



# Technology, Innovation & Engineering Committee Report NASA Advisory Council

Dr. Bill Ballhaus, Chair | 03.29.18

**“The scope of the Committee includes all NASA programs focused on technology research and innovation.”**

***–NASA Advisory Council Technology & Innovation Committee Terms of Reference, signed 6/28/12***

## TI&E Committee Meeting Attendees: March 26, 2018

- Dr. William Ballhaus, Chair
- Mr. Gordon Eichhorst, Aperios Partners LLP
- Mr. Michael Johns, Southern Research Institute
- Dr. Matt Mountain, Association of Universities for Research in Astronomy
- Mr. Jim Oschmann, Ball Aerospace Corp.
- Dr. Mary Ellen Weber, Stellar Strategies, LLC

# TI&E Committee Meeting Presentations: March 26, 2018

- Welcome to NASA GSFC
  - Mr. Chris Scolese, Director, NASA Goddard Space Flight Center
- STMD Update and FY 2019 President's Budget proposal
  - Mr. Steve Jurczyk, Associate Administrator (Acting), NASA
  - Mr. James Reuter, Associate Administrator (Acting), Space Technology Mission Directorate (STMD)
- Tour of GSFC projects
  - NICER/SEXTANT and X-Ray Communications
  - Laser Communications Relay Demonstration
  - Satellite-Servicing and Assembly



# Technology: A Definition

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**A solution that arises from applying the disciplines of engineering science to synthesize a device, process, or subsystem, to enable a specific capability.**

*from July 2012*

# Technology Budget Challenges

Technology budgets have been disadvantaged by a lack of an urgency argument.

Lack of an urgency argument has been due to the lack of an overarching agency exploration architecture and plan, e.g. we know what technologies need to be developed to get humans to Mars, we just don't know when we need them.

The Space Policy Directive-1 provides a near-term destination for which a detailed program plan could be formulated along with required technologies and need dates.

# Space Policy Directive - 1

On December 11, 2017, President Trump once again set America's sights toward the stars by signing Space Policy Directive – 1, which instructed the National Aeronautics and Space Administration (NASA) to return American astronauts to the moon for long-term exploration and utilization, followed by human missions to Mars and other destinations.

# Proposed Agency Restructuring

NASA will restructure the Agency to align with our focus on accelerating human exploration beyond low-Earth orbit. There are two options currently under review:

- 1) Creation of two new exploration-focused mission directorates, eliminating the current HEO and STMD structure –
  - a. An Exploration Operations Mission Directorate that will focus ISS, LEO operations, and cross cutting support areas required to support exploration such as communications, and propulsion testing, etc.
  - b. An Exploration Systems and Technology Mission Directorate that will focus on deep space mission elements and technology developments needed for sustainable human exploration.
  
- 2) Creation of a single exploration-focused mission directorate, consolidating all the exploration-focused content in the current HEOMD and STMD organization.

NASA will assess these two options (and any hybrid options that may arise), and prepare for implementation at the start of the FY 2019 budget year.



# TI&E Committee Finding – March 2018

NASA's major missions have been enabled by technology investment over a number of years.

Previous experience with housing “seed corn” and crosscutting technologies in development mission directorates produced unfortunate results

- Drastic reductions in those technology budgets
- Alienation of university connections—the major source of human capital for NASA and its contractors

STMD was established to reverse these outcomes and has produced a robust technology portfolio with university and industry partnerships.

***Question: With the proposed demise of STMD, how would NASA in its new structure assure future such unfortunate results don't materialize?***



# Relevant Past Committee Input to the Council Dating Back to 2012



# T&I Committee Agency-Level Observations

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NASA “grand” missions are technology-enabled.

- JWST, MSL, ISS—type of work NASA should be doing
- Demonstrates NASA/U.S. technical leadership

*“Future U.S. leadership in space requires a foundation of sustained technology advances...NASA’s technology base is largely depleted.” –NRC Report*

***from March 2012***



- **NASA needs cutting edge technologies to undertake its missions.**
  - Current missions are based on technologies developed through investments made over several decades.
- **In the timeframe FY2005-FY2009, technology budgets (basic research -\$500M; applied research -\$900M) were drastically reduced**
- **To reverse this decline, NASA established OCT (in 2010) and STMD (in 2013) and rebuilt the crosscutting technology program as well as made focused investments in technology development in HEOMD and SMD.**



# T&I Committee Findings for the NASA Advisory Council

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- NASA technology shelf depleted over the last decade due to a lack of investment. NASA has begun to correct this over the last three years (e.g., Space Technology Program (STP)).

*from November 2012*



# Questions for NASA Administrator

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- What is the appropriate percentage of NASA's budget that should be devoted to technology investment?
- What fraction of that allocation should be organizationally fenced off as "seed corn" and crosscutting investment?
- How is NASA managing its technical, critical core competencies?

*from March 2012*



# T&I Committee Agency-Level Observations

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## What is the appropriate percentage of NASA's budget that should be devoted to technology investment? Ten percent?

- We couldn't find accounting that told us what percentage of NASA budget is technology investment. *(Although effort under way by OCT to determine this.)*
- Three Categories
  - Mission Support/Pull (mission specific or vehicle/architecture specific, mid-high TRL)
  - Crosscutting (mid-high TRL)
    - e.g. cryogenic fluid management in space, solar electric propulsion
  - "Seed Corn" (low-mid TRL)
    - Disruptive
    - Developing people, as well as ideas/maintaining core competencies

***from March 2012***



# T&I Committee Agency-Level Observations

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- A number of astute administrators, including present, have organizationally fenced off the budget for “seed corn” and crosscutting investments that includes research and technology and system-level demonstrations to preserve options for the future.
  - When “seed corn” investment isn’t organizationally fenced off, it gets eaten!
  - e.g. Constellation eating tech budget to fix development issues
- What fraction of the technology budget should be set aside for “seed corn”?

*From March 2012*





## **STMD University Engagement:**

- During the mid-2000s, NASA's university engineering research programs were decimated.
- STMD has reestablished contacts with the university community through the Space Technology Research Grants program, including the NASA Space Technology Research Fellowship program.
- Committee met at lunch with 15 Fellows working at JPL this summer from universities across the nation
- Committee very impressed with technical knowledge and capabilities of the Fellows

*from July 2015*



# STRG Portfolio – Awards To-Date Universities

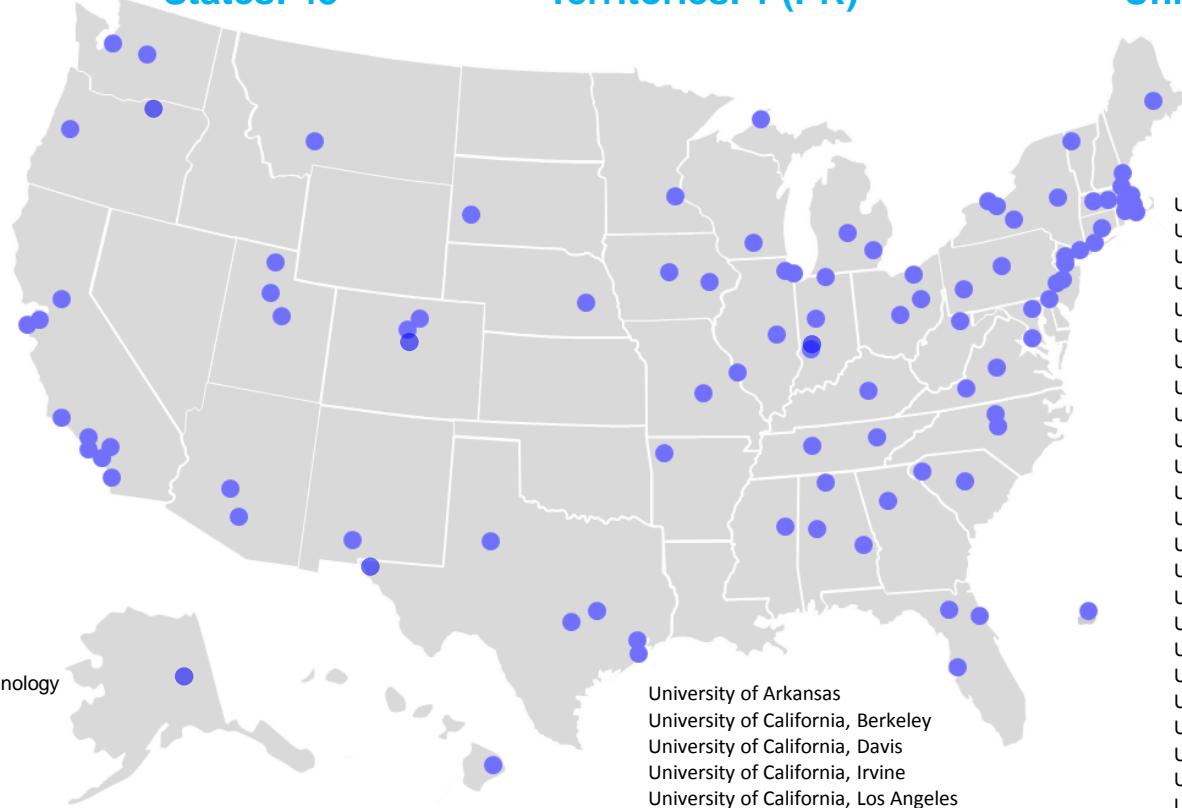


Awards: 539

States: 43

Territories: 1 (PR)

Universities: 106



- Arizona State University
- Auburn University
- Boston University
- Brigham Young University
- Brown University
- California Institute of Technology
- Carnegie Mellon University
- Case Western Reserve University
- Clemson University
- Colorado State University
- Colorado School of Mines
- Columbia University
- Cornell University
- Duke University
- Florida Institute of Technology
- Georgia Institute of Technology
- Harvard University
- Illinois Institute of Technology
- Iowa State University
- Johns Hopkins University
- Massachusetts Institute of Technology
- Michigan State University
- Michigan Technological University
- Mississippi State University
- Missouri University of Science and Technology
- Montana State University
- New Jersey Institute of Technology
- New Mexico State University
- New York University
- North Carolina State University
- Northeastern University
- Northwestern University
- Ohio State University
- Oregon State University
- Pennsylvania State University
- Portland State University
- Princeton University
- Purdue University
- Rensselaer Polytechnic University
- Rochester Institute of Technology
- Rose-Hulman Institute of Technology
- Rutgers University
- South Dakota School of Mines and Technology

- Stanford University
- State University of New York, College of Nanoscale Science & Engineering
- State University of New York, Stony Brook
- Texas A&M University
- Texas Tech University
- Tufts University
- University of Akron
- University of Alabama, Huntsville
- University of Alabama, Tuscaloosa
- University of Alaska, Fairbanks
- University of Arizona

- University of Arkansas
- University of California, Berkeley
- University of California, Davis
- University of California, Irvine
- University of California, Los Angeles
- University of California, San Diego
- University of California, Santa Barbara
- University of Central Florida
- University of Colorado, Boulder
- University of Connecticut
- University of Delaware
- University of Florida
- University of Hawaii
- University of Houston
- University of Illinois, Chicago
- University of Illinois, Urbana-Champaign
- University of Iowa

- University of Kentucky
- University of Maine
- University of Maryland
- University of Massachusetts, Amherst
- University of Massachusetts, Lowell
- University of Michigan
- University of Minnesota
- University of Nebraska, Lincoln
- University of New Hampshire
- University of Notre Dame
- University of Pennsylvania
- University of Pittsburgh
- University of Puerto Rico, Rio Pedras
- University of Rochester
- University of South Carolina
- University of South Florida
- University of Southern California
- University of Tennessee
- University of Texas, Austin
- University of Texas, El Paso
- University of Utah
- University of Vermont
- University of Virginia
- University of Washington
- University of Wisconsin, Madison
- Utah State University
- Vanderbilt University
- Virginia Polytechnic Institute & State University
- Washington State University
- Washington University, St. Louis
- Western Michigan University
- West Virginia University
- William Marsh Rice University
- Worcester Polytechnic Institute
- Yale University



- **NASA management has done an excellent job of formulating the technology program and executing it, within annual budget constraints.**
  - Examples of past accomplishments (2010 to 2015): Composite Cryotank, Advanced Solar Arrays, High Power Electric Propulsion Thrusters, EDL including inflatable decelerators, High Performance Thermal Protection Systems, BEAM (Commercial Inflatable Habitat at ISS), and Small Spacecraft Technologies
  - Examples of upcoming accomplishments (2016 to 2020): Green Propellant Infusion Mission (GPIM), Deep Space Atomic Clock (DSAC), Solar Electric Propulsion demo, laser comm demos, RESTORE–L satellite servicing demo, in-space robotic manufacture & assembly, ISRU demo and Terrain Relative Navigation on Mars 2020
- **STMD reengaged the academic community in engineering research and technology development and has rekindled interest in NASA among students, especially at the graduate level.**
- **STMD has effectively used internal and external partnerships to mature and develop technologies.**

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