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Aeronautics and Space Engineering Board News

Welcome to the latest installment of the ASEB News! This newsletter will update you on ASEB events and activities, as well as policy items of interest to the aerospace community.

Inside this issue:

New Decadal Survey Defines the Renewal of a Life and Physical Sciences Research Program at NASA

On April 4, 2011, the Committee for the Decadal Survey on Biological and Physical Sciences in Space released its report, *Recapturing a Future for Space Exploration: Life and Physical Sciences Research for a New Era*, after nearly two years of study and with the input of close to 70 committee and panel members, 40 reviewers, and 12 staff members. Co-chaired by Elizabeth Cantwell and Wendy Kohrt, the report makes a wide range of programmatic and technical recommendations to re-establish a robust life and physical sciences research program in space.

Introduction

While great strides have been made in human space exploration since the dawn of the space age, further progress will require overcoming substantial scientific and technical challenges. The scientific agenda for meeting these challenges can also have substantial terrestrial benefits. To help set this agenda, Congress in the FY2008 Omnibus Appropriations Act directed NASA to request from the NRC a "decadal survey" of life a physical sciences research in microgravity and partial gravity environments. Among other things, this study was to define research areas, recommend a research portfolio and timelines, identify terrestrial benefits, and specify whether the results of the research would directly enable exploration or produce fundamental new knowledge.

A copy of the decadal survey can be purchased, or downloaded as a PDF document for free, from <http://www.nap.edu/catalog.php?record_id=13048.>.

Findings and Recommendations

Since its inception, NASA's progress in human space exploration has depended on its ability to overcome a wide range of biomedical, engineering, and physical science challenges. In the past decade, however, the agency's life and physical science research program has declined substantially, leaving it in a poor position to continue that progress and take advantage of the fully equipped International Space Station (ISS). Nevertheless, a focused science and engineering program can make possible the achievements needed to ensure that the nation is ready for the next significant phase of human spaceflight. This report presents an examination of the science and technology that can bring about these achievements such as a deeper understanding of the role of gravity in the regulation of biological systems, production of large amounts of water from extraterrestrial sources, and research on fire safety and regenerative fuel cells. The assessment has two foci: research that *enables* space exploration and research that is *enabled by* access to space.

Programmatic Issues—Currently, life and physical science research has no clear institutional home at NASA. Successful renewal of such research requires high-level, strong leadership that facilitates the necessary research and integration with the mission activities. Life and physical science research should be central to NASA's space exploration mission and integral to spaceflight operations. In addition, a renewed stable funding base for this research is essential, and the budget must be sufficient, sustained, and appropri-

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Board Members

From the Chair: Planned Study on Human Spaceflight

Raymond S. Colladay

Presently, there are five ongoing studies underway at the ASEB that promise to shape and impact program decisions of our sponsors in the federal government. More are being planned for next year. The ASEB/SSB NASA Technology Roadmap Study for the agency's Office of the Chief Technologist is in full stride with six panels and a steering committee addressing 14 technology roadmaps. To kick off the effort, NASA provided a comprehensive set of draft roadmaps that served as the starting point for the NRC study. We will release an interim report to NASA mid-year and a final report early next year. The link to each of the Draft Technology Roadmaps is http://www.nasa.gov/offices/oct/home/roadmaps/index.html. An important aspect of the review is providing an opportunity for public comment, as well as an evaluation of the roadmaps using the same evaluation criteria that the study members use to prioritize all the technologies in the roadmaps. In addition the study has asked the public to provide comments on technologies that are considered missing from the initial draft roadmaps. When it comes to public outreach to the technical community, no matter how extensive and complete the website is to collect public input from the technical community, no one will know it is there and how to access it unless a campaign of active networking, press announcements, media advisories, and the newer medium for networking and information transmittal like blogs, Twitter, Facebook, and other similar means are fully utilized.

Other ongoing studies that are works-in-progress in various stages are:

- **Flight Research** – an assessment of aeronautics flight research activities at NASA
- **Orbital Debris** – a review of NASA's micrometeoroid and orbital debris programs
- **Spaceflight Crew Operations** – an assessment of the spaceflight crew operations office
- **Astrodynamics Standards** – an assessment of the astrodynamics standards and their effectiveness in meeting mission performance needs
- **Proposal Review for the 2011 Ohio Third Frontier Wright Projects Program** – a study to identify proposals that best meet the scientific, technical, and commercialization criteria of the award program for the State of Ohio

More details on these studies can be found on page 10 of this newsletter.

In addition to these ongoing studies, we are working with the Space Studies Board to define the statement of task for a major new study on human spaceflight to get underway before the end of the year. The NASA Space Authorization Act of 2010 called for a decadal-like study by the National Academies to begin in fiscal year 2012. It would be a joint effort of the ASEB and SSB to provide a comprehensive engineering- and science-based assessment to support NASA and the decision-makers with options and recommendations toward the best path forward for the country's human spaceflight program. It would not be a decadal survey per se, because those are typically undertaken for the space science programs. In many respects, calling this a "generational survey" more accurately conveys the scope and span of what we have in mind. Planning for the study was a major topic of discussion at the recently held joint Board meeting of the ASEB and SSB. During the meeting, we heard from the leadership of NASA and had discussions with staff from Congress and the Executive Office of the President.

The scope of a generational study of human space exploration would necessarily be broader than a typical ASEB or SSB study, drawing on the full breadth of expertise of the National Academies. There are many stakeholders and constituencies who will have their voices heard at appropriate points in the study. But within this broad context, we need to keep focused on the thing that makes us credible: a sound technical assessment of options going forward, formed by building a broad consensus from the engineering and science community characteristic of NRC studies, so that when final decisions are made

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From the Chair: New Technology for a New NASA

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through the political process, Congress and the Administration have the benefit of a well-considered technical and scientific rationale for their decision.

Returning to the bigger picture of the broad scope of work currently being undertaken by the ASEB, we are at a point in time where input from our NRC studies can help provide NASA with options and recommendations as it considers the best choices for the country's aeronautics and space programs in a time of scarce resources. These reports can have an impact going forward on the shape of the agency, the expanding commercial sector, the aerospace industrial base, academia, international partnerships, and the expectations and support of the general public.

"We are at a point in time where input from our NRC studies can help provide NASA with options and recommendations as it considers the best choices for the country's aeronautics and space programs in a time of scarce resources."

Raymond S. Colladay
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James Reuther of NASA's Office of the Chief Technologist briefs the Roadmap Steering Committee and members of the six technology panels on January 26, 2011 in Washington, DC.

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Director's Corner

Michael Moloney

For the third year in a row the ASEB and SSB held one day of their respective Spring meetings in a joint session on April 6, and once again this unique event provided a unique forum for a dialogue among the experts on the two boards, the leadership at NASA, and staff from Capitol Hill and the Executive Office of the President. The keynote element of the day's agenda was when NASA Administrator Major General Charlie Bolden (U.S. Marine Corps, retired) was gracious enough to spend more than 90 minutes attending the meeting.

The Administrator opened the session by giving a short overview of the FY 2012 budget request. He stressed that, while these are difficult fiscal times, NASA should still be able to fly out the space shuttle safely, operate the ISS, and develop a new transportation infrastructure—all in the context of the new NASA vision, as embodied in the recently released Strategic Plan.

In response to questions, the Administrator stressed that NASA is adopting a capabilities strategy regarding exploration—that is, developing what is needed (enabling technologies and systems) for where NASA wants to go. For a first "target" the President had spoken of an asteroid rendezvous by 2025 and getting humans to Mars by the mid-2030s and developing the capability to land there. The Administrator told the ASEB and SSB that NASA will have an architecture this summer that will lay out a plan using existing assets to the greatest possible extent. He added that this architecture must be affordable, sustainable over multiple Congresses and Administrations, and realistic.

Turning to the science program, the Administrator reported that Earth Science program was recovering from the recent loss of the Glory mission, as well as the earlier OCO mission. He also noted that NASA is looking into the use of the ISS as a platform for Earth science.

On the future of the James Webb Space Telescope, the Administrator noted that NASA is looking at a variety of options, from flat funding to additional funding. Significant management changes have been made both at NASA and by the contractors, and he reported that a realistic launch date for JWST would be 2018. Currently, NASA is trying to identify incremental budget increases to achieve JWST program stability and a clearly defined launch date.

On the Planetary Sciences program, the Administrator noted that at a recent bilateral meeting with ESA on Mars exploration, both sides have recognized that they have budget limitations and have agreed that they will have to de-scope their planned missions to keep them affordable and sustainable while still working together on a joint Mars program.

Speaking about the Astrophysics program, the Administrator noted that the Astro2010 decadal survey listed WFIRST as a critical flagship mission, but that in the current fiscal and programmatic context he forecasted that the mission would probably not fly until the 2020's. Meanwhile, ESA is considering a dark energy mission, Euclid, and if that mission emerges from ESA's m-class competition, ESA has indicated that it will then be prepared to discuss NASA involvement in that mission further.

The Administrator was asked what the design reference missions for heavy lift and the multiple-purpose crew vehicle will look like. He replied that the current focus is on a space shuttle-derived configuration for the launcher and an Orion-based configuration for the vehicle. But he added that the resulting configuration may not look anything like the vehicles that will actually fly. He also noted that, while it is true that a deep space vehicle can go to the ISS in principle, it is a very inefficient approach, since it is cheaper in the longer term to design a vehicle for a specific task.

Finally, when asked about what advice he had for the upcoming NRC study on long-range goals for the

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Administrator Bolden talks with the ASEB and SSB on April 6, 2011, in Washington, DC.

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human spaceflight program, he noted that if the program does not know where we are going, we cannot decide what capabilities are needed, and we will "look like we are playing in a sandbox". He stressed that international engagement will be absolutely critical to the future of human space exploration, and for the program to be successful public engagement will also be critical, as will demonstrated affordability. He finished the session by urging the NRC to be honest in the study: "If the baby is ugly, tell us."

I left the session with the Administrator struck by the continuing complexity of the policy and budgetary contexts in which the ASEB and SSB conduct their work. Although we are cognizant of these important issues and their impact, our study committees are challenged to respond to the tasks they have been asked to address without too much speculation on possible outcomes. It is a sign of the strength of the NRC process that we manage time and again to stay focused on providing advice that is clearly based on the engineering and science foundations of our work.

Michael H. Moloney
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ASEB Calendar—Spring/Summer 2011

May 9-11	NASA Technology Roadmap: Propulsion and Power Panel Meeting 2: Washington, DC.
May 10-12	NASA Technology Roadmap: Instruments and Computing Panel Meeting 2 and Workshop: Washington, DC.
May 16-17	NASA Technology Roadmap: Materials Panel Meeting 2: Irvine, CA.
May 16-17	NASA Technology Roadmap: Entry, Descent, and Landing Panel Meeting 2: Washington, DC.
May 18-20	NASA Technology Roadmap: Steering Committee Meeting 2: Washington, DC.
May 18-20	Committee on Spaceflight Crew Operations Meeting 3: Woods Hole, MA.
June 1-3	NASA Technology Roadmap: Human Health and Surface Exploration Panel Meeting 2: Irvine, CA.
June 14-16	NASA Technology Roadmap: Instruments and Computing Panel Meeting 3: location TBD.
June 20-21	NASA Technology Roadmap: Materials Panel Meeting 3: Woods Hole, MA.
June 21-22	NASA Technology Roadmap: Robotics, Communications, and Navigation Panel Meeting 3: Woods Hole, MA.
June 22-23	NASA Technology Roadmap: Entry, Descent, and Landing Panel Meeting 3: Woods Hole, MA.
July 6-8	NASA Technology Roadmap: Human Health and Surface Exploration Panel Meeting 3: Washington, DC.
July 11-13	NASA Technology Roadmap: Propulsion and Power Panel Meeting 3: Irvine, CA.

For updates to the ASEB calendar, please see http://www.national-academies.org/aseb

The ASEB Welcomes New Board Members and Staff

The Aeronautics and Space Engineering Board is pleased to welcome seven new members to the Board. The Board is made up of experts in aeronautics, space engineering, and complementary disciplines. Members serve staggered terms. Full biographical information is available on our website at <http://www.national-academies.org/aseb>. In addition, we welcome two new staff members: Dwayne Day, a senior program officer transitioning from the SSB to the ASEB, and Amanda Thibault, a new research associate.

New Members

Lester Lyles, USAF (RET.) (NAE), *Vice Chair*, is a consultant with The Lyles Group. He retired from the U.S. Air Force (USAF) in 2003 as commander of the Air Force Material Command at Wright-Patterson Air Force Base (AFB). General Lyles entered the USAF in 1968 as a distinguished graduate of the Air Force ROTC program. He served in various positions, including program element monitor of the Short-Range Attack Missile at USAF Headquarters (USAF/HQ), special assistant and aide-de-camp to the commander of Air Force Systems Command (AFSC), chief of the Avionics Division in the F-16 Systems Program Office, director of Tactical Aircraft Systems at AFSC headquarters, and as director of the Medium-Launch Vehicles Program and Space-Launch Systems offices. General Lyles became the AFSC headquarters assistant deputy chief of staff for requirements in 1989 and deputy chief of staff for requirements in 1990. In 1992, he became vice commander of the Ogden Air Logistics Center at Hill AFB. He served as commander of the center until 1994, when he was assigned to command the Space and Missile Systems Center at Los Angeles AFB. In 1996, General Lyles became the director of the Ballistic Missile Defense Organization. In 1999, he was assigned as vice chief of staff at USAF/HQ. He served on the NASA Advisory Council. In 2009, General Lyles served on the Augustine Space Committee for developing the agenda for NASA's human spaceflight missions. He received his B.S. in mechanical engineering from Howard University and his M.S. in mechanical and nuclear engineering from the Air Force Institute of Technology Program. He is a member of the NRC Air Force Studies Board and recently served as chair of the Committee on the Rationale and Goals of the U.S. Space Program.

Ella M. Atkins is an associate professor in the Department of Aerospace Engineering at the University of Michigan, where she is director of the Autonomous Aerospace Systems Laboratory. She previously served on the Aerospace Engineering faculty at University of Maryland. Dr. Atkins' research focuses on the integration of strategic and tactical planning and optimization algorithms to enable robust operation in the presence of system failures and environmental uncertainties. She has collaboratively pursued challenging autonomous flight applications for manned aircraft and unmanned aircraft systems (UAS), including the Flying Fish autonomous unmanned seaplane and an emerging flexible wing platform. Dr. Atkins also studies the optimization of and safety analysis in congested airspace, with early efforts in simultaneous non-interfering terminal area airspace planning for runway-independent aircraft and small UAS safety assessment based on maintaining acceptable risk to people and property. She is author of more than 75 journal and conference publications and serves as an associate editor for the AIAA *Journal of Aerospace Computing, Information, and Communication.* She is also a small, public airport owner/operator, a private pilot, and an Academy of Model Aeronautics pilot (radio/control). Dr. Atkins holds B.S. and M. S. degrees in aeronautics and astronautics from MIT and M.S. and Ph.D. degrees in computer science and engineering from the University of Michigan. She has served on the NRC NASA Aviation Safety Program Review and the NRC Decadal Survey of Aeronautics.

Vijay K. Dhir (NAE) is dean of the University of California, Los Angeles (UCLA) Henry Samueli School of Engineering and Applied Science. He also leads the Boiling Heat Transfer Laboratory, which is involved in the study of flow boiling, microgravity boiling, and nuclear reactor thermal hydraulics. For the past 30 years he has been a consultant for numerous organizations, including GE Corporation, Rockwell International, Hughes Aircraft, the Nuclear Regulatory Commission, and the Los Alamos and Brookhaven National Laboratories. Dr. Dhir has served as vice chair and chair of the UCLA Department of Mechanical and Aerospace Engineering and as the school's associate dean for academic and faculty issues. In 2006, he was elected to NAE for his work in boiling heat transfer and nuclear reactor thermal hydraulics and safety. He is a fellow of ASME and the American Nuclear Society. Dr. Dhir has received the following awards: the 2004 Max Jakob Memorial Award, the ASME Heat Transfer

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Members New to the Board in 2011:

Lester Lyles, Vice Chair

Ella Atkins

Vijay Dhir

Earl Dowell

William Johnson

Alan Poindexter

Helen Reed

Staff New to the Board in 2011:

Dwayne Day

Amanda Thibault

New Board Members and Staff

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Memorial Award in the science category, the Donald Q. Kern Award from the American Institute of Chemical Engineers, and the Technical Achievement Award of the Thermal Hydraulics Division of the American Nuclear Society. Dr. Dhir has served as senior technical editor and associate editor for ASME's *Journal of Heat Transfer* and is a former assistant editor of *Applied Mechanics Review*. He is author or co-author of almost 300 papers published in archival journals and proceedings of conferences. Dr. Dhir received his B.S. degree from Punjab Engineering College in Chandigarh, India, his M.T. degree from the Indian Institute of Technology in Kanpur, India, and his Ph.D. from the University of Kentucky. He is a member of the NRC Decadal Survey on Life and Physical Sciences in Space Steering Committee.

Earl H. Dowell (NAE) is the William Holland Hall Professor and Dean Emeritus in the Edmund T. Pratt, Jr. School of Engineering at Duke University. He is a consultant to government, industry, and universities in science and technology policy and engineering education as well as on the topics of his research—aeroelasticity, nonsteady aerodynamics, and nonlinear dynamics. Currently he serves on boards of visitors at Carnegie Mellon University, Georgia Institute of Technology, Princeton University, University of Illinois, and the University of Rochester. Before serving as dean of the School of Engineering at Duke, he taught at the Massachusetts Institute of Technology (MIT) and Princeton. He has also worked with the Boeing Company. He is the author of more than 200 research articles and four books. Dr. Dowell is an elected member of NAE, an honorary fellow of AIAA, and a fellow of the American Academy of Mechanics (AAM) and the American Society of Mechanical Engineers (ASME). He served as vice president for publications for AIAA and as a member of the Executive Committee of the Board of Directors of the AIAA, the U.S. Air Force Scientific Advisory Board, the Air Force Studies Board, and the AGARD (NATO) advisory panel for aerospace engineering. Dr. Dowell has also served as president of AAM, chair of the U.S. National Committee on Theoretical and Applied Mechanics, and chair of the National Council of Deans of Engineering. From AIAA he has received the Structure, Structural Dynamics and Materials Award, the Von Karman Lectureship, and the Crichlow Prize; from the ASME he has received the Spirit of St. Louis Medal and the Den Hartog Award; and he has also received the Guggenheim Medal. Dr. Dowell received his B.S. degree from the University of Illinois and his S.M. and Sc.D. degrees from MIT. Dr. Dowell has served on 22 different NRC studies and activities and is currently a member of the Board on Army Science and Technology and the Panel on Air and Ground Vehicle Technology, and he chairs the Aerospace Engineering Section of the NAE.

William L. Johnson (NAS/NAE) is the Ruben and Donna Mettler Professor of Materials Science at the California Institute of Technology (Caltech). He spent two years at IBM's Thomas J. Watson Research Center prior to joining the faculty at Caltech. Dr. Johnson's research interests are centered on non-equilibrium thermodynamic systems. He, along with Ricardo Schwarz, discovered solid-state amorphization, leading to many years of fruitful research. His research accomplishments include the first studies of superconductivity in metallic glasses, pioneering studies of crystal to glass transformations. This work was followed by the synthesis of nanocrystalline and amorphous materials by high energy ball milling, and the discovery of bulk metallic glasses. Dr. Johnson has pioneered the discovery, characterization and science of bulk metallic glass forming alloys and their use as engineering materials. His recent work has involved the development of a theory that establishes fundamental physical principles governing flow in amorphous materials. He is an inventor on over 25 issued patents. He is a cofounder of Liquidmetal Technologies, in Lake Forrest California, which commercialized one of Dr. Johnson's BMG alloys for golf club heads (under the company name LiquidMetal Golf). Dr. Johnson served on the editorial board of the Journal of Rapid Solidification, and serves as an associate editor for *Journal of Applied Physics*, and *Applied Physics Letters*. He was a principal editor of the *MRS Journal of Material Science*. He is author or co-author of more than 360 publications in the scientific literature, and has contributed chapters to seven books. He received his B.A. in physics from Hamilton College and his Ph.D. in applied physics from Caltech. Previous NRC service includes the Committee on Materials Needs and R&D Strategy for Future Military Aerospace Propulsion Systems.

Alan G. Poindexter is dean of students and executive director of programs at the Naval Postgraduate School (NPS). He is also a captain in the U.S. Navy and commanding officer of the Student Element. Prior to NPS,

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New Board Members and Staff

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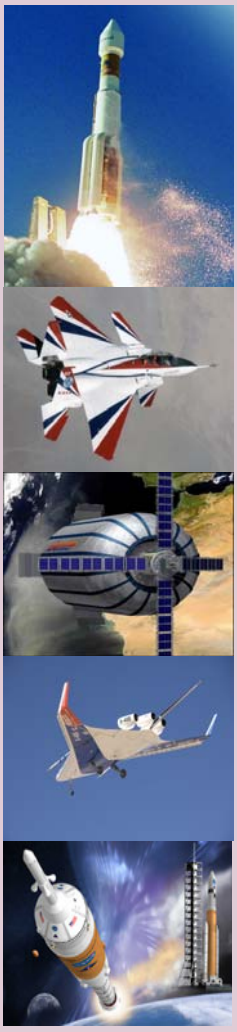
Captain Poindexter was a U.S. astronaut. Initially, he served in the Astronaut Office Shuttle Operations Branch performing duties as the lead support astronaut at NASA's Kennedy Space Center. Captain Poindexter served as a CAPCOM for several missions and is a veteran of two space flights. He has logged more than 669 hours in space. He served as pilot on STS-122 and was the commander of STS-131. Prior to serving in the astronaut corps, Captain Poindexter was a department head at Fighter Squadron 32, Naval Air Station Oceana, and was a test pilot and project officer at the Naval Strike Aircraft Test Squadron, Naval Air Station Patuxent River. He is entitled to wear the following awards: Legion of Merit, Distinguished Flying Cross, Defense Meritorious Service Medal, NASA Flight Medal, the Navy and Marine Corps Commendation Medal with Combat V, and various other service and campaign awards. Captain Poindexter holds a B.S. in aerospace engineering from Georgia Tech and M.S. in aeronautical engineering from the Naval Postgraduate School.

Helen L. Reed is a professor of aerospace engineering at Texas A&M University, having served as department head from 2004 to 2008. Her prior positions include faculty appointments at Stanford University, Arizona State University, and Tohoku University in Sendai Japan; and appointments at Sandia National Laboratories and NASA Langley Research Center. Dr. Reed has 18 years of experience in integrating small-spacecraft research, design-build-fly, and education, with particular emphasis in spaceflight, satellite design, and autonomous rendezvous and docking (AR&D) and 33 years in boundary-layer transition and laminar flow control, and hypersonics. She has 170 journal articles and refereed conference papers (41 invited), and 124 invited talks in these areas. She is a fellow of AIAA, APS, and ASEM. She was the recipient of the 2007 J. Leland "Lee" Atwood Award from the American Society for Engineering's Education Aerospace Division and AIAA. Dr. Reed was inducted into the Academy of Engineering Excellence in 2008 and the College of Engineering "Committee of 100" in 2010 at the Virginia Polytechnic Institute and State University (Virginia Tech). She has served on numerous advisory boards and committees, including NASA Headquarters aeronautics advisory committees, subcommittees, and task forces; the NASA Federal Laboratory Review Task Force of the NAC; and the NATO/AGARD Fluid Dynamics Panel. She was an associate editor for *Annual Review of Fluid Mechanics* and has served on numerous AIAA committees as well as the APS Division of Fluid Dynamics Executive Committee, the Society of Engineering Science board of directors; the USRA board of trustees and Space Technology Council (chair); the advisory board for National Institute of Aerospace; the National Space Grant Student Satellite Initiative (deputy co-chair), the Arizona Space Grant Consortium (associate director); the Aerospace Department Chairs' Association (chair); and the Arizona Space Commission (governor-appointed member). Dr. Reed also served on the advisory committees for aerospace programs at New Mexico State University, the University of California, Irvine, the University of Washington, and Virginia Tech. She received her Ph.D. in engineering mechanics from Virginia Tech in 1981. She served on the NRC Aerodynamics Panel from 1990 to 1992.

New Staff

Dwayne A. Day joined the Aeronautics and Space Engineering Board in 2011 after nearly 6 years with the Space Studies Board. He has served as the staff officer and study director for NRC studies on: the assessment of space radiation hazards to astronauts, the future of NASA's workforce, NASA's performance in solar system exploration, and on options for the next New Frontiers mission selection. He has a Ph.D. in political science from George Washington University, specializing in space and national security policy. Dr. Day is the author of *Lightning Rod*, a history of the Air Force chief scientist's office; has co-edited or edited several books and journal issues, and has written on American civil and military space policy and history. Prior to joining the SSB, he worked as an investigator for the Columbia Accident Investigation Board. Prior to that, he worked for the Congressional Budget Office and at George Washington University's Space Policy Institute.

Amanda Thibault grew up in Wichita, Kansas, and received her B.S. in atmospheric science from Creighton University in 2008. She went on to study lightning trends in tornadic and non-tornadic supercell thunderstorms at Texas Tech University and participated in both phases of the VORTEX II field project. She graduated from Texas Tech with a M.S. in atmospheric science in August 2010. She is a member of the American Meteorological Society.



Committee News

Orbital Debris. For the past two decades, NASA has built a robust program to evaluate and limit the generation of orbital debris and the risk to NASA spacecraft associated with debris and micrometeoroids. NASA's programs are recognized worldwide, yet with the growth of orbital debris over the past few years, NASA recognizes the responsibility to use their capabilities and assets to support not just NASA needs, but also to support other national and international debris and micrometeoroid activities. In the 1990s, the ASEB generated foundational studies of these issues, and it is now conducting a study to examine NASA's programs and provide guidance on any additional areas in which NASA should be devoting its resources. The committee held its second and third meetings in January and March 2011. The third meeting included a workshop where the committee was able to engage with stakeholders from government, academia, and industry. A summary of the workshop is expected in May. The committee's final meeting was April 25-27, and its final report will be released this summer.

Astrodynamics Standards. The NRC is forming a committee to assess the astrodynamics standards established by Air Force Space Command (AFSPC) and their effectiveness in meeting mission performance needs. The Joint Space Operations Center (JSpOC) uses astrodynamic algorithms to perform satellite orbit determination and prediction in order to maintain a catalog of over 20,000 objects, ranging from active satellites to tiny pieces of orbital debris. These standards were implemented to achieve interoperability between the JSpOC and the mission systems and to ensure mission performance. The committee will assess current AFSPC astrodynamics standards, compare those to leading alternatives in the community, outline options for using alternate standards, and examine issues related to cost and risk of different options. The study committee, a collaboration between the ASEB and the Board on Mathematical Sciences and their Applications, is currently being formed and will meet for the first time this summer.

2011 Ohio Third Frontier Wright Projects Program. Continuing the previous work of the National Academies for the State of Ohio, a committee was established to review applications to the Wright Projects (WP) competition of the Ohio Third Frontier (OTF) Program for Fiscal Year 2011 to identify proposals that best meet the scientific, technical, and commercialization criteria of the award program. The WP competition focuses on capital improvement and research and development at universities (which have teamed up with businesses) for near-term commercialization of new products. The committee, chaired by T.S. Sudarshan, held its first meeting March 3-4 and its second and final meeting April 20-21. The committee expects to publicly release its final report on May 25.

NASA Technology Roadmap Study. NASA has developed a set of 14 draft roadmaps to guide the development of space technologies under the leadership of the NASA Office of the Chief Technologist. These roadmaps are intended to foster the development of advanced technologies and concepts that address NASA's needs and contribute to other national space applications. The NRC has appointed a steering committee and six panels to evaluate the draft roadmaps and recommend improvements as NASA finalizes the roadmaps. The members of the steering committee and panels met in joint session in January, and the panels are in the process of holding 1-day workshops on each of the roadmaps under their purview. ASEB Chair Ray Colladay is chairing the steering committee. For more information, see <http://www.nationalacademies.org/NASAroadmaps>.

Human Spaceflight Crew Operations. A committee, co-chaired by Fred Gregory and Joe Rothenberg, is assessing how the role and size of the activities managed by the human spaceflight crew office should change when the ISS is complete, the requirements of crew-related ground facilities after the space shuttle program ends, and the cost-effectiveness of the astronaut corps' fleet of training aircraft. The committee held its second meeting at the Keck Center in early March. The committee's third and final meeting is scheduled for May at Woods Hole, MA. This last meeting will primarily be a writing meeting and may be entirely in closed session. The committee is on track to produce a report for review by June.

Aeronautics Flight Research. The ASEB has been asked by NASA to conduct a study of aeronautics flight research activities at NASA. Specifically, the committee will identify situations where research program success can be achieved most effectively through flight research, review the current portfolio of flight research activities at NASA, and recommend how NASA might maintain a robust flight research program within defined budget scenarios. The committee was named in January and is chaired by Wes Harris. The committee's first meeting was held April 20-22 at NASA Dryden Flight Research Center on Edwards Air Force Base.

Decadal Survey in Life and Physical Sciences

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ately balanced. Regular research solicitations are also necessary, and the review process must be transparent and incorporate the rationale for setting priorities. A research advisory committee to oversee and endorse the process would enhance the quality of the research. Finally, a long-term strategic plan to maximize research opportunities would improve the efficiency of translating discoveries to solutions.

Research Priorities—Priorities are presented as broad topic areas that will allow the development of an integrated portfolio of enabling and enabled-by research. Further priority setting, however, will require the specification of policy directions.

- Plant and microbial biology research to understand its evolution in a low-gravity environment, to determine how plants can play a role in biologically based life support systems, and the role of microbes during long-duration missions
- Behavior and mental health research to develop new methods to minimize psychiatric and sociopsychological costs of long-duration missions and enhance selection, training, and support of astronaut crews
- Animal and human biology research to better understand factors that limit human exploration of space, enhance understanding of fundamental biological mechanisms, and develop countermeasures to current limiting factors
- An integrated research approach to cross-cutting issues for humans in the space environment to address the sum effect of a range of physiological and behavioral changes taking place during long-duration missions
- Research in fundamental physical sciences to help address important questions about the laws of nature using the unique environment of space and to discover and understand organizing principals of complex systems
- Research in applied physical sciences to enable new exploration capabilities and new insights into a range of physical phenomena in space
- Translation to space exploration systems to identify technologies that enable extended space missions and to develop these enabling technologies

Portfolio Implementation—Flexibility of implementation of this portfolio is aided by a set of metrics that can also be used as a basis of policy-related ordering of an integrated research portfolio. These metrics include the extent the research would reduce uncertainty about risks and benefits; reduce exploration costs; lead to new exploration options; provide answers to grand science challenges; lead to developments uniquely needed by NASA and/or are synergistic with other agency needs; and result in solutions to terrestrial problems.

Facilities, Platforms, and the ISS—Facilities with suborbital flights and drop towers offer unique advantages for selected experiments. Eventually access to lunar and planetary surfaces will allow critical low-gravity studies and testbeds. All allow reduced gravity, increased radiation, vacuum and planetary atmospheres, and human isolation. The capabilities provided by the ISS are vital to addressing many of the important research questions identified in the report. The ISS is a unique platform, and it is essential that it be fully utilized for life and physical science research in the next decade. Interaction with the commercial sector, particularly flight providers, is also important.

Science Impact on Defining Space Exploration—This report offers integrative visions for the science advances necessary to underpin and enable evolutionary systems and bold architectures for human space exploration. It specifies the scientific resources and toolboxes to define and develop future space exploration and scientific discovery.

Where's the executive summary?

Looking for a more extended summary of one of our reports? On the report's page on the National Academies Press website (such as <http://www.nap.edu/catalog.php?record_id=12202>), scroll down a little bit to a section called "Free Resources." There, in a box titled "Download Free," you will see a link called "PDF Summary." Click the link to download the full executive summary in PDF format.

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The Aeronautics and Space Engineering Board (ASEB) was established in 1967 "to focus talents and energies of the engineering community on significant aerospace policies and programs." In undertaking its responsibility, the ASEB oversees ad hoc committees that recommend priorities and procedures for achieving aerospace engineering objectives and offers a way to bring engineering and other related expertise to bear on aerospace issues of national importance.

The majority of ASEB studies originate with the National Aeronautics and Space Administration (NASA), particularly the Aeronautics Research Mission Directorate and the Exploration Systems Mission Directorate. Some of these studies are requested by Congress in related legislation. ASEB also conducts proposal reviews for the State of Ohio's Third Millennium Program through the Ohio Department of Development, and identifies experts to assist the Government Accountability Office in conducting its studies. The ASEB also has performed technical and policy studies for the Nuclear Regulatory Commission, the Defense Nuclear Agency, the Federal Aviation Administration, the National Science Foundation, the Defense Threat Reduction Agency, Air Force Space Command, the Air Force Office of Scientific Research, the National Oceanic and Atmospheric Administration, and others.