



Workshop Series on Issues in Space Science and Technology: Summary of Space and Earth Science Issues from the Workshop on U.S. Civil Space Policy

Bernard A. Fisk, Rapporteur, National Research Council
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Workshop Series on Issues in Space Science and Technology

Summary of Space and Earth Science Issues from the Workshop on U.S. Civil Space Policy

Lennard A. Fisk, Rapporteur

Space Studies Board

Division on Engineering and Physical Sciences

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Preface

In response to a request from the NASA Associate Administrator for the Science Mission Directorate, S. Alan Stern, it was decided that the Space Studies Board would hold workshops in conjunction with its November 2007, March 2008, and June 2008 board meetings. Summary reports from these workshops will be prepared by a rapporteur and published as part of a series entitled “Workshop Series on Issues in Space Science and Technology.” (See Appendix A.) A planning committee appointed to organize the series of workshops will not participate in the writing of the three workshop reports, which will summarize what transpired but will not offer advice or recommendations.¹ The purpose of the reports is to provide a brief, timely summary of space science (including Earth observations) and technology issues with immediate relevance as discussed at the workshops.

This report is the first in the series. It follows the November 29-30, 2007, SSB board meeting, which had previously been organized to include a separate workshop, the Workshop on Civil Space Policy (see Appendix B), planned by a separately appointed committee, and slated to be summarized in a separately published workshop report that is currently in preparation and will cover the entire discussion at the workshop. This report, by contrast, is limited to a brief summary of those issues raised at the workshop that are relevant to space and Earth science.

¹ The members of the planning committee are A. Thomas Young, Lockheed Martin Corporation (retired), *Chair*; Daniel N. Baker, University of Colorado; Charles L. Bennett, Johns Hopkins University; Molly Macauley, Resources for the Future, Inc.; Berrien Moore III, University of New Hampshire; Kenneth H. Nealson, University of Southern California; James Pawelczyk, Pennsylvania State University; and Charles E. Woodward, University of Minnesota.

Acknowledgment of Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Lewis M. Branscomb, University of California, San Diego,
Alexander H. Flax, Institute for Defense Analyses (retired),
Robert A. Frosch, Harvard University,
George M. Hornberger, University of Virginia,
Molly Macauley, Resources for the Future, Inc., and
George Paulikas, The Aerospace Corporation (retired).

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by W. Carl Lineberger, University of Colorado at Boulder. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the author and the institution.

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Space and Earth Science Issues from the November 29-30, 2007, Workshop on U.S. Civil Space Policy

THE WORKSHOP ON U.S. CIVIL SPACE POLICY IN RELATION TO THIS REPORT

The November 2007 Space Studies Board (SSB) workshop on U.S. Civil Space Policy took place almost exactly 4 years after an SSB workshop on a similar topic—the Workshop on Issues and Opportunities Regarding the U.S. Space Program, held on November 12-13, 2003. The 2003 workshop occurred in the aftermath of the space shuttle *Columbia* accident, when it was becoming widely acknowledged that the human spaceflight program lacked direction. Some of the space program's leaders, from academia, industry, and past government service, gathered at the 2003 workshop to discuss what factors were considered both necessary and sufficient in setting a comprehensive policy for civil space in the United States. The report of the 2003 workshop² was issued on the morning of January 14, 2004, the very day that President George W. Bush announced his Vision for Space Exploration,³ and the accompanying new goals for space science and technology, in a speech at NASA headquarters.

There were strong similarities between the president's new Vision and the policies articulated by the 2003 workshop participants, with much of that workshop discussion focusing on a rationale for how human and robotic exploration could go forward in synergy.

The November 2007 workshop was designed as an opportunity to assess where the Vision for Space Exploration, and U.S. civil space policy in general, stand today. The present report, which summarizes opinions relevant to space and Earth science issues expressed by individual workshop participants, does not necessarily reflect the consensus views of these participants, the SSB, or the workshop planning committee.

The expertise of the approximately 60 workshop participants spanned the fields of human space exploration, space science, and commercial space, as well as science and technology policy, economics, international relations, and history. Participants came from the ranks of academia, industry, government, and the media. The discussion covered government and commercial space activities in human spaceflight and in space and Earth science, including programs at the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA).

The workshop was organized into panel sessions as shown in Appendix B and was structured to promote active dialogue among the entire audience rather than as a series of presentations followed by question-and-answer sessions. The first half-day was devoted to a situational assessment of where the civil space program is today compared to November 2003 and a review of the broader national and international context for the space program. The second day featured four sessions addressing (1) sustainability issues and options for solutions, with a focus on affordability, public interest, and political will; (2) program balance issues within NASA and in relation to other agencies, and options for solutions; (3) NASA and NOAA roles and responsibilities in Earth observations; and (4) meeting needs for space infrastructure and capabilities. Some of the sessions focused more than others on issues of interest to NASA's Science Mission Directorate and hence receive more attention in this report, because, as noted

² National Research Council, *Issues and Opportunities Regarding the U.S. Space Program: A Summary Report of a Workshop on National Space Policy*, The National Academies Press, Washington, D.C., 2004.

³ The Vision for Space Exploration initiative, announced by President George W. Bush on January 14, 2004, is outlined in *The Vision for Space Exploration*, NP-2004-01-334-HQ, NASA, Washington, D.C., 2004.

above and in the Preface, this report summarizes only the issues and discussion that were of particular relevance to space and Earth sciences at NASA. Thus a number of other space policy issues that were discussed at the workshop are not covered here, or are only mentioned briefly. The full range of issues discussed will be reflected in a separate, more complete report currently being prepared to summarize the Workshop on U.S. Civil Space Policy.

The workshop opened with comments from the chair of the Space Studies Board, Lennard Fisk, and the chair of the Aeronautics and Space Engineering Board, Ray Colladay. Dr. Fisk noted that although the report covering the full workshop would be a summary only, without findings and recommendations, it would serve as input to another National Research Council (NRC) study, "Critical Issues in U.S. Space Policy," that will commence in January 2008. The report of the Critical Issues study is scheduled for release in April 2009; it will offer findings and recommendations.

SUMMARY OF DISCUSSIONS OF PARTICULAR INTEREST TO NASA'S SCIENCE MISSION DIRECTORATE

Overall, as noted by the participants themselves, the tone of the workshop was surprisingly sober, with frequent expressions of discouragement, disappointment, and apprehension about the future of the U.S. civil space program. During the one and one-half days of discussion, an often-repeated statement by workshop participants was that the goals of the U.S. civil space program are completely mismatched with the resources provided to accomplish them. The moderator of the "Situational Assessment" session, A. Thomas Young (Lockheed Martin, retired), commented that there is either too much program for the budget or not enough budget for the program. He added that the probability of obtaining a larger budget is low, but no one is stepping forward to identify how to reduce the program content. Other participants made reference to the NRC 2006 report *An Assessment of Balance in NASA's Science Programs*, whose number-one finding was that "NASA is being asked to accomplish too much with too little."⁴

Day One

During the first day a number of prominent themes emerged from the two panel discussions, including the question of robustness in the civil space program, budget realism, public support, and the emerging role in space of countries such as China. For the day's first session, "Situational Assessment," the panel members were Bretton Alexander of the X Prize Foundation, Fiona Harrison from the California Institute of Technology, and James Zimmerman of International Space Services, Inc. During the panel's discussions, several members of the space-based astronomy and astrophysics community noted the challenges that have resulted from the most recent NRC decadal survey on astronomy and astrophysics⁵ because the cost estimates provided by NASA for the various projects under consideration by the NRC were too optimistic. One comment was that future decadal surveys need to include program managers and cost analysts in addition to scientists, as was done with the recent NRC study on the Beyond Einstein missions,⁶ to ensure more realistic predictions of what future missions might cost.⁷ Another comment

⁴ National Research Council, *An Assessment of Balance in NASA's Science Programs*, The National Academies Press, Washington, D.C., 2006, p. 29.

⁵ National Research Council, *Astronomy and Astrophysics in the New Millennium*, The National Academies Press, Washington, D.C., 2001.

⁶ National Research Council, *NASA's Beyond Einstein Program: An Architecture for Implementation*, The National Academies Press, Washington, D.C., 2007.

⁷ This viewpoint was also a major theme that emerged from the 2006 SSB workshop on decadal surveys. See National Research Council, *Decadal Science Strategy Surveys: Report of a Workshop*, The National Academies Press, Washington, D.C., 2007.

was that when a sudden change occurs in projections of the resources available to meet the priorities set by decadal surveys, as recently happened with the science budget at NASA, the agency should call on its internal scientific advisory committees to determine how best to change course.⁸ However, in that case, those advisory committees were not in place at the critical moment. The problem was not so much the amount of funding available to do scientific missions, but the sudden change in direction.

In additional discussion one workshop participant suggested that using humans to assemble scientific infrastructure in space, such as large space telescopes, would change the paradigm of how we work in space. Others championed small missions for space science, arguing that a program dedicated only to large projects would stifle creativity.

A significant portion of the discussion focused on the status of the Vision for Space Exploration 4 years after it was announced. As recounted during the panel discussion in the “Situational Assessment” session, the Vision originally stipulated that human and robotic exploration of the solar system would go forth synergistically; that the space science program would prosper along with human spaceflight; and that a human spaceflight journey would be undertaken that would start with a return to the Moon and then move on to Mars and beyond.⁹ Construction of the International Space Station (ISS) would be completed and utilized to facilitate that longer journey into space, although U.S. use of the ISS would be terminated earlier than planned,¹⁰ as would the space shuttle system (in 2010), in order to make those funds available for accomplishing the Vision. One panelist expressed optimism that the ISS would be successful and would not, in fact, be discontinued early. He emphasized the advantages of the international partnership developed for the ISS, noting that by not characterizing the ISS as the first step in the Vision, NASA had lost an opportunity to “grandfather” the ISS partners into the Vision. He contrasted NASA’s approach with that used by NOAA in leading the creation of the Global Earth Observation System of Systems (GEOSS) effort. In his view, NOAA has been successful in crafting a broad international program even though many of the participating countries do not agree with the U.S. stance on global climate change.

Participants discussed at length their views that implementation of the Vision has not lived up to its original objectives or its promise, indicating that this was so primarily because NASA has not been provided with the necessary resources to accomplish the new goals. Many participants reiterated throughout the workshop that the inadequacies of the NASA budget, either what has been requested by the Bush Administration or appropriated by Congress, have made the Vision unrealistic, unsustainable, or unachievable.

A prevalent theme was how funding constraints have negatively affected every aspect of NASA’s activities, whether in human spaceflight, space and Earth science, or aeronautics. Consequently, many workshop participants argued that rather than synergy having been achieved between science and human spaceflight, as was once envisioned, the gap is now wider than ever. Importantly, despite considerable discussion on this issue by workshop participants, almost no one expressed the view that the plans¹¹ for the return to the Moon would succeed at current funding levels. One participant, however, felt that the Vision could succeed. Drawing on his knowledge of the crafting of the Vision when he worked for the government, he argued that the Vision could be accomplished within NASA’s current budget, but only if it was not conducted as “business as usual.”

However, the more widespread point of view was that the program is not executable. The panel moderator emphasized that there is an imbalance between the size of the program and the resources that have been allocated and stated, “This train wreck has a probability of 100 percent.”

⁸ This viewpoint was also noted in the 2006 SSB *Balance* report. See National Research Council, *An Assessment of Balance in NASA’s Science Programs*, The National Academies Press, Washington, D.C., 2006.

⁹ The Vision for Space Exploration initiative, announced by President George W. Bush on January 14, 2004, is outlined in *The Vision for Space Exploration*, NP-2004-01-334-HQ, NASA, Washington, D.C., 2004.

¹⁰ A budget chart released the day the Vision was announced showed U.S. support for the ISS ending in FY 2017.

¹¹ Current plans call for the Moon to be used as a significant test bed for human spaceflight to Mars and beyond, or as a scientific research site.

The panelists for the afternoon session, “National and International Context,” were journalist and author Guy Gugliotta, Joan Johnson-Freese of the Naval War College, and Roger Launius of the National Air and Space Museum. The panel was moderated by Charles L. Bennett of Johns Hopkins University. This panel discussion began with an observation that the Vision did not create a clear, well-articulated geopolitical role for NASA, as had been true during the Apollo era. One panelist discussed the Chinese space program and whether China was now attempting to compete with the United States. She and others at the workshop cast doubt on Western media reports that China is intent on sending humans to the Moon in a “race” with the United States, stressing that official Chinese space policy calls for robotic missions only to the Moon through the end of the next decade. She added that the Chinese human spaceflight program and its robotic lunar exploration program are almost competitive within the Chinese space program. The United States, she argued, has missed an opportunity to use the space program to improve its image as a “benevolent hegemon” instead of a “unilateral hegemon.” A benevolent hegemon, she argued, would focus on being a world leader in creating programs that would benefit all.

Day Two

One goal of the second day of the workshop was to stimulate discussion about potential solutions to problems identified during the first day. The first two sessions thus returned to exploring questions about available resources, the role of U.S. leadership, and goals for the entire civil space program. For the first session, “Sustainability Issues and Options for Solutions,” the panelists were independent consultant Paul Carliner, George A. Paulikas (Aerospace Corporation, retired), former NASA Administrator Richard Truly, and George T. Whitesides of the National Space Society. The panel was moderated by James Pawelczyk of Pennsylvania State University. The panelists for the session titled “Balance Issues and Options for Solutions” were Tamara Jernigan of Lawrence Livermore National Laboratory, Charles F. Kennel of the Scripps Institution of Oceanography, and Lori B. Garver of the Avascent Group. The panel moderator was former astronaut Charles Bolden, Jr., of Jack and Panther, LLC.

During the later “Civil Government Missions in Earth Observations” session, the discussion picked up on the theme of the space program once again playing a prominent geopolitical role by providing the scientific data on which to base policies regarding global climate change. The panelists for this discussion were former congressional staffer Johannes Loschnigg, Berrien Moore of the University of New Hampshire, and Soroosh Sorooshian of the University of California, Irvine. The panel moderator was Jack D. Fellows of the University Corporation for Atmospheric Research. One session panelist argued that all the citizens and all the countries of the world are in need of sound scientific information and reliable predictions of regional consequences of climate change on which to base policies that will protect our future, and that NASA is the U.S. government agency that has the technical capability to lead this global mission.

Overall, however, the tone of the discussion in the “Civil Government Missions in Earth Observations” session also was pessimistic. Panelists discussed the troubled NASA-NOAA-Department of Defense (DOD) National Polar-orbiting Operational Environmental Satellite System (NPOESS) program and NOAA’s Geostationary Operational Environmental Satellite series R (GOES-R) program. One panelist noted that the roles of NASA as developer of cutting-edge technology for Earth observation missions and of NOAA as the operational agency have not meshed well in practice.¹² NOAA’s focus necessarily is on weather forecasting and not on climate measurements, so when the NPOESS and GOES-R programs each encountered significant cost overruns, NOAA (and DOD) cut the instruments intended

¹² See also National Research Council, *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond*, The National Academies Press, Washington, D.C., 2007, and National Research Council, *Satellite Observations of the Earth’s Environment: Accelerating the Transition of Research to Operations*, The National Academies Press, Washington, D.C., 2003.

to perform climate measurements. When the Tropical Rainfall Measuring Mission (TRMM) reached the end of its extended mission and NOAA wanted it to be further extended, NASA initially refused to do so unless NOAA provided the funding. One participant noted that President Bush's 2006 national space policy¹³ called for greater cooperation and coordination between the two agencies, but that the policy had not worked. Another participant expressed the viewpoint that, given the decline in Earth science funding in NASA over the past decade, the Earth science community is somewhat dysfunctional and may not be able to respond effectively to a major initiative in the new federal administration.

In addition to discussions of Earth observation programs and the space program's potential geopolitical role, Day Two involved considerable discussion of how to maintain interest in the goals enunciated in the Vision.

The day's final panel session was titled "Capabilities and Infrastructure." The panelists were John M. Klineberg (Space Systems/Loral, retired), Thomas H. Zurbuchen of the University of Michigan, and Ian W. Pryke of George Mason University; the panel was moderated by Raymond Colladay (Lockheed Martin Astronautics, retired). One member of the panel likened the Vision to the "emperor's new clothes," concluding his presentation with the observation that there was no national will to support the Vision and citing examples of how, lacking sufficient funding, NASA was abdicating its responsibilities in space and Earth science, as well as in aeronautics.

Another focus of the panel discussion was concern that the goals in the Vision do not appeal to the generation that will be called on to execute it—those now under 30 years old. Noting that the under-30 generation lives in a world of instant communications and is comfortable with information technologies that allow participation in events on a more personal level, a workshop participant commented that the under-30 generation appears more interested in the robotic Mars Rovers than with the slow-motion choreography of an extravehicular excursion by an astronaut.

Conversely, a panelist in the earlier "Balance" session who was also a former astronaut recounted experiences in trying to connect with young people by offering to talk to school groups. She said that she found significant interest if she explained that she was a scientist, but once she revealed that she was an astronaut, the level of interest increased dramatically and schools were very anxious to invite her to speak. Thus, she concluded that youth do connect with the space program through the excitement stimulated by the human spaceflight program, possibly because they envision themselves as someday venturing into space.

Other participants countered, however, that the younger generation may find astronauts working on the Moon no more interesting than they appear to find astronauts building or working in the ISS. There was a perception on the part of these workshop participants that although astronauts might appeal to younger children, as well as to older policy makers who hearken back to the excitement of the Apollo era, they may hold less attraction for the technically savvy 18- to 24-year-olds who will be needed to execute the Vision. A member of the "Capabilities and Infrastructure" session reviewed polling data showing that the 18-24 age group is not interested in sending people to the Moon or Mars. This present-day situation was contrasted with the Apollo era and the fact that much of the Apollo program was carried out by engineers and scientists who were in their 20s—and who, by today's standards in NASA, were exceptionally young to have had such responsibility and authority. One participant argued that young people need to be given a chance to make creative and innovative contributions when working on space programs, or they will not choose to pursue careers in space science.

¹³ President George W. Bush authorized a new national space policy on August 31, 2006, that establishes overarching national policy that governs the conduct of U.S. space activities. The U.S. National Space Policy is available at <http://www.ostp.gov/html/US%20National%20Space%20Policy.pdf>.

SYNTHESIS AND WRAP-UP

The final session of the workshop provided an opportunity for every workshop participant to make one comment. Most participants reiterated points they had made earlier, focusing again on the mismatch between NASA's assigned responsibilities and its resources, and the need for leadership. Collectively, these participants expressed surprise at the "grim attitude" that pervaded the workshop.

However, a few participants who had been less vocal used this opportunity to share countervailing viewpoints. One participant, a former reporter for the *Washington Post*, stated that he was "distressed by the level of defeatism" and surprised that so many of the participants expressed the opinion that space activities had become boring. He added, "I have covered a lot of bureaucracy and you don't know boring. This is space. Even on its worst day, space is interesting." A non-U.S. participant thought it ironic that the Americans at the workshop didn't seem to appreciate that the United States is leading the world in science and technology, and has been doing so since World War II. One participant commented that he was "astonished and disappointed" that the group was dwelling on problems and that he did not see the fortitude to do what needs to be done. He argued that NASA and the science program are both productive, and that "we're the best in the world at what we do." He called for political will and leadership, and said that "we need to turn around our thinking."

The workshop did not identify specific solutions to the dilemmas with current space policy, other than to flag some of the potential corrective actions mentioned above, such as giving NASA a compelling geopolitical role (e.g., providing leadership in using space science and technology to address global issues such as climate change or energy resources). The need to identify solutions was articulated by several participants, but such identification was beyond the scope of this workshop.

Appendixes

A

Statement of Task

Issues in Space Science and Technology: Workshop Series

An ad hoc committee under the auspices of the Space Studies Board will organize a series of public workshops summarizing space and Earth science and technology issues. These issues will be discussed at workshops convened to complement Space Studies Board meetings in November 2007 (which will focus on critical issues in U.S. space policy), March 2008 (which will focus on the FY2009 President's budget request for space and Earth science), and June 2008 (which will focus on the status of space and Earth science projects and funding).

An individually authored summary of each workshop will be prepared in accordance with institutional guidelines.

B

Workshop on U.S. Civil Space Policy Agenda and Participants

Beckman Center, Irvine, California

AGENDA

November 29, 2007

- 1:30 pm Welcome, Introductions, Workshop Objectives *R. Colladay and L. Fisk*
- 2:00 pm Situational Assessment *Moderator: T. Young*
- Panelists: B. Alexander, F. Harrison, J. Zimmerman*
- Key changes and developments since 2003, such as the following:
- Confronting a fundamental lack of financial robustness in the overall civil space program
 - Progress to date and challenges ahead for the Vision for Space Exploration
 - Emergence of China as a space contender as other international players also continue to become more independent and competitive
 - NPOESS and GOES-R program crises in U.S. Earth observations program
 - Evolution in public and political views about climate change
 - Budgetary and political developments and their impact on the current environment
- 3:15 pm Break
- 3:30 pm National and International Context for Space *Moderator: C. Bennett*
- Panelists: G. Gugliotta, J. Johnson-Freese, R. Launius*
- Are the expectations of space program advocates out of step with reality with regard to NASA's position in the national agenda?
 - Where does NASA sit in the larger national and international context?
 - How important are civil space activities to broad national goals to promote national security, societal and cultural benefits, scientific and technological advancement, commercial competitiveness and economic benefits, and international relations?
 - What are the relationships between U.S. national space goals and those of other countries, and where are there current and future opportunities for cooperation and synergism?
 - How important to U.S. space exploration are the stated intentions of China and Russia for exploitation of the Moon?
- 6:00 pm Reception and Dinner

November 30, 2007

- 8:30 am Sustainability Issues and Options for Solutions: *Moderator: J. Pawelczyk*
Affordability, Public Interest, and Political Will
Panelists: P. Carliner, G. Paulikas, R. Truly, G. Whitesides
- How can expansive expectations for the total content of the civil space program be reconciled with realistic expectations for total program resources?
 - What is required to ensure that national goals for human space exploration are sustainable?
 - Are there proven strategies for ensuring sustainability for large federal programs?
- 10:15 am Break
- 10:30 am Balance Issues and Options for Solutions *Moderator: C. Bolden*
Panelists: T. Jernigan, C. Kennel, L. Garver
- How should decision makers assess an appropriate balance between NASA's programs (or do we mean "responsibilities" or "investments"?) in human spaceflight versus science versus aeronautics?
 - Is "balance" the same as "investment portfolio mix"?
 - What are appropriate criteria or metrics for achieving "balance"?
 - Roles of NASA versus roles of others
 - What are the appropriate roles of NASA vis-à-vis other government agencies?
 - What are the appropriate roles of the federal government vis-à-vis the private sector?
- 12:15 pm Lunch
- 1:30 pm Civil Government Missions in Earth Observations *Moderator: J. Fellows*
Panelists: J. Loschnigg, B. Moore, S. Sorooshian
- What should be NASA's role in helping NOAA acquire the data needed to assess global climate change?
 - What are the appropriate roles and responsibilities of NASA, NOAA, and other agencies in Earth observations from space?
- 2:15 pm Capabilities and Infrastructure *Moderator: R. Colladay*
Panelists: J. Klineberg, T. Zurbuchen, I. Pryke
- Are there critical unmet needs or anticipated needs that should be addressed to give the United States the capability to achieve its civil space goals, and what strategies are needed to meet expected long-term needs?
 - U.S. space industrial base, NASA centers, and academia
 - Access to space
 - Technology development
- 3:15 pm Break
- 3:30 pm Synthesis and Wrap-up: Summary Comments *Moderator: R. Colladay*
by a Small Panel of Speakers Plus Plenary Discussion

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