASA "move the needle"?

Finding for NAC:

Committee believes it is important for STMD to maintain a balanced space technology portfolio across all of the TRL-levels in the coming budget deliberations.

Recommendation for NAC:

Recommendation:

The Council recommends that the STMD AA & SMD AA collaborate to investigate whether policies and procedures should be modified to encourage the infusion of new technologies in small to medium class missions. The T&I Committee requests a briefing on the results of the investigation by the next meeting.

Major Reasons for the Recommendation:

- In highly competitive program solicitations, such as Discovery and Explorer, there is a disincentive to propose new technology because of the perceived risk.
- As a result, NASA may be missing an opportunity to leverage scientifically beneficial technology through small and medium science missions. In the long-term, this could erode NASA's scientific and technical capabilities.
- If the Agency wants to encourage and infuse appropriate new technologies in its small and medium class missions, it must develop a policy that incentivizes the inclusion of these technologies in the solicitation release.

Consequences of No Action on the Recommendation:

Erosion of NASA's science and technical capabilities

The meeting was adjourned at 5:06 pm.

Appendix A

Agenda

NAC Technology and Innovation Committee Meeting

April 15, 2014

NASA Headquarters

MIC 5A

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

April 15,2014 – FACA Open Meeting

8:30 a.m.	Welcome and overview of agenda/logistics (FACA Session – Public meeting) Mike Green, Executive Secretary
8:35 a.m.	Opening Remarks and Thoughts Dr. William Ballhaus, Chair
8:45 a.m.	Space Technology Mission Directorate Update Dr. Michael Gazarik, Associate Administrator, STMD
9:45 a.m.	Break
10:00 a.m.	Office of Chief Engineer Overview and Discussion Mr. Ralph Roe, NASA Chief Engineer

11:15 a.m.	Update on NASA Advanced Manufacturing Activities Dr. Lanetra Tate, NASA Principal Investigator for Advanced Manufacturing, STMD
12:00 p.m.	Lunch Break – on own
1:00 p.m.	Chief Technologist Introduction and Update Dr. David Miller, NASA Chief Technologist
2:00 p.m.	Update on NASA Small Spacecraft Program Mr. Andy Petro, NASA Program Executive for Small Spacecraft Technology Program, STMD
2:45 p.m.	Annual Ethics Briefing Ms. Kathleen Teale, Staff Attorney, NASA OGC
3:45 p.m.	Discussion and Recommendations
5:15 p.m.	Adjournment

The WebEx link is https://nasa.webex.com/, the meeting number is 997 239 320, and the password is Technology0414#.

Appendix B

NAC Technology and Innovation Committee

NASA Headquarters

Washington, DC

April 15, 2014

Committee Membership

Dr. William Ballhaus, Chair

Mr. Gordon Eichhorst, Aperios Partners, LLC

Dr. Matt Mountain, HST Institute

Dr. Randall Correll, Consultant

Mr. David Neyland, Office of Naval Research

Dr. Mary Ellen Weber, Stellar Strategies, LLC

Appendix C

NAC Technology and Innovation Committee

NASA Headquarters

Washington, DC

April 15, 2014

Meeting Attendance

Committee Members

Name	Affiliation
Dr. William Ballhaus, Jr., Chair	*[retired]*
Mr. Gordon Eichhorst	Aperios Partners, LLC
Dr. Matt Mountain	HST Institute
Dr. Randall Correll	Consultant
Mr. David Neyland	Office of Naval Research
Dr. Mary Ellen Weber	Stellar Strategies, LLC

Attendees From NASA

Name	Affiliation
Mr. Mike Green	NASA STMD, Executive Secretary
Dr. LaNetra Tate	NASA STMD
Ms. Gwyn Smith	NASA HEO
Dr. David W. Miller	NASA CTO
Ms. Dorothy Raser	NASA STMD
Mr. David Sleilt	NASA OCOMM
Dr. Michael Gazarik	NASA STMD
Dr. Katie Gallagher	NASA OCT
Mr. Ralph Roe	NASA OCE
Ms. Anyah Dembling	NASA STMD
Ms. Sarah Ramo	NASA OCOMM
Mr. Andrew Petro	NASA STMD
Ms. Kathleen Teah	NASA OGC

Other Attendees

Name	Affiliation
Ms. Bergit Uhran	PB Frankel LLC
Ms. Linda Karamida	PPC

Appendix D

NAC Technology and Innovation Committee

NASA Headquarters

Washington, DC

April 15, 2014

Presentation Materials:

1) Space Technology Mission Update [Gazarik]

2) Office of Chief Engineer Overview and Discussion [Roe]

3) Update on NASA Advanced Manufacturing Activities [Tate]

4) Chief Technologist Introduction and Update [Miller]

5) Update on NASA Small Spacecraft Technology Program [Petro]

6) Annual Ethics Briefing [Teale]