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MEETING REPORT

Ellen Williams 1/9/2023

Ellen Williams, Chair

1/11/2023

Jason Callahan, Executive Secretary

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Opening Remarks / Introduction of Members

Mr. Jason Callahan, Designated Federal Officer (DFO) for the Science Committee, called the meeting to order, made administrative announcements, detailed the guidelines of the Federal Advisory Committee Act (FACA), and introduced Dr. Ellen Williams, Chair of the Science Committee (SC). Dr. Williams reviewed the goals of the meeting and noted the impending retirement of SMD Associate Administrator (AA), Thomas Zurbuchen, the longest consecutively serving Associate Administrator of the Science Mission Directorate (SMD).

SMD Update

Dr. Zurbuchen addressed the Committee, noting he was 46 days to retiring from his position, and said that he very much appreciated the guidance and wisdom of the group. He said his briefing would touch on two or three topics of importance (things that worked and things that didn't), and that he would then engage with Dr. Mini Wadhwa in an "exit interview" of sorts.

First, Dr. Zurbuchen acknowledged the tremendous contribution of the entire SMD team and thanked them for their efforts in supporting the NASA science mission. Presenting some budget statistics, he noted that during his tenure SMD received an overall top-line increase from $5.75 billion to $7.6 billion, and an addition of 108 hires. He said he was a strong believer in responsibility and accountability and that the hires represented growth positions intended to fill the gaps in the Civil Service levels. SMD created additional Flight Director positions to help complete missions on schedule and within budget. The SMD portfolio was diversified as well, with 47 missions that included 7 innovative Commercial Lunar Payload Services (CLPS) missions. Dr. Zurbuchen noted that when he came to SMD, the Joint Polar Satellite Services (JPSS) office, a joint office with the National Oceanic and Atmospheric Administration (NOAA), had been somewhat dysfunctional, and that today NOAA and NASA enjoy a greatly improved partnership, most recently reflected in the successful JPSS-2 launch. He noted that SMD missions have also been deliberately expanded with a perspective of mission diversity in mind; more is not necessarily better and balance in mission size is important. Ten years ago, he said, the International Space Station (ISS) was underutilized but today the situation is the opposite. Researchers are clamoring for space on ISS. It is a good problem, he stated, but still a problem.

Dr. Zurbuchen said he was most proud of NASA's science accomplishments and stressed that applying diversity to the science realm is essential to destroying "groupthink." Pursuing diversity in thought has changed processes and systems and has kept NASA focused on its pipeline of applicants without having to resort to choosing any "second-best" people. It has helped to eliminate snap judgements and has relied heavily on analysis. He said a focus on diversity in thought also helped "stopped the war" between HEO and SMD while enabling a good discussion going forward, and has strengthened international partnerships. He said SMD has increased its focus on high-risk/high-impact science and has been able to regularly infuse SmallSat capabilities into science missions. The Roman Space Telescope is now on schedule and within budget following a review and a $500 million cut. Looking forward, the Artemis 1 mission, due to launch on 16 November, will provide a foundation for deep space exploration that will require

integrating science into human space flight. Moving further out into the Solar System will require strategic principles and NASA guidance for constancy of purpose and focus in integrating human and robotic exploration using multiple mission modalities. Success in the Artemis program will require new thought, unprecedented understanding, and trust within the entire community. The Endurance-A mission, an ambitious lunar traverse concept recommended by the National Academies of Sciences, Engineering, and Medicine (NASEM), will require NASA to incorporate human and robotic capabilities on a Lunar Terrain Vehicle in a maximal way to meet the mission requirements

"Exit Interview" with Thomas Zurbuchen

Dr. Wadhwa began the discussion, first stating that it had been an honor to serve as Chair of the SC during Dr. Zurbuchen's tenure.

She asked, "What led you to seek this job as AA? Do you have any regrets?"
Dr. Zurbuchen said that before he took the AA position, he had spent two decades at the University of Michigan at Ann Arbor where he had performed essentially three jobs; conducting research and building instruments, building academic programs (empowering others to do even better, unleashing the imagination of individuals), and scaling/building student pipelines. He found that the position at Ann Arbor eventually became repetitive and not conducive to learning. He looked at multiple choices and hired a career coach who employed pattern-matching techniques that eventually led to multiple offers, including one from Amazon. Dr. Zurbuchen said he had no regrets about accepting the position and that after interviews with Robert Lightfoot and former NASA Administrator Charlie Bolden, he embarked on a course with SMD that resulted in 6 years and 3 months of impact.

Dr. Wadhwa noted that a significant fraction of Dr. Zurbuchen's tenure had transpired under pandemic conditions, and asked if there were any lessons learned that might help NASA SMD do better in the coming years. Dr. Zurbuchen said he thought that the Agency faces real problems. COVID-19 has shown the need for learning new work modalities and has also revealed that travel is not as necessary as once believed. Quite a number of people have retired and NASA has a new workforce with new capabilities, but also huge challenges. As the Psyche Independent Review Board (IRB) study indicated, reviewers found the Psyche mission issues to be a "canary in the coal mine." He said that, as a community, NASA is not as good as it once was. The Agency needs to re-learn how how to build strong teams. He noted a significant erosion in the number of science proposals as an indication that there are not enough new ideas. Dr. Zurbuchen felt this circumstance had been worsened by the lack of human interaction during the pandemic lockdown that reduced opportunities for mentorship and cultural influence. While the Agency did learn new methods and now has new people in the community, it can't go back to exactly where it was. He said NASA must improve.

Dr. Wadhwa cited Diversity, Equity, Inclusion, and Accessibility (DEIA) as a major focus of Dr. Zurbuchen's tenure and asked how the Agency could keep the momentum going forward. Dr. Zurbuchen said that DEIA should be an integral part of all missions, noting that DEIA is not its own "thing." If NASA wants to enjoy the support of the entire nation, it has to invite the entire nation to participate. DEIA must remain part of the mission and part of how NASA selects research, runs teams, and trains its workforce. DEIA can't be some group or program on the side

that "does" diversity and inclusion. DEIA is not the icing on the cake; it is the cake. He stated it will be important for NASA to keep learning and to keep identifying the next hurdles. It will take multiple generations to get to the other side of this problem and the effort needs to make people uncomfortable enough to learn. Dr. Zurbuchen said he had heard so many terrible and heartbreaking stories from female and POC colleagues, demonstrating that these are hard problems that need consistency of action. He said NASA needed to do it for the right reasons: Move Learn Fix.

Dr. Wadhwa named innovation as another major theme of Dr. Zurbuchen's tenure and asked him to describe any "good" failures. Dr. Zurbuchen cited an attempt to attach science instruments onto commercial satellites in geostationary orbit at a time when the 5G spectrum was being introduced. He said this situation caused NASA to lose rides on launch vehicles and hundreds of millions of dollars. Could it have been anticipated? He said he did not know but all the launches that have been planned toward the end of the current year are a result of the backlog caused by 2017. Another failure of note is a Venture-class mission in the Earth Science Division (ESD), called Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of SmallSats (TROPICS). A six-satellite mission, it lost two satellites quickly (a $5-6 million loss). Dr. Zurbuchen said he released a Tweet immediately. Within an hour he received a call from a CEO offering a deal to help NASA acquire the data that the two satellites would have collected. NASA is still growing and developing the SmallSat platform and as such must accept and manage risk. In the case of Lunar Trailblazer, NASA gave the project more money because it is on track to succeed. He said the Agency was hesitant but provided the funding in part because "you don't want to stink up the neighborhood," thereby sucking the innovation out of the next mission. He said taking on more risk can mean being more ready to terminate missions.

Dr. Wadhwa asked how one maintains balance between missions. Do you focus on balancing Flagship and small missions? Do you try to find parity between SMD's Divisions? What are some useful criteria? Dr. Zurbuchen recommended remaining focused on the Decadal Survey inputs, because NASEM is telling NASA what the science community wants. He said NASA looks at these recommendations carefully. The key is to perform. He recalled having an argument with a colleague over a budget item for the James Webb Space Telescope (JWST) in which he brought up the fact that a 1 percent budget increase to JWST equals the cost of 20 graduate students, illustrating that a small percentage of a big number can still be a big number. He said NASA can't allow big missions to eat the "seed corn" of small missions. He said SMD walled off the Research and Analysis (R&A) budget from potential cuts due to cost increases elsewhere in the Directorate during COVID-19 for that very reason, with unanimous agreement. The research announcements provide the heartbeat of science. He noted it resulted in some mission delays but it was a practical and worthwhile decision.

Dr. Wadhwa asked what kinds of input were most useful as SMD AA. Dr. Zurbuchen said that the statement "You're wrong" is the most useful, even if harsh. He said he valued advisory committee advice as well, from members who volunteer for this service. Positive reinforcement is also very helpful and it is important to thank all the people who do the amazing work, including Program Executives, Program Scientists, Program Officers, and Engineers.

Dr. Wadhwa asked what the most surprising thing was during Dr. Zurbuchen's time in SMD. Dr. Zurbuchen said he found that a lot more was possible than he initially thought. He reported having become very bullish about the power of science for uniting people, an ability he would have totally underestimated before his tenure with NASA. In a bureaucracy, it is amazing how many people are trying to do the right thing and how hard it is to make changes. He never quite appreciated that challenge previously and noted that one can do the right thing and still be wrong. He said there is a generally negative view of bureaucrats and the trick for overcoming this perception is to change the boundary conditions, to help good people who are trying very hard to do the right thing. Dr. Wadhwa expressed her gratitude to Dr. Zurbuchen on behalf of the entire audience.

Discussion

Dr. Vinton Cerf commented on the value of commercial industry in space and was excited and optimistic that NASA can take advantage of private sector advances. Dr. Zurbuchen agreed, citing the roughly ten-fold savings that have been achieved by working with the commercial sector. The market has expanded and the industry has found new business models, both of which will continue to be critical in opening up the "area of regard." Dr. Zurbuchen noted that it takes about six years to get a mission off the ground at NASA. Speed matters. For the scale of climate change missions, however, six years is too long. The mission should be focused on science per dollar, and doubt should be mitigated by experimentation. Dr. Zurbuchen said, speaking from his experience on Capitol Hill, NASA should aim to over-deliver but not overpromise. He thought NASA should be doing things differently. Many missions that take ten years to accomplish should not be taking so long. Dr. Cerf noted that the commercial sector is doing well, particularly in remote sensing.

Dr. Noël Bakhtian spoke to the importance of DEIA and how it could be integrated across NASA's portfolio. Dr. Zurbuchen said that DEIA needs an individual to be the responsible party, who has to listen to all the voices in the room, and that those voices must be heard throughout the organization. Dr. Willie May asked what the nation can do to attract more dedicated and able-minded people into positions like that of the SMD AA. Dr. Zurbuchen said he would do it all over again in a minute, and that being AA had been fun, impactful, and also a source of insomnia. He said, however, that the position is emotional and difficult. NASA needs to grow the talent before the Agency can hire it. This can be achieved in an academic environment. Crucially, a sense of service is required. He said everyone in SMD works for the science community and it is imperative to give people opportunities as well as celebrate that sense of service. He noted that in some academic circles, service jobs can be death knells. It is a much different situation in the engineering disciplines where service is celebrated. In science, service is not celebrated (i.e. the publish-or-perish atmosphere can be debilitating). Mr. Marc Weiser asked how the SC could help with continuity as the new AA arrives. Dr. Zurbuchen encouraged the SC to reach out and gather around the new AA to support him or her. What you say in other rooms matters. He said that he was not that worried about continuity because SMD has an amazing team and they won't be quiet about issues. The team is not made up of pushovers. In the meantime, Dr. Zurbuchen said he had spent hours talking with two community members each day, stakeholders, so as not to become sequestered in NASA Headquarters.

Dr. Chick Woodward asked how the SC could help advance cooperation between Exploration Systems Development Mission Directorate (ESDMD) and Space Operations Mission Directorate (SOMD) [formerly known as Human Exploration and Operations Mission Directorate (HEOMD)] and SMD. Dr. Zurbuchen said that NASEM would have to amplify this message. He noted that the most recent Planetary Decadal Survey (DS) was a big help. He felt the recent Astrophysics DS missed the opportunity to advance cooperation between the Directorates. It also must be recognized that the members of these communities must work together and they must be protected and trusted to do their jobs. There is every reason to trust these people. At the working level, Dr. Zurbuchen said he was not worried. Somewhere in the middle management, however, NASA must break through old-fashioned values and must focus on success. It doesn't have to be a huge change but it will take a few years. The change is not an "off-on switch," and it will be challenging.

Dr. Cerf suggested the SC create a resolution of thanks for Dr. Zurbuchen's service. The Committee concurred unanimously.

Beyond ISS for Biological and Physical Sciences

Dr. Craig Kundrot, Biological and Physical Sciences (BPS) Division Director, provided a status of the BPS Division and its current engagement with the commercial world. He noted that Dr. Jamie Foster is the new Chair of the Biological and Physical Sciences Advisory Committee (BPAC). First providing an overview of the Division, Dr. Kundrot explained that BPS is different from other SMD divisions in that it is almost entirely devoted to taking terrestrial biology and physical experiments to the spaceflight environment. It does this to advance fundamental knowledge in science, to help enable sustainable exploration, and to benefit life on Earth. BPS missions aim to pioneer scientific discovery and enable sustainable exploration on a small budget, about $80 million annually. The newest Presidential Budget Request (PBR) calls for $100 million annually. This funding is fundamentally R&A, with 210 investigations in flight and on the ground. The portfolio of investigations is dominated by projects and missions on ISS. BPS continues its longstanding collaboration with Russia, as well as the RAD-SEED experiment, an investigation of the effects of long-duration exposure to microgravity and space radiation on seed viability and quality. In preparation for lunar exploration, BPS is providing Biological Experiment-01 (BioExpt-01) comprised of four different systems that will fly on Artemis I, and he Lunar Explorer Instrument for space biology Applications (LEIA), a derivative of the BioSentinel CubeSat. The Exploration Science Strategy and Integration Office (ESSIO) will take over the execution of LEIA. BPS uses many research platforms, including those that provide minutes of microgravity through use of suborbital and balloon platforms and drop towers. BPS is currently executing a "base" program and is soliciting new research in two areas: quantum science, and the Thriving in Deep Space (TIDES) program.

BPS is preparing for three big changes. The first is the release of the next Decadal Survey (2023-2032) that will provide recommendations for the next decade of transformative science at the frontiers of biological and physical sciences research in space. The placement of BPS within SMD puts an emphasis on compelling, transformative science that is coming to an inflection point. Asked to provide concrete examples of transformative science, Dr. Kundrot cited cold atom work in which free fall provides gentler "traps" to enable the formation of more long-lived condensates. A second change will be the increased use of commercial capabilities such as CLPS

and commercial suborbital flights, including from Blue Origin and Virgin Galactic. Four different companies have been selected to develop a "successor space station." The third change is change is BPS Division's increased involvement with the Artemis program, the Orion capsule, CLPS Lander, Gateway, and Human Landing Systems. BPS is coupled into all of these programs through funding lines.

Dr. Cerf asked for clarification of hind-limb suspension experiments on ISS. Dr. Kundrot explained that these rodent studies were analogous to bed rest studies in humans, often used as precursor experiments for flight, to examine bone and muscle loss. BPS has both formal and informal relationships with the Flight Opportunities office, and is also working with NASA civil servants in suborbital flight experiments. BPS will continue to use ISS for its low Earth orbit (LEO) work until the ISS is decommissioned. Afterward, BPS will use commercial LEO destinations (CLDs), special opportunities such as the US Space Force X37B vehicle, CubeSats, and other free flyers. Most of the missions are awaiting new DS recommendations. BPS will also be closely involved in deep space and lunar surface activities via CLPS, Gateway, and Artemis.

BPS is launching an initiative, the Commercially Enabled Rapid Space Science (CERISS), to develop transformative research capabilities in LEO through the use of Scientist Astronaut Missions (SAMs). These are analogous to existing Private Astronaut Missions (PAMs), commercial missions that have been successfully deployed on ISS. SAMs would be PI-led mission concepts. As an example, a physician would work with a NASA astronaut for a given period of time in LEO to transfer his/her knowledge in a particular discipline. After the specialist/scientist returns to Earth, the astronaut, newly trained in a set of skills, would continue the work on orbit. The other goal of CERISS is to develop automated hardware for experiments beyond LEO (e.g., on the lunar surface). CERISS can dramatically accelerate the pace of ISS research by improving *in-situ* analysis capability and *in-situ* experiment preparation. The goal is to move from 12- to 16-month ISS research cycles to less than a one-week cycle by starting with human-performed experiments and moving to increasingly automated experiments. BPS has issued a Request for Information (RFI) to the commercial sector for this work; so far, most of the investment seems to be going to liquid and powder handling, and analytic techniques on orbit. These experiments are envisioned as modular, small-scale, and portable. Following the RFI, BPS will issue a Request for Proposals (RFP) followed by a Research Opportunities in Space and Earth Sciences (ROSES) announcement and further planning and development. Asked about the environmental impact of BPS studies, Dr. Kundrot indicated that the safety program at Johnson Space Center oversees this area, providing appropriate levels of containment for samples. A human mission to Mars will be a closed ecosystem for 30 months, an area of keen interest, and will be a topic of the upcoming BPS Decadal Survey. Dr. Woodward asked about the link between SOMD and BPS. Dr. Kundrot said the SOMD Human Research Program (HRP) looks for ways to mitigate risk at the phenomenological level; bone loss, muscle loss, etc. BPS looks at the underlying mechanisms of these phenomena that can help to identify countermeasures and biomarkers. BPS also works with the Space Technology Mission Directorate (STMD) and recently flew a zero boiloff experiment with STMD to understand the dominating physics of computational fluid dynamics (CFD). SpaceX and others will be using this CFD data. BPS is keeping an eye on any potential gap between ISS retirement and new LEO platforms and is considering other LEO vehicles, CubeSats, and future commercial free flyers as it awaits the release of the Decadal Survey.

Dr. Serina Diniega asked if BPS had any synergies with PSD. Dr. Kundrot said that BPS is looking at Artificial Intelligence/Machine Learning (AI/ML) in PSD areas of interest. To address DEIA, BPS will be doing dual anonymous peer review (DAPR) for the first time., At present, however, most BPS investigators are working under other agencies such as the National Science Foundation. BPS has added a diversification program to its outreach efforts (e.g., a program that engages middle school/high school students to help conduct plant experiments). While BPS is trying to track progress in DEIA, there are still many difficulties in getting to the metrics and demographics for participants. Dr. Sara Tucker asked if BPS was taking care to study both biological sexes in experiments. Dr. Kundrot said that BPS usually flies animals of one sex (male or female) but that BPS is not ignoring the issue. Dr. Godwin asked if there were a defined pathway through which astronaut issues (like formation of blood clots in flight) could be brought forward. Dr. Kundrot said that BPS and SOMD/HRP are well connected and talk regularly. He noted it's a two-way street, push and pull.

Public Comments

Online question: What besides the Decadal Survey drives science priorities at NASA?. Dr. Woodward said that priorities are discussed in the Division advisory committees such as the Astrophysics Advisory Committee (APAC) and science advisory groups such as the Analysis Groups (AGs). Dr. Williams said there are often a sequence of missions, that build into further planning for larger missions. There can also be "pivot" events like the Allan Hills ALH48001 meteorite to catalyze action. Dr. Cerf noted that a change in infrastructure for space could also drive science priorities, saying the idea of chain hotels in space was "not totally nuts." He mentioned the advent of the Citizen Scientist Model or interaction with large databases as possible drivers as well. As an example, he said Google Earth has revealed sites for archaeological digs. Dr. Bakhtian mentioned non-governmental organizations (NGOs) can also play a role. Dr. Tucker noted that climate change is also driving science priorities. Mr. Callahan said that scientific publications and conferences from within the scientific communities inform the DS committees, so it can be a somewhat circular or iterative process. The DS process involves public comment periods and white paper submissions. If technology changes, it can also enable some science missions, another iterative discussion. Dr. Barjatya said that in heliophysics, the community has close ties to NSF-sponsored conferences and the science communities meet together. He said all the "cooking" for the Decadal Survey occurs in these communities.

Online question: To what extent does the mood of the lay public influence NASA?
Dr. Woodward said the wonder of science, if presented properly, can be very captivating. He said some agencies do this well and noted that it is also important that this activity goes hand in hand with workforce development and the challenges that face the nation. Mr. Callahan said studies have indicated that NASA draws public interest and tends to inspire the public. Dr. May said one can see how the public can get behind NASA and cheer it on, to the benefit of the Agency and any of its partners in industry. Dr. Godwin observed there was a high level of interest in DART as an example of Dr. May's point. Mr. Callahan noted that DART was not a DS mission, not a science-driven mission.

Cross-cutting Lessons from SMD's Independent Review Boards (IRBs)

Mr. Orlando Figueroa, Co-Chair of the Geospace Dynamics Constellation (GDC) IRB and member of the Psyche IRB, presented select findings from the two IRB efforts. Mr. Figueroa began with a discussion of Psyche because its IRB charter requested identification of institutional issues that might have contributed to a delay. Psyche is a Principal Investigator-led Discovery mission with a cost estimate of about $1 billion and was being implemented as proposed. Psyche is an important mission to a unique body that would contribute to understanding of the Solar System in a significant way.

General findings for Psyche

The IRB agreed that late Guidance, Navigation, and Control software delivery and lack of testbed maturity are the proximate causes of the Psyche launch delay.

The IRB assessment was that additional issues could have led to a launch delay on their own:

- Open flight software issues
- Incomplete verification and validation (V&V), including fault protection
- Operational readiness

Recommendations

- Develop a plan forward that prioritizes and completes development activities
- Establish a new launch date with sufficient margin to have high confidence in mission success
- Review work performed in the last several months prior to the launch delay to assure it is at the required level of excellence with no embedded problems
- Conduct a detailed review and assessment of "use-as-is" problem dispositions and "unverified failures"

Mr. Figueroa said it would have been easy to blame the Guidance, Navigation, and Control (GNC) team, but as the IRB dug deeper it found issues that required significant corrections, many resulting from broader institutional issues at the Jet Propulsion Laboratory (JPL). Mr. Figueroa said the IRB concluded that COVID-19 was undoubtedly a factor but its contribution should not be overestimated. The IRB has reviewed the plan forward from JPL and believes it is executable. A large amount of work on Psyche was conducted at JPL, thus the following findings and recommendations are JPL-specific.

Flight Project Workload

- JPL currently has an unprecedented workload with the concurrent implementation of six large spaceflight projects, plus numerous smaller missions and scientific instruments
    - Two projects are Flagship class: Europa Clipper and Mars Sample Return
    - Two projects are Discovery class: Psyche and Venus Emissivity, Radio Science, InSAR, Topography & Spectroscopy (VERITAS)
    - Two projects have significant payload development efforts: Surface Water and Ocean Topography (SWOT) and NASA-ISRO Synthetic Aperture Radar (NISAR)
- Large imbalance exists between workload and available JPL resources

- Most acute in lack of experienced managers; systems engineers; and GNC, Flight Software (FSW), and Avionics engineers
- Imbalance represents a root cause for the Psyche issues
- Adversely affects all flight project activity at JPL

Recommendations

- Flight projects must be fully staffed with appropriately experienced personnel from the beginning, particularly in Systems Engineering, GNC, FSW, and Avionics.
- Balance must be achieved between the workforce needs of flight projects and the available JPL workforce
  - Timing of achieving this balance is critical
  - Psyche is an example of the major problems this imbalance is causing today
- Significant corrective actions must be implemented to achieve balance by the end of March 2023
- For any corrective actions requiring more time, a detailed plan of action must be developed and approved by JPL, Caltech, and NASA

Dr. Woodward asked if this was an acute or a more systematic problem. Mr. Figueroa replied that the continuum of early career, mid- and senior-level staffing is out of balance, and that the IRB considers this an acute problem. Dr. Woodward asked if the IRB saw this as a fatal problem and Mr. Figueroa replied no, that goes too far. He also stated that the problem is not limited to JPL, it's an issue at other NASA centers as well. As a board, Mr. Figueroa said the IRB feels that by the first quarter of next year NASA should proceed with a significant response to this recommendation, as well as for missions beyond Psyche. Dr. Cerf asked if the IRB could distinguish between technical and management skills affected by the imbalance, and the ability to cope with procedures. In other words, could the IRB differentiate effects caused by inefficient bureaucracy and inexperience? Mr. Figueroa replied that the IRB found there to be a difference, but it is not suggesting new bureaucratic procedures/staffing to be put in place.

Options to Achieve Workforce Balance Within JPL

- No new flight projects until balance is achieved
- Cancel, redirect, or delay a flight project
- Transfer required talent from non-flight projects within JPL to flight projects
- Focused personnel training and development in key areas
- Significantly increased use of industry prime and support services contractors
- Increase use of and collaboration with other NASA Centers
- Aggressive recruitment and hiring
- Accept the risk of layoffs

Mr. Figueroa cautioned that the options to achieve workforce balance within JPL do not constitute a comprehensive list of items. Dr. Barjatya mentioned that government salaries in technical fields are often not competitive with those in the commercial sector. Mr. Figueroa agreed that JPL competes in a tricky environment, particularly regarding California's laws about recruitment of employees.

JPL Line Organization

Findings

JPL has encountered significant erosion of technical acumen in the Line organization

- Prevents Line organization from adequately engaging with fight projects, independently assessing status, identifying problems, working with projects to develop solutions, and providing mentorship
- Represents loss of critical safety net
- Technical leadership has migrated from the Line organization to the flight projects
- Without this Line organization capability/safety net, Psyche issues will become the norm and not the exception
- The IRB recognizes the institutional need for more experienced managers and lead engineers is a primary cause of this erosion

Division 31 (Systems Engineering) and Division 34 (Autonomous Systems) issues:

- Modern space systems are complex, highly integrated, and rapidly evolving, especially in the domains of these two divisions
- The magnitude of responsibility in these technical areas has necessitated the partitioning of their work into two divisions
- Ambiguity and confusion exist between the two divisions in terms of roles and responsibilities and accountabilities
- The hybrid work environment has exacerbated these issues
- Both Divisions are critically understaffed, especially in terms of engineers with flight project experience

Recommendations

- Repopulate the Line organization with experienced leaders and engineers to reestablish the Line organization as an equal partner with flight projects during implementation
- Add experienced people and include them in the effort to achieve balance
- Address the Division 31/34 staffing, accountability, and coordination issues
- Continually examine the issues between and within Divisions 31 and 34 because of the importance of these Divisions to the execution of flight projects

Mr. Figueroa stated that the lack of experienced personnel is an issue that needs to be attended to in short order, in Divisions 31 (SE) and 34 (Autonomous Systems) in particular. He said there is currently ambiguity and confusion in the divisions; the hybrid environment did not help, but it was not the main reason for the confusion. The issue is critical understaffing in terms of both bodies and expertise. People coming on board were not quite trained to "pick up the ball and run." Dr. Williams asked if there was a clear distinction between the science package and the flight package on Psyche. Mr. Figueroa said he would never call a science package straightforward (laughter) but that the IRB did not see the science package as a driver of the issues. He said the Line Organization issue will need a lot of attention. He stated that this issue is specific to JPL and not to Caltech, and to the two divisions, specifically.

Senior Management Engagement

Findings

- JPL senior management did not adequately penetrate the Psyche project status
- The large number of small projects, instrument developments, etc., at JPL dilutes senior management's attention, contributing to a lack of appropriate levels of engagement in the execution of major flight projects
- JPL's management review process and tracking metrics during the critical pre-launch period are inadequate

Recommendations

- JPL senior management must establish regularly scheduled meetings, formal and informal communications, and "drop-in" visits to facilitate necessary engagement on major flight projects, communicate priority, and maintain cognizance of status
- Prioritize the large number of activities competing for senior management's attention to focus on those in greatest need and importance such that commitments to NASA and the various stakeholders are met
- Senior management should develop and codify in JPL's Flight Project Practices the metrics that will be employed for tracking progress, especially during system integration and testing (I&T) and verification and validation (V&V)

Mr. Figueroa said there was much discussion of the value of SRBs versus IRBs. He said the IRB found that when NASA Procedural Requirement (NPR) 7120.5F guidelines are strictly followed there still needed to be attention paid to the intervals between milestones, particularly as the time between gate reviews may become too long. He said the IRB found that COVID-19 may have had an impact but it was not instrumental. He stated that the finding that COVID-19 was not a major causal factor is a "heads-up" to NASA in general. When there are flags sent up, it is incumbent upon the institution to respond. He highlighted that the IRB is not implying ill intent, just recognizing that it is very easy to continue on a set course. He stated the message is that timeliness is critical. There is so much activity going on, it is easy to lose track.

Mr. Weiser asked if there are other models for mission-critical programs. Mr. Figueroa responded that the recommendation is to explore and benchmark tools to help build a stronger system for checks and balances, and also for interpretation. Mr. Weiser noted that when hiring for this type of mission NASA can only recruit from certain sectors, and recruits usually bring their own programmatic approaches with them. Dr. Cerf asked if there is something missing from management practices. Mr. Figueroa said Discovery-class missions are cost- and schedule-capped. Since these projects already operate in a highly charged environment, management really needs ground truth about what is being delivered. When COVID-19 hit the mission teams started to lose the human interaction and transfer of knowledge, hampering them as well. The team switched to an agile approach and the system was not set up to keep up with such an approach. He said the IRB applauds the fact that the lab caught the issues prior to launch. Dr. Cerf said that making the boundary conditions fast and cheap can produce a self-fulfilling disaster. Management needs to be more thoughtful about this at the proposal stage. Mr. Figueroa said there have been many Discovery missions that have been successful when provided with adequate reserves. Mr. Weiser said that NASA shouldn't "throw out the baby with the bathwater," there are many fast and cheap missions that have been outstandingly successful (e.g. the Ingenuity helicopter on Perseverance). Mr. Figueroa agreed that NASA wants to attack the

right problem. Dr. Woodward said the findings raise the question of whether NASA is oversaturated with high-value missions. He stated that there is currently lots of activity occurring concurrently.

Hiring and Retention

Findings

- JPL is experiencing difficulty attracting and retaining necessary experienced workforce, especially in critical areas such as Systems Engineering, GNC, FSW, and Avionics
- Local competition and aggressive hiring from commercial space firms and start-up firms have changed the position of JPL and its competitiveness in hiring, including compensation and remote work options
- Incoming workforce has different expectations about career opportunities and mobility

Recommendations

- JPL must develop the capability to successfully hire and retain mid-level people in this new environment
- JPL must develop approaches for the career growth and retention of critical and high-potential personnel
- JPL must characterize problems with retention and develop incisive and decisive actions to address the identified problems

Mr. Weiser asked about the average tenure for a project employee. Mr. Figueroa said the IRB saw a fair amount of mobility with mid-career individuals. Attrition is running double to triple the average. Mr. Weiser asked if this is the new normal. Mr. Figueroa said it is not clear when this dust will settle. JPL technical employees who leave are either going to local markets (such as Google) or other more competitive areas (salary); he said management needs to appeal to the "lure" of NASA.

Hybrid Work Environment

Findings

- The current JPL policy for remote and hybrid work will have an adverse impact on flight projects
    - Remote/hybrid work heightens barriers between sub-teams, which impedes communication and integration
    - Without appropriate in-person interaction, remote/hybrid work can increase miscommunications and create reporting problems up the chain
    - Physical access to shared resources, i.e., testbeds, helps build team rapport and familiarity with the spacecraft
- At present, it is difficult to estimate the impact of remote/hybrid work on flight project schedule and budget planning.

Recommendations

- JPL should immediately revisit its policy for hybrid work to make it more effective and better reflect the evolving needs of flight projects in different mission phases

- Carefully consider which tasks, project phases, and circumstances permit hybrid and remote work arrangements
- Any hybrid work arrangements should recognize the need for in-person interactions. In addition, it is critically important that early-career employees work alongside seasoned employees for their long-term development
- Inefficiencies in productivity and communications associated with hybrid work must be included in the workforce, cost, and schedule plans for flight projects

Mr. Figueroa said the IRB found that the current policy for remote and hybrid work will have an adverse impact on flight projects. It hampers team-building interactions, particularly for inspections. Mr. Weiser asked if there was an opportunity to back up to the design phase and plan for hybrid/remote work? Mr. Figueroa said leadership would need to look at the options and understand the pressure points. Dr. Woodward asked if the organization is relevant to the workforce, can you incentivize the workforce in other ways? Mr. Figueroa said that, related to the hiring and retention finding, the key was to identify the individuals you can't afford to lose and sustain them in the present environment. Again, he said, these recommendations are broader than JPL, that all leadership needs to recognize that human interaction is important. The new normal environment has implications for all future projects. Mr. Weiser asked if the current state of work is leading to more confusion. Mr. Figueroa said that the environment still hasn't settled, it is still approaching a steady state. Dr. Woodward noted that the employee opportunity space for promotion does not stretch from the line to management. It is not equitably distributed. Sometimes, he said, you have to lead from the front. Mr. Figueroa said the PI for Psyche was very hands-on and involved and a lack of input was not an issue here. Dr. Tucker noted this happened to a program led by a female PI. She asked if the IRB found evidence of any deeper cultural challenge. Mr. Figueroa said the IRB asked this very important question. He said the IRB did notice that the Center Director and management were uneven in their response. Dr. Tucker said she was glad the question was asked and noted that the IRB's observation echoes that these problems go beyond JPL. Mr. Callahan mentioned that leadership at JPL has changed recently. Dr. Laurie Leshin is now the Director. Dr. Woodward stated that this had been an important question-and-answer session and that the SC members appreciated the frank responses. He said NASA will have to make sure these barriers are removed. Dr. Tucker said it was important to raise the issue, as we don't want to discourage other female PIs or the next generation.

JPL Caltech Governance (FFRDC structure)

Findings

- There are deficiencies in Caltech's awareness of flight project status and progress.
- Caltech hasn't been sufficiently engaged in helping JPL address its workforce challenges

Recommendations

- Caltech should have a better understanding of the JPL institutional issues and play a supporting role in addressing them
- JPL should strengthen the quality of flight projects status presentations to Caltech
- Caltech should develop a more rigorous annual review and evaluation approach for the performance of the Laboratory Director

Dr. Barjatya reiterated that these findings contained nothing Psyche-specific. Mr. Figueroa agreed, saying it was just bad luck and bad timing for the project. Dr. Barjatya said this distinction was important because VERITAS is a female PI-led mission. Mr. Figueroa agreed but also said the IRB highlighted institutional issues because it considered Psyche a "canary in the coal mine." Dr. Woodward noted the criticality of having a workforce that can sustain the effort, required to successfully complete projects in the current working environment. Mr. Figueroa said it behooves the projects and Centers to pay attention to these findings and recommendations.

JPL Summary and Conclusions

- JPL Institutional issues:
    - Inadequate flight project staffing, in both number of personnel and experience
    - Erosion of Line organization technical acumen
    - Insufficient JPL senior management engagement in flight projects
    - The post-pandemic work environment
- These issues are having a significant adverse impact on the implementation of JPL flight projects
- Many of Psyche's issues are a direct result of the JPL institutional issues
- Corrective actions are urgently needed, and failure to act will result in more "Psyches" and potentially in-flight failures

<u>GDC</u>

Mr. Figueroa introduced Dr. Maura Hagan, co-chair of the GDC IRB. He said she is the science conscience of the whole effort. He stated the IRB was specifically asked to look at the architecture of the project but was not specifically asked to look at institutional issues. Nevertheless, the IRB did find some areas that were relevant for the entirety of NASA. GDC is a strategic Heliophysics Division (HPD) mission that was approved for formulation in 2020. At the time of the IRB, some instrumentation was still in competition, thus hampering some examination.

The GDC IRB Executive Summary flagged some possible institutional issues, and these issues were the subject of the remainder of the briefing:

The GDC mission architecture was not supported by the Fiscal Year 2023 budget profile to meet a Launch Readiness Date (LRD) of 2029 or 2030. GDC presents a unique opportunity for NASA to examine the mission as a model for future constellation architectures. GDC consists of six instruments on six spacecraft. Each spacecraft has its own set of requirements but all the spacecraft requirements must also be integrated. The GDC teams worked within a highly constrained environment characterized as "walking on eggshells," a situation that may have devolved from the use of a Federal Advisory Committee Act (FACA) for instrument selection recommendations. Dr. Hagan stated the IRB found that there was a lot of confusion about roles and responsibilities of Project and Program Scientists during the Announcement of Opportunity (AO) period, though she said this was pretty specific to GDC. She noted that there were parallel processes occurring at the same time. Dr. Barjatya said that GDC is not really a PI-led mission because PIs can only propose an instrument that fits inside a box and then the Project Scientist figures out how to put everything together. He said this was a new approach. Dr. Hagan said Dr.

Barjatya's description is accurate and it wasn't clear how important that the Interdisciplinary Scientists were going to be in bringing the overarching objectives of the mission together.

Dr. Hagan said the GDC architecture is comprised of six spacecraft with six identical sets of instruments in different inclinations, and that the project needs the full capability of five of the spacecraft to meet the science objectives in three years, a difficult task. The IRB was asked to look at scope, complexity, management approach and structure, and whether the science team and planned collaborations were focused to maximize the return on NASA's investment, both scientifically and for potential contributions to national interests. Dr. Woodward asked how the management of GDC reflects on other constellations. Dr. Hagan said management of the Magnetic MultiScale (MMS) mission is close, but in the case of MMS, the instruments were procured as a suite.

Top recommendations that are related to institutional issues:

- The GDC budget (total and yearly profile) needs to be corrected to be better aligned with plans, correct deficiencies identified, and to assign the proper Unallocated Future Expenses (UFE) at the Project and NASA/SMD level
- A system-level optimization approach should be undertaken by the Project in the very near future to steer the plans for formulation and implementation towards global system-level optimization and solutions, including designating a lead position whose job is to focus on the issues of supply chain, logistics, and production
    - A probabilistic risk assessment to inform trades for implementation of the Class C risk classification (e.g., Level 2 versus Level 3 parts, selective redundancy, etc.) is urged
    - Define the trade space for instrument requirements against the spacecraft provider offerings so that there is clear understanding from the beginning
- The Project should aggressively address risks associated with non-recurring engineering, multiple unit production, supply chain, interfaces and instrument accommodation to reduce risk during the non-recurring phase, such as:
    - Develop a fully integrated engineering unit (S/C and instruments) of sufficient fidelity to be upgradable to protoflight as 6th S/C for flight
    - Downselect a suitable spacecraft/SI&T provider from two candidate in a two-step process
    - Explore other approaches designed to reduce the burden of the effort

Dr. Tucker said that all instrument builds are going to be different. Mr. Figueroa said the latter recommendation is directed toward avoiding the "endless improvement" of the same instrument.

Recommendations, continued

- NASA should develop a strategy in close collaboration with the National Science Foundation (NSF) and other national and international GB facility operators for GB measurements (e.g., Incoherent Scatter Radars (ISRs) and Fabry-Perot Interferometers (FPIs)) to calibrate and validate GDC measurements
- NASA should undertake a valuation exercise to assess the capability of the suite of simultaneous GDC, DYNAMIC like, and GB observations, and to calculate the extent to

which the collective contributions exceed the sum of individual element contributions NASA should capture lessons learned and revisit the approach for interactions and engagement with the heliophysics community for missions in the early stages, particularly strategic missions
- The approach for GDC was unnecessarily constrained, and eroded confidence in the plans and motivations
- Mission plans, definition, and early formulation processes should be open and transparent with the community to every extent possible
- Best practices for the conduct of a Science and Technology Definition Team (STDT) (or equivalent) process should be captured and normalized across NASA/SMD in the form of a handbook
- Much stronger collaboration between NASA and other agencies, including the National Oceanographic and Atmospheric Administration (NOAA) National Satellite, Data and Information Service/Office of Projects, Planning, and Analysis (NESDIS/OPPA), the National Weather Service/Space Weather Prediction Center (NWS/SWPC), Space Force, Air Force, and the Navy, and the Defense Advanced Research Projects Agency (DARPA) as well as commercial stakeholders is urged to understand and proactively address space weather impacts on space assets and to develop plans to incorporate GDC data streams into operational models; coordination with NOAA NWS/SWPC which holds the federal mandate for space weather operations, is particularly encouraged

Dr. Woodward asked if the IRB had considered interagency collaborations about Space Weather. Mr. Figueroa said the IRB acknowledges the body but finds the collaboration is not sufficient.

Other observations:
- The selection of investigations/instruments from multiple and varied organizations (e.g., Goddard Space Flight Center (GSFC), universities, other institutions) may create unintentional inequities in access and turnaround times for resources, support, and response to actions; the GDC Project should be proactive in assuring the same opportunities to GSFC and non-GSFC investigation teams so that they are treated equitably and as full members of the GDC team
- GDC offers a unique opportunity for a new approach to constellation architectures of the future; NASA should take advantage of that possibility to find new and strategic approaches to formulation and implementation
- An IRB, when performing independent cost, schedule and risk estimates at this early stage, fills a gap to better inform KDP-A and how NASA approaches the formulation of assigned (i.e., non-competed) missionsA more diverse NASA science community will set the stage for the success of future missions and programs. NASA SMD and HPD should continue and expand ongoing efforts to reach out to, educate, train, and develop more diversity in the broader science community and in heliophysics, starting with GDC

Dr. Barjatya said the GDC life cycle cost is about $1 billion but that the mission is very different from Psyche. He noted that Psyche is PI-driven as opposed to the unique GDC situation. The Heliophysics Advisory Committee (HPAC) had a finding addressing the process of defining the box into which the instrument fits, then determining what spacecraft to use, then finding a way to interface the two. He said communication is an issue on GDC because there is not a single PI

tasked with championing the mission. He said this situation could be avoided by assigning such a PI at the beginning of the project. He asked if the IRB had examined this possibility and asked if the IRB determined whether the PI-led method might be preferable. Mr. Figueroa said the question relates to acquisition strategy that has to be decided before phase A and that the conversation has to occur much earlier in a project's life cycle. He also said such a discussion was outside of the IRB charter, stating that it is a larger conversation for SMD leadership to consider. Dr. Hagan said it is important to note that Living With a Star (LWS) missions are Center-led but beyond the purview of the SRB charge. In response to Dr. Barjatya, Mr. Figueroa said the Program Scientist (or Project Scientist) should be the face of the mission. Dr. Barjatya said there is never an instrument that will fit in the budget box. Mr. Figueroa replied that there must be some control of cost while also considering headroom. Dr. Tucker asked about the number of IRBs NASA establishes per year in SMD. Mr. Boll said there were three in the last year, though this is not typical. He said an internal 5-year review of the IRB process is underway, examining how IRBs fit in the entire project/program development cycle. He noted the use of IRBs varies and that they are established using different charters. Dr. Tucker asked how SMD is transferring LLs across divisions. Mr. Figueroa said the IRB addressed the issue in its recommendation on standardizing IRBs in order to reduce confusion in the community. Likewise, he said, in reviewing comments on the process the IRB noted constraints on the process to challenge the boxes. Dr. Hagan said she expects that the LLs are shared at the Associate Administrator level. She said there are surely best practices that can be codified, which is why the recommendations were made. Mr. Figueroa said the IRB also captured thoughts from the community and passed them on. Dr. Woodward asked about the GDC team's reaction to the IRB. Mr. Figueroa said they were very receptive.

Dr. Woodward mentioned that the conversation on GDC issues has implications for the commercial side as well. Dr. Diniega said that the Psyche IRB findings noted that the possible mitigation techniques may be at odds with DEIA. She asked if there is a way to make strides in recruitment and retention without losing progress in NASA's stated value of inclusion. Mr. Figueroa said that the case of Psyche the events took place in a unique place and time, and he would hope DEIA policies would not adversely affect hiring. He said the IRB saw a very diverse group of people on Psyche, reflective of a diverse project. Dr. Hagan said that diversity is an important point, and that NASA must ensure it is not abandoning DEIA efforts when aggressively recruiting. Mr. Figueroa noted that the recent Decadal Surveys have integrated DEIA. Dr. Cerf stated that paying adequate attention to nurturing staff is important as well. Mr. Figueroa said that from a personal perspective he found it impressive that communication coming from the Psyche personnel was very open. Mr. Weiser said such an observation implies that the Psyche personnel all knew it was going off the rails. Mr. Figueroa noted that multiple things occurred leading to collapse. Mr. Weiser suggested the telegram story from Pearl Harbor as an analogy, in which there was no "emergency cord" to pull to warn of intercepted communications indicating an imminent attack. He asked if there was an emergency cord equivalent on Psyche. Mr. Figueroa said that in a healthy environment one would expect to be able to detect the presence of a safety net, but some of the Psyche situation was impacted by COVID-19, a lack of experienced people, a "new normal" work environment, and other factors. He said sometimes people can't know what they don't know. Dr. Barjatya said he is very thankful to the GDC IRB and that the current situation is better than ever. Mr. Figueroa said he is also very grateful to Nikki Fox, Director of the Heliophysics Division at NASA, for being

receptive. Dr. Hagan said the IRB is already seeing the recommendations on communication being implemented.

Double Asteroid Redirection Test (DART) Update

Dr. Robert Braun, head of the Space Exploration Sector at the Johns Hopkins Applied Physics Laboratory (APL), presented a briefing on the successful Double Asteroid Redirection Test (DART) mission, a planetary defense mission whose goal was to safely demonstrate a kinetic impact deflection technique on a dual asteroid system. The Dimorphos/Didymos asteroid system was chosen for its relatively close distance from Earth. Dr. Braun displayed a video of impact, and noted that the last 4 hours of the operation was entirely autonomous. DART was an APL mission and included some other international agencies. The level of public interest in this $325 million mission (including launch vehicle) was considerable. DART received great press engagement, media engagement, and attention on social and digital media. DART is just part of a larger program, led by the Planetary Defense Coordination Office (PDCO) within SMD, which has already had a number of notable successes, including a comprehensive "tabletop exercise" across the federal agencies, simulating response to an asteroid impact. The success of DART has engendered awareness of much support for the proposed Near Earth Object (NEO) Surveyor mission, as well.

Dr. Elena Adams, DART mission systems engineer, covered the DART mission requirement aspects. The purpose of the impact was to change the binary orbital period, measure the period change, and also measure the momentum enhancement factor (beta). The European Space Agency (ESA) now has a sister mission, Hera, that will measure the mass of Dimorphos, and image the effect of the impactor, in the 2025/26 time frame. The binary asteroid system was picked for its safety factor, so as to avoid disturbing an asteroid that could possibly impact Earth. The LICIACube camera, contributed by the Italian Space Agency, was able to image the impact as it flew by, and provided a good illustration of a planetary defense response. In addition to LICIACube, DART also demonstrated roll-out solar arrays, (ROSAs), the NEXT-C ion engine, and Smart Navigation (NavCam) techniques. The LICIACube also demonstrated the utility of cubesats in deep space, where they can be used to take informative images. The Didymos system was impacted at roughly 1 A.U., at its closest approach to Earth. The appearance of Didymos has been roughly known through radar imagery since 1996, but the appearance and composition of Dimorphos was not known at all. The mission had to take these uncertainties into consideration when planning the autonomous approach to navigation. The mission team did not actually "see" the asteroid it was to hit until 68 minutes before impact.

Dr. Nancy Chabot, Planetary Chief Scientist at APL and Coordination Lead for DART, delivered the science briefing, first noting that the mission was supported by over 100 institutions in 28 countries, underscoring the importance of international cooperation for planetary defense. Dimorphos is the smallest object ever visited by a spacecraft; scientists are still reviewing data and trying to understand its mass and shape, whether it is a rubble pile, or a solid mass. The LICIACube provided extraordinary footage of the impact, showing details of the ejecta streamers. Over 300 ground-based telescopes, as well as the Lucy spacecraft, viewed the impact. The James Webb Space Telescope and the Hubble Space Telescope returned images the next day. The Southern Astrophysical Research (SOAR) telescope in Chile captured images of the tail of ejecta. The mission team is meeting twice a week to review all the telescopic observations,

and data from all seven continents. The mission will continue to observe the system through 2023. The original period was 11 hours, 55 minutes, and post-impact, the new orbital period was measured to be 11 hours, 23 minutes. The prediction had been a 7-minute change, in contrast to the 32-minute observed change, a difference of 4 percent; it is still not clear what the difference between predicted and observed data signifies. The measurement of the orbital period was based on light curves from optical telescopes, as well as radar images. Overall, the mission has high confidence that the impact caused the period change. Decadal Survey studies have offered strategies and assessments of the variables to be considered for deflection of planet-threatening asteroids; these studies have included assessments of kinetic impactors and ion beam deflection (slow push over long period time) as opposed as to nuclear or other scenarios. Most important is the warning time; any mitigation has to be part of a larger planetary defense strategy, which also underscores the importance of a Near Earth Object (NEO) Surveyor mission. The strategy for asteroid deflection is not one-size-fits-all; asteroids and other NEOs can differ greatly in composition: metal asteroids, solid core, rubble piles, etc.

Planetary defense requires international cooperation for an international issue, and there is much modeling and analysis going on to further progress in this arena. DART is an amazing mission; it was accomplished during a global pandemic, and is a great example of what NASA does and can do. NASA has found most of the larger "civilization-ender" objects, on the scale of the 10-km Chicxulub object believed to have caused the K-T extinction. Statistically, however, Earth is more likely to be hit by much smaller objects, of which only approximately 50% have been discovered to date. Dr. Adams noted pretty much only a nuclear shockwave could move the trajectory of a 10-km asteroid, and it would have to be a very well-known asteroid. Much reconnaissance would be required before an attempt to move such an object. Dr. Woodward asked if there had been any evidence of subsurface ices (on Dimorphos). Dr. Chabot said that there was no evidence of ice. Asked if there were any change in reflectivity, Dr. Chabot said that an analysis of the ejecta spectra, which will help determine resurfacing and composition, will be presented at the upcoming American Geophysical Union (AGU) conference. Hera will also answer similar questions. The rough estimate of mass that was ejected upon impact is about 10^6 to 10^7 kilograms. Dr. Cerf asked for further details on Artificial Intelligence/Machine Learning (AI/ML)-enhanced identification of about 100 new NEOs. Dr. Chabot referred Dr. Cerf to PDCO's Kelly Fast for more information about this ongoing effort. Asked what had been learned from the use of NavCam, Dr. Chabot said she thought an infrared (IR) camera would have added value beyond the visible-wavelength camera. She also observed that the spacecraft would have benefited from a quieter mechanical design, to enable better guidance. Any jitter or motion can misrepresent the motion of the asteroid, as can thermal changes that affect the alignment of the sensors. Correcting for these conditions would need much pre-mission simulation.

Wrap-up Discussion

Dr. Williams began the findings and recommendations discussion, noting that first, the Committee would be crafting a resolution of thanks to Dr. Zurbuchen. Dr. Woodward raised the issue of BPS and what it might accomplish on the Gateway platform, or what Gateway might offer in terms of dock modules. Mr. Weiser said there was also the question of hiring a new SMD AA before the release of a new Decadal Survey. Dr. Barjatya was interested in the proposed BPS Scientist Astronaut program, and how training might take place on orbit, as well as how non-astronauts would cope with massive physiological changes. Dr. Woodward noted the

distinction of having high-priority science to be done by astronauts, unlike the Apollo era, where science was not upfront. Dr. Williams said the LEO module concept presupposes a market opportunity for BPS; and the goal of doing transformational research makes BPS an applied research arm for HEO. Mr. Weiser felt that the Committee should advise BPS on how to be best prepared for the Decadal Survey, and encourage them to swing big, because the budget is not large. Dr. Barjatya asked how BPS would compete with organizations with deeper pockets. Dr. Woodward supported the use of modular platforms, which could address many radiation and microgravity issues for humans. BPS should have a good science vision going forward; he hoped they would get a highly focused Decadal Survey. Dr. Williams suggested a finding on the many opportunities available to BPS. Dr. Barjatya commented that BPS should engage more with Gateway, learn about the interfaces, and perhaps piggyback on space weather instruments already planned for Gateway.

Dr. Woodward felt the Committee should make a strong statement on DEIA, in order to help carry it forward. Dr. Barjatya said his HPAC briefing would contain a finding echoing this sentiment, but added that the community is split on DEIA requirements in solicitations. Dr. Williams agreed with the spirit of the recommendation. Mr. Willie May noted that DEIA is a means, not an end, for accomplishing NASA goals. Dr. Cerf offered to write the finding.

Dr. Godwin referred to Dr. Zurbuchen's statement on instilling a sense of service, which is important to everything. Dr. Tucker said that there must be more incentivization to be an educator, or for providing a service, that is not based on measuring the number of publications (increasing the H number). Mr. May said the measurement must more qualitative than quantitative, and reflected that during his own career, for promotion purposes, he had had to articulate this sort of impact. Dr. Tucker said that it is indeed a privilege to work for NASA, and it is important to recognize this. It is a privilege to work in science, period. Mr. Callahan suggested a finding recognizing the current saturation of research experiments on ISS, to ensure that BPS is positioning itself to take advantage of future LEO plans.

The Committee discussed the IRB findings on workforce issues. Dr. Barjatya asked if there were typically any "closing of the loop" activities after IRB reports. Mr. Callahan said that NASA responds to the recommendations, but was not sure how much follow-up was pursued. He added that Dr. Zurbuchen had made it a requirement that the chair of the (relevant) SRB sit on any IRBs. Dr. Woodward noted that here is where the timing of the SRB is really important; the mission needs continual conversation. Dr. Williams said that on the other hand, too many IRBs can be a bad idea. Mr. Weiser asked: are there things we can say about the hybrid environment? Get ahead of things? Mid-career compensation issues? Dr. Woodward commented that a similar situation had occurred in the film industry, with the advent of digital imaging, when job insecurity suddenly became rampant. Dr. Williams said there was also the question of autonomy; NASA Centers have lost a lot of control over how the workforce is managed. Mr. May suggested salary adjustments were one way to make the job more attractive; conversely, should NASA just manage the contractors who do the science? Dr. Woodward commented that proficiency in launch vehicles has been ceded almost entirely to the commercial sector. Mr. Weiser said that unit economics doesn't work for the commercial sector; they don't want to do the same thing twice. Dr. Tucker said that some industries feel they are competing with NASA at times. Mr. Weiser said that the workforce problem will only get worse unless NASA can attract mid-career

talent. NASA must go solve the problem or it will negatively impact the nation's ability to do science. Each delay has a cascading effect. Imagine getting a Decadal Survey that cannot be executed due to lack of expertise. Dr. Diniega suggested including an explicit recognition of the larger goal of inclusion. Dr. Tucker felt NASA was well aware that the only way to do this is to include those who have not been traditionally included. Mr. May commented that many immigrants are going back to their homelands because they are being offered more lucrative packages than they can find in the US; they are going back even though the conditions that had originally driven them away have not changed. Dr. Godwin said she was seeing this with her graduate students. Dr. Woodward said that NASA needs to promote STEM as well. Dr. Tucker said that diversity winnows down very quickly at NASA Centers- the people who are building things are still largely white males. Dr. Woodward said that's why DEIA must be the fifth pillar, to carry things forward. Dr. Barjatya commented on other issues raised by the IRBs, such as better communication, giving more power to the project scientists. He suggested a finding on the judicious use of IRBs, as there are a lot of people who got wronged by the "boxes," argument. This section of the community needs to hear that they must move on. Dr. Barjatya also noted that the GDC report is rather sanitized, and that the community sometimes needs to hear the harder comments. Mr. Callahan took an action to follow up on retrieving IRB community commentary.

Dr. Woodward suggested a finding on putting science at the forefront of human exploration, and also that it would be valuable (for the community) to be part of writing up how NASA will engage with the National Academies before each Decadal Survey, taking into account the timing of missions as well as commercial space capabilities. Mr. Weiser commented that science is no longer constrained by lift or shroud. Dr. Barjatya noted that SpaceX had had many failures, but they did it on their own dime, and that cubesats are a big part of the future for science. Dr. Williams commented that DART was tremendously successful and asked how much more complicated it had been than Psyche. Dr. Barjatya felt that the DART mission had taken tremendous risk but had also been very lucky. Dr. Woodward said that the DART mission shows the value of high-risk, high-reward missions, and was analogous to the Mar helicopter, another successful technology demonstration.

November 16, 2022

Dr. Callahan made opening announcements.

SMD Bridge Program

Dr. Padi Boyd gave a briefing on the SMD Bridge Program, describing her broad experience in Astrophysics management at the Goddard Space Flight Center, and with professional and educational development, and mentorship. Dr. Boyd described having sat on the State of the Profession (SoP) panel for the Astrophysics and Astronomy 2020 Decadal Survey, the first time such a panel had been charged with bringing findings and recommendation to the full Decadal Survey panel. A diverse group served on the SoP panel, which brought forth several recommendations on professional development; the SMD Bridge Program is part of their recommendations. The Program is based on a "braided river" model of the workforce, vs. traditional concept of the pipeline, because it has been observed that the STEM workforce

pipeline model may not truly be representative of many career trajectories. These trajectories often include gap years, time spent in and out of industry, time spent raising families, etc. Dr. Boyd referenced a 2021 article describing the concept, by Batchelor et al.: [Eos 10.1029/2021eo157277]. The SMD Bridge Support Team at NASA Headquarters includes two student interns with backgrounds in linguistics and anthropology, and a graduate from an HBCU who was part of a Bridge-like program 20 years ago.

The SMD Bridge Program is a new initiative (Fiscal Year 2022 President's Budget Request), and was introduced about a year ago. Its goals are to increase diversity, equity, inclusion and accessibility within the NASA workforce and the US science and engineering community. SMD will be facilitating one or more community workshops; the latter is where most time and effort has been spent this past year. Building the pieces of the bridge will require recognition that STEM exists in the larger environment, and that this focus affects people differentially. The "landscape" in which STEM must be considered includes racial injustice, police brutality, increasing incidence of hate crimes targeting Black and Asian communities, and enduring pandemic impacts, which are distributed inequitably along gender, class, race and generational lines. There are also a number of federal Executive Orders and mandates that impact federal agencies on the issue, including NASA's Agency Equity Action Plan. The American Institute of Physics (AIP) released a TEAM-UP report with both recommendations and an implementation pathway for increasing African American degrees in STEM. Inclusive Astronomy Meetings I and II have been held in Nashville. The Bridge Program will endeavor to take advantage of what NASA already has: science missions, the DEIA effort already being implemented NASA-wide, the multiple NASA Centers, and existing connections to educational institutions, partners, and professional societies. NAS reports have also lent support with the release of publications such as Increasing Diversity and Inclusion in the Leadership of Competed Space Missions (2022), which contained a specific finding on institutional, systemic and human-centered barriers. The most recent Planetary Science and Astrophysics Decadal Surveys included specific findings on DEIA as well.

The number of Bachelor of Science degrees earned in astronomy has increased from 150 in the 1970s to 500 in recent years. There is still a smaller number of women in the field, but they are tracing the rising trend. PhDs earned during that same time period rose from 80 to 160; the number of women is again lower, but the numbers are still going up. For African Americans and Hispanic Americans, however, these same statistics start at 0 and go up to 60. These are very small numbers; these populations are very underrepresented by about a factor of 10. There were not even 10 African American PhDs in astronomy in 2018-19. These numbers provide a motivation to do something very different to be more effective. Mr. Weiser asked if it were possible to identify a cause for a noticeable spike in undergraduate astronomy degrees in 2017-2019, such as a particular funding initiative. Dr. Boyd said she had not seen attempts to tie trends to lagging funding. Mr. Weiser encouraged Dr. Boyd to identify positive trends and how to keep them going. Dr. Cerf said he had sat on the American Institute of Physics (AIP) Foundation Board when TEAM-UP was rolled out and emphasized that the barriers to STEM are not just economic, there is also a social component: isolation, lack of counseling or role models, and feeling unwelcome in STEM fields. This will be an important part of the program. Dr. Boyd noted that the TEAM-UP effort continues, and that she had been impressed with how it was

rolled out. The sense of belonging issue is real, and the Bridge Program is really focusing on what good mentoring looks like, and how to evaluate it.

In terms of Historically Black Colleges and Universities (HBCU) and Predominantly White Institutions (PWI) R&D expenditures, data indicate that HBCUs are clearly underresourced, which is one imbalance the Bridge Program would like to see addressed. Many Bridge models are operating at present, both university-led and professional society-led, and many involve partnerships with Minority-Serving Institutions (MSIs). The goal of the SMD Bridge Program is to develop sustainable partnerships among institutions historically under-resourced by NASA: Minority-serving institutions (MSIs) such as HBCUs, Tribal Colleges and Universities (TCUs)), Primarily Undergraduate Institutions (PUIs), Primarily Black Institutions (PBIs), Hispanic Serving Institutions (HSIs) and Community Colleges; and very highly research-intensive universities and NASA Centers or Facilities. The Bridge Program would like to see these students to transition any STEM career, not just NASA. Trying to widen the aperture.

A Bridge Program Workshop was held in October of this year, to bring all stakeholders together to co-create program. The stakeholders are faculty at HBCUs and MSIs, early-career faculty, and former student participants in bridge programs, as well as NASA staff that have been engaged in STEM education, in all areas of science and engineering. Industry and professional societies were invited. There was not a specific breakout session on industry, but there was one on the role of professional societies. A Dear Colleague letter was sent out in May, which attracted over 80 applicants. The Workshop Organizing Committee was co-chaired by Bri Hart, Diversity Program Manager at the American Physical Society and Edqard Gonzalez, DEIA lead for Heliophysics NASA Goddard. In addition to the organizing committee, there were also several working groups. The workshop had 421 registrants from the US and the world; some were HBCUs, HSIs, tribal college and university partners. There was much clustering near Centers, and the organizers tried to get every state represented. There was a bit of a concern that HBCU participation was so low. The total registration included 47 students and 276 professionals. There were 48 breakout rooms focused on early-career, HBCU challenges, workshop goals, etc. Guest speakers include Dr. Zurbuchen and other keynote speakers, each of whom set the day's tone and closed the day's proceedings. The workshop report will be delivered to SMD by the end of the month.

The Bridge program has identified NASA stakeholder working groups at Headquarters, Centers and missions; the program did a NASA Listening Session in July, resulting in a number of Lessons Learned and the identification of barriers to address. A ROSES-23 call is in progress for building Bridge teams. Dr. Boyd said she expected the mentoring process to be the "glue" of this program, and is leaving the definition of "capacity building" to ROSES proposers. SMD expects to award $5M per year to successful Bridge teams. NASA will be encouraging proposals to be led by PIs from underserved institutions. Smaller institutions have higher barriers to getting proposals across the finish line, so NASA is also trying to give them a chance to participate in a consortium with a larger institution. The proposal will not require a detailed budget until the proposal is deemed selectable. Asked how proposers could eliminate the budget requirement from the usual NSPIRES paperwork, Dr. Boyd said the initial proposal might be a large Notice of Intent, or can come through a different portal; it is not yet certain what the format will be.

The Bridge Program will seek to have annual symposia in order to connect Bridge teams to each other, offer opportunities for faculty, students and NASA Center or Project mentors to network, share experiences, foster new collaborations and communicate with each other. Key takeaways from the workshop include:

- There is significant potential energy within NASA, key stakeholder institutions, and broader community to build a Bridge program.
- It takes time to build strong, long-term relationships and trust between partners. It cannot be rushed.
- Different types of institutions face different barriers to participation.
- It is important to engage with all institutional stakeholders
- Longer grant performance periods are better for Bridge programs.
- Focus should be on the student experience, building relevant skills for broad STEM career options, and assuring research experience occurs in a positive, supportive environment

Dr. Cerf asked if there could be a private sector role here, such as offering opportunities for summer internships. Dr. Boyd said private sector involvement in missions could bring about these sorts of opportunities. Dr. Williams asked how many students Dr. Boyd would like to see in five years. How many students are there per cost category? Dr. Diniega asked if non-US persons were eligible, or those without documentation. Dr. Boyd said that NASA didn't have solution for that yet. The Program will have the capacity to bring on international students; the main issue here would be badging to Centers. Dr. Diniega asked if there were any longitudinal plan to track students beyond the Bridge Program. Dr. Boyd said the report outcome may reveal this, but that she did want to be able to do that. Dr. Tucker commented that she had some concerns about people "leaving STEM to go to industry," pointing out that industry does in fact have STEM in it; what role can industry play to support this effort, and are they invited to the workshops? Dr. Boyd said there had been very small numbers of industry applicants. She felt that the best way to engage them was to recognize that they are ahead of NASA in many respects. As partners to the Bridge program, they would have to show that their engagement is relevant to a stated science objective. Dr. Woodward asked if they had investigated why industry didn't apply, or why some supplied an incomplete proposal. The answer to the question might reveal some tidbits about program structure/barriers. Dr. Boyd agreed the question was something to consider, and said the Program planned to keep some of the workshop organizing committee engaged, and to have "HBCU office hours," to shake out the reasons that people are not applying.

Dr. Bakhtian asked how the team decided that its model was the right answer. Are there any data on what actual challenges people are facing? How will this program help overcome the challenges? Dr. Boyd said the reason the model is focused on students is because that is where the common goals lie: get those students across the finish line to graduation. In the breakout rooms, there were questions about challenges that will appear in the report. Dr. Bakhtian asked about plans for keeping the model flexible, to enable improvement in the future. Dr. Boyd said that in addition to graduation statistics, the Program would like to see proposals from more PIs associated with underserved institutions. Flexibility will depend on what change is desired. Mr. Weiser asked if the Program was coordinating with other programs to communicate the Bridge goals. Dr. Boyd said the Bridge Program was communicating through OSTEM and MUREP, as

well as the NASA HBCU Road Show. Dr. Bakhtian recommended partnering with other agencies who are engaged in similar efforts, such as DOE. Mr. Weiser suggested the Program capture as much demographic data as possible through the PI Launchpad, and get Lessons Learned from those activities. Dr. Williams noted it would be good to know how many students go through the NASA Internship Program.

Advisory Committee reports

Astrophysics Advisory Committee (APAC) Report

Dr. Woodward, Chair of the APAC, reported on the Committee's late October meeting, largely concentrated on the Government Performance Reporting and Accountability (GPRAMA) exercise. APAC judged both APD science goals as Green. Dr. Woodward presented science highlights, including a JWST image of Stephan's Quintet, Chandra images of a pulsar, and some examples from the ever-growing list of exoplanets; "Earth 2.0" is in the data just waiting to be found. APD Director Dr. Paul Hertz has retired, and Dr. Mark Clampin is the new Director. One of the APAC's initial conversations with Dr. Clampin was about a reconfiguration of an ESA mission (Athena), and another conversation about the LISA mission; the issues were similar to GDC IRB concerns. APAC also heard from Dr. Zurbuchen about the Nancy Roman Space Telescope re-plan to enable sufficient schedule. The Committee also heard updates on JWST, which is exceeding mission requirements and which will likely have a long-duration mission. There are, however, new concerns about micrometeoroid strikes on Webb's optical surfaces, which have been mitigated by new restrictions on conducting observations, and turning the back of the spacecraft against the stream of debris. There is not yet enough data on whether the stream is constant or variable.

APAC issued findings on JWST and NPP, and made recommendations that cautioned that future missions like Euclid and Roman will pose another strain on the Great Observatories Mission & Technology Maturation Program (GOMAP). APAC also issued findings on Astrophysics packages on ISS and noted that Balloon Program consumables (e.g., helium) are becoming difficult to find; this scarcity might impact other divisions as well. APAC still lacks a resolution on the JWST/Webb memorialization design, and discussed changes in policy documents about how missions are memorialized; the Committee has asked for an outbrief in March 2023, at which time it would like to bring the issue up the chain to the SC. Other minor issues include the timeliness and implementation of next Decadal Survey viz à viz Federal budget releases and the timing of new AOs. APAC made a recommendation to the APD Director is to think about the timing of Decadal Survey announcements (recognizing it took 20 years to get Webb into orbit): how do you steward large missions in this atmosphere? Dr. Diniega said the same concerns had been raised by the Planetary Science Advisory Committee (PAC). Dr. Cerf asked about the strike hazards on Webb and whether a shield could be deployed *post hoc*. Mr. Weiser asked if robotic repair and refueling efforts were possible with Webb, whether there was any expectation of degradation of performance over time, due to debris strikes, or if there had been any re-thinking of how observations are being prioritized. Dr. Woodward said that APD is implementing a MMOD avoidance zone criteria for proposals. The degradation of optics in space will have to be studied further.

Planetary Science Advisory Committee (PAC) Report

Dr. Diniega, Chair of the PAC, presented science highlights: Mars sample collection and caching via the Perseverance rover is progressing; the first sample depot is at the Three Forks delta site in Jezero Crater. The Juno mission did its first pass of Europa, and the spacecraft continues to be healthy. The ATLO phase of the Europa Clipper mission pace is accelerating, with five of nine science instruments having been delivered; the mission is moving along to its launch in October 2024. The Dragonfly mission to the Saturnian moon, Titan, is also doing well. PAC has brought on four new members; at its last meeting PAC performed the GPRAMA, voting all science goals Green; the PAC's next meeting will be in December.

PAC addressed Inclusivity Plans in PSD, which issued its first call within the 2021 PRISM AO; based in part on that experience, SMD held an informational "Inclusion Plans Best Practices" workshop in early November. As a result, there seems to have been some confusion in the community, and PAC hopes that SMD is doing a cross-directorate look at this. Dr. Diniega offered the SC the opportunity to comment on how SMD might help the community move forward on creating and writing standard inclusion plans. Some areas that might benefit from clarification include processes within the team (training and mentoring can be part of it), how to communicate within the team, and how to overcome location constraints. One area of confusion was inclusion being narrowly defined as targeting HBCU/MSIs, while it is recognized that inclusion is much more than that. Dr. Woodward noted that DEIA will need deliberative motion and it will take some time to drag communities along. Dr. Diniega noted that particularly with some AAs retiring, the PAC is concerned about the DEIA effort going forward. Dr. Bakhtian said that DOE is putting much effort into defining what inclusion looks like in the research proposal piece, and suggested examining NSF and DOE best practices.

Heliophysics Advisory Committee (HPAC)
Dr. Barjatya, acting Chair of the HPAC, presented highlights of the HPAC's September meeting, which included the status of Parker Solar Probe (PSP) and the Voyager spacecraft. HPD has two AOs out for small Explorer (SMEXes) missions that are due in December. Approximately 500 white papers were submitted to the upcoming Helipophysics Decadal Survey. HPAC carried out its GPRAMA exercise and found all goals to be Green. HPAC has been pushing HPD to give more detailed budget breakdown numbers: how much to R&A, Flagships, etc. Recently the Committee heard a well-detailed breakdown, but wants to drill down even more, which might or not be allowed. HPAC had an update from HPD IDEA (DEIA) working group, and a briefing on Open Data/Open Software policy.

Dr. Barjatya presented a quick science highlight about the many assets that viewed the January 2022 eruption of the Hunga-Tonga-Hunga Ha'api volcano. This week's Science issue contained a paper on particulates from this eruption going all the way up to the mesosphere. Among HPAC's findings was a recognition of an upcoming Big Year; there will be two North American solar eclipses (October 2023 annular and April 2024 total). This is an incredible opportunity for NASA, as it will be another 20 years before these phenomena will be visible again in the contiguous 48 states. NASA just approved a mission to launch three rockets from Vandenburg and three from Wallops to view the eclipses. The April 2024 eclipse will be four minutes in totality. HPAC commended HPD for supporting public engagement in this area. There are calls going out for Citizen Scientists, high-altitude balloon missions, ham radio ionosphere reporting. HPAC wondered if ISS could pass before the Sun while it is in total eclipse. Dr. Bakhtian

wondered if NASA might fund school travel, and connect it to the HBCU/MSI effort; bus kids to the totality area, get money to the under-resourced community. Dr. Barjatya said he was PI on one of the rocket launches, and was trying to get local schools invited through the mission auspices. Mr. Weiser suggested putting this on the agenda of the STEM Outreach group in SMD. Dr. Barjatya felt it was a great opportunity for the entire science community, to see how it connects with the other disciplines in SMD.

HPAC issued a finding and recommendation on the HPD IDEA working group; the Committee is split on how much IDEA becomes a requirement in proposals. There is a fear that it will eliminate the very people NASA is trying to include. There also restrictions being implemented by state laws that interfere with this process. Mr. Weiser said this was the second or third time the SC was hearing about challenges to small institutions; partnering with a bigger institution is just a band-aid. Hearing a trend. Dr. Williams said she didn't like slamming R-1 institutions; it becomes a matter of spending money on resources vs. science. Dr. Diniega said that inclusion is science, not just a part of science. Dr. Williams suggested that proposers could make hiring an inclusion consultant part of the budget proposal. Dr. Woodward felt SMD should give a presentation on how to overcome barriers, because these institutions are responding to Executive Orders and federal mandates. It can be a big deal for a small proposal. Mr. May thought perhaps proposers should articulate in writing why and how diversity/inclusion is beneficial to the team. Dr. Diniega said this schema was part of the original pilot; the point is to prompt the thinking at the proposal stage, instead of slapping it on or ticking the box after the fact. It shouldn't be difficult, but the thought should prompt some discomfort. Dr. Barjatya said there has to be some sort of metric: how do we measure the benefit at the end? Dr. Williams asked: how do you write an inclusion proposal? Is the goal to hire an inclusion candidate? Dr. Woodward said the point was to get IDEA into the forefront of the thinking, thoughts that are beyond the scope of what one normally thinks about. Writing an inclusion plan is a similar thought process to writing a data management plan for a proposal; it requires stretching the boundaries of thought. Diversity implies and supports innovation. Dr. Barjatya noted that small institutions have a limited pool of selection- if the pool is un-diverse, there's nothing that can be done about it.

Earth Science Advisory Committee (ESAC)

Dr. Tucker, Chair of the ESAC, reported that ESAC has had some turnover such that it is a largely new committee. Its last meeting spanned two full days in August. Nine topics were on the agenda, plus a briefing from the Applied Sciences Program. The Committee heard presentations on the status of ESD, Earth Systematic Missions and Explorers, Open Source Science, Earth Venture-class missions, Modeling Strategy Development, Decadal Survey Incubation Studies, DEIA (IDEA), Research and Applications Coordination, and the ESD Commercial Data Buy. ESD does have two current ROSES calls that are requiring inclusion plans; they will get feedback on whether the proposals are adequate in the IDEA domain. In the ESD Flight Program, there is a lot going on, with many missions in formulation. ESD had two recent launches: Joint Polar Satellite System (JPSS)-2, carrying a limb sounder, and the Earth Surface Mineral Dust Source Investigation (EMIT) instrument, which is studying dust in the Earth's atmosphere from the vantage point of ISS.

ESAC has issued no formal findings as yet, but the meeting discussion was dominated by the cultural shift in ESD, where there is emphasis on IDEA, as well as a new focus on observations, tracking climate change, and environmental justice. NASA is a leader in producing data sets that can be publicly accessed, to help different communities deal with important existential issues such as climate change, disaster, and food supply. Dr. Bakhtian noted that DOE is also focused on environmental justice with their Focus 40 program, using satellite data, and recommended that NASA partner with the Department of Energy (DOE) in this area. Dr. Tucker said that the United States Geological Survey (USGS) Landsat satellite is also a major source of this type of data.

ESAC is also concerned about burdens imposed by Open Source Science and IDEA, and has been pushing NASA to provide templates, proposal-writing workshops, etc. ESAC is also concerned that pilot programs may drop away, and urges continuity for these programs. The PI Launchpad has been quite successful; ESAC feels it should be increased in frequency, expanded, and held at HBCUs/MSIs. A proposal-writing workshop for ROSES proposals would be valuable, as would more emphasis on IDEA at Centers. The ESAC also discussed the paradigm shift that will be needed to incentivize Applied Science careers (replacements for the H number, e.g.). ESAC also held its GPRAMA exercise and voted Green for all goals. Mr. May observed that there seem to be questions about sincerity regarding the IDEA approach, and wondered whether it would be possible for the SC to have a session with HBCU/MSI community, primarily to listen and learn, and to allow an advisory committee to enumerate some of the opportunities, instead of NASA bureaucrats. Dr. Diniega agreed that the level of listening is important; NASA must authentically listen to and connect to the community it is trying to partner with. Dr. Barjatya cited Dr. Boyd's presentation, which showed low participation in the workshop from the HBCUs. It is imperative to get to the bottom of the reason why this participation was low. The Bridge Program might give some answers. Mr. May said that because the Bridge Program is a set-aside, it might be perceived as not serious; it might be taken more seriously if professionals from industry and academia on the SC could approach the community through the provosts of HBCUs/MSIs. Mr. May said that since he had joined Morgan State University, he had not always had the time to respond to some of the requests that have been levied on the proposals from IDEA/Open Source, for example.

<u>Findings & Recommendations Discussion</u>
Drs. Cerf and Diniega approved of the SMD Bridge Program concept; Dr. Diniega liked the level of listening, and wanted to hear more about how to measure impact. Dr. Barjatya asked for identification of metric types, and whether they should be measured across all programs, or inside programs. Dr. Bakhtian noted that there seemed to be a good level of engagement with the community, but challenges to the end goals were missing. This issue ties to metrics and how we know it's working. There is a lack of outreach to industry. In addition, $5M is not a lot, which speaks to the "sincerity" point made by Mr. May. Dr. Williams said that one goal of the Bridge Program was trying to discover Best Practices and share them; a positive aspect. Dr. Bakhtian asked: why is the Bridge goal getting more proposals by faculty members at HBCUs? Why so targeted? Dr. Barjatya said the Bridge seems to be a very university-centric program. Dr. Cerf commented that there is an equity problem at small institutions, with their small quantity of available students; NASA needs to recognize that small institutions must be carefully considered

and not be cut off by "best practices." Dr. Tucker added that there is also the importance of continuity (through SMD AAs, administrations).

The SC discussed carrying through concerns about the timing of the Decadal Survey with a finding and possible recommendation. The timing of the Surveys affects new starts, and is also affected by changing administrators, and finishing the program of record for the previous Survey. Mr. Weiser said there is also a shift in spacecraft accommodations and instrumentation, as the launch industry is moving to universal buses, etc.; it doesn't take as long as it used to take to put together some missions. Dr. Williams agreed, saying that the Decadal Survey mostly sets the tone for the large missions. Dr. Bakhtian requested a briefing on how technology is accelerating the possibilities for science missions. Dr. Barjatya suggested NASA make some requirements for instrument packages designed for a standard bus. He noted that GDC is going to be super expensive and slow because the "car" is being built from scratch, instead of picking and choosing what is available and customizing. Cubesats have changed the landscape, and can help science catch up with the lag time caused by the Decadal Survey. A good example of this strategy is the Sounding Rocket program; they have a standing supply of rockets, and all a proposer needs to do is pick the "car" and customize it. This strategy allows them to do 20 missions a year. Dr. Cerf said he resonated with the standardization argument, but some missions may be unique and require special attention and instrumentation; NASA should be careful not to overdo on standardization.

Dr. Barjatya suggested a finding on the Big Year of eclipses, the path of totality as opportunity for both STEM outreach and for DEIA.

Outbrief to DAA

The SC briefed out its results to Ms. Sandra Connelly, Deputy Associate Administrator (DAA) for SMD, who opened the discussion by referencing the successful launch of Artemis I, along with the six science instruments on the mission.

Dr. Williams offered bullet-point topics to Ms. Connelly:

- Resolution of thanks to Thomas Zurbuchen for his service as SMD AA
- Human Space Flight should be considered in science planning for the Decadal Surveys, if science is to be a focus of human space flight. Modality concepts are strong, but Modality 3 should be flipped to prioritize science.

Beyond ISS for BPS-

- BPS should think strategically about positioning itself to use the upcoming DS-
- Increase rapid turnaround of research
- Modularity
- IDEA should remain a strong consideration

IRBs

- IRBs should be used cautiously and conservatively- it is a blunt instrument
- Project Scientist should be assigned early in project lifecycle
- IRB input should flow to SRBs, frequency/timing of SRB input should be considered

- NASA should develop a broader "toolbox" for recruitment and retention of workforce, particularly for mid-career employees, including compensation, intellectual freedom, inclusivity (but not as a burden), value of work as opposed to quantity of work
- Hybrid environment highlighted the existing issues but was not the entire cause
- Have NASA Centers lost too much autonomy?

Ms. Connelly asked for elaboration about a loss of autonomy at Centers. Dr. Williams said that the feeling in the SC because everyone has a salary tied to a specific mission, it can tie hands. Ms. Connelly agreed that this situation could be related to the historical implementation of full-cost accounting (FCA) at NASA. Dr. Bakhtian said the IRB finding came with a caution against adding bureaucracy. Ms. Connelly said she wanted to share intent behind the recent IRBs, and that SMD was not planning to use IRBs as a big hammer. Typically IRBs are used between pre-phase A and phase A for every Flagship mission. The SMD intent is to structure these missions to be successful. One thing to know about the IRBs is that they are chartered by the Mission Directorate, and they are even more independent than SRBs. Dr. Williams said the Committee had appreciated that the SRB Chair was on the IRB. Ms. Connelly said she supported that statement. Dr. Tucker noted there had just been an IRB for the Earth Observing System (EOS). Ms. Connelly agreed, saying that SMD was setting it up for the integrated mission concept.

Dr. Williams reiterated that DART was a great example of a high-risk, high-reward mission, and that NASA should consider balancing these types of missions in its portfolio, also impressed that the mission included so many new concepts, including the late addition of the LICIACube.

Dr. Williams cited the SMD Bridge Program and asked on behalf of the SC if there was SMD-wide coordination re: inclusion plans in ROSES proposals as opposed to division-by-division implementation, and that additionally, the Bridge is a well thought-out and comprehensive program, and should be continued beyond Dr. Zurbuchen's tenure.

Dr. Williams discussed the issue of implementation through ROSES as presenting a barrier to smaller institutions, and that SC would formulate some type of recommendation on that problem. Dr. Bakhtian added that there was a concern about the lack of industry participation in the Bridge program, and that perhaps NASA might make the Bridge bigger with other agencies. Dr. Williams commented that $5M/year is relatively small amount, probably appropriate for a pilot, but still a small amount. In addition, the SC is concerned about individual PIs having to reinvent the wheel when putting inclusion plans in their ROSES proposals. It is the tenor of the SC that NASA should support these PIs with resources to help them design effective DEIA plans. Ms. Connelly asked if the SC had discussed any concerns about DEIA inclusions plans stifling the opportunity for new ideas. Dr. Diniega felt there was a realization that the inclusion plans are a little harder than data management plans; definitely will take more work in getting it understood; will take more time.

Dr. Williams described a potential finding/recommendation on the Decadal Survey getting out of sync with the budget process, sometimes acting as a straitjacket on budgets and programs. The timing can constrain what can be done.

Dr. Williams concluded with a finding that NASA take advantage of HPD's Big Year of eclipses; the SC feels this is a huge opportunity for getting resources to MSIs and HBCUs, drawing on the inspiration provided by these phenomena, carrying through continuity, and reaching a broader community.

Ms. Connelly said she appreciated the brain trust in the room, and was looking forward to next time.

Mr. Callahan adjourned the meeting at 12:07 pm.

SC Membership

Dr. Ellen D. Williams, Chair
University of Maryland

Mr. Jason Callahan, Designated Federal Officer
NASA Headquarters

Dr. Aroh Barjatya
Embry-Riddle Aeronautical University

Dr. Vinton G. Cerf
Google

Mr. Marc Weiser
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Dr. Linda Godwin
University of Missouri

Dr. Willie May
Morgan State University

Dr. Noël Bakhtian
Lawrence Berkeley National Laboratory Energy

Dr. Sara Tucker
Ball Aerospace and Technologies Corporation

Dr. Serina Diniega
Jet Propulsion Laboratory

Dr. Charles “Chick” Woodward
University of Minnesota

Appendix C
Presentations

1. Science Mission Directorate; *Thomas Zurbuchen*
2. Beyond ISS for Biological and Physical Sciences; *Craig Kundrot*
3. Cross-Cutting Comments from SMD's IRBs (Psyche and GDC); *Orlando Figueroa*
4. DART Update; *Bobby Braun, Elena Adams, Nancy Chabot*
5. SMD Bridge Program; *Padi Boyd*