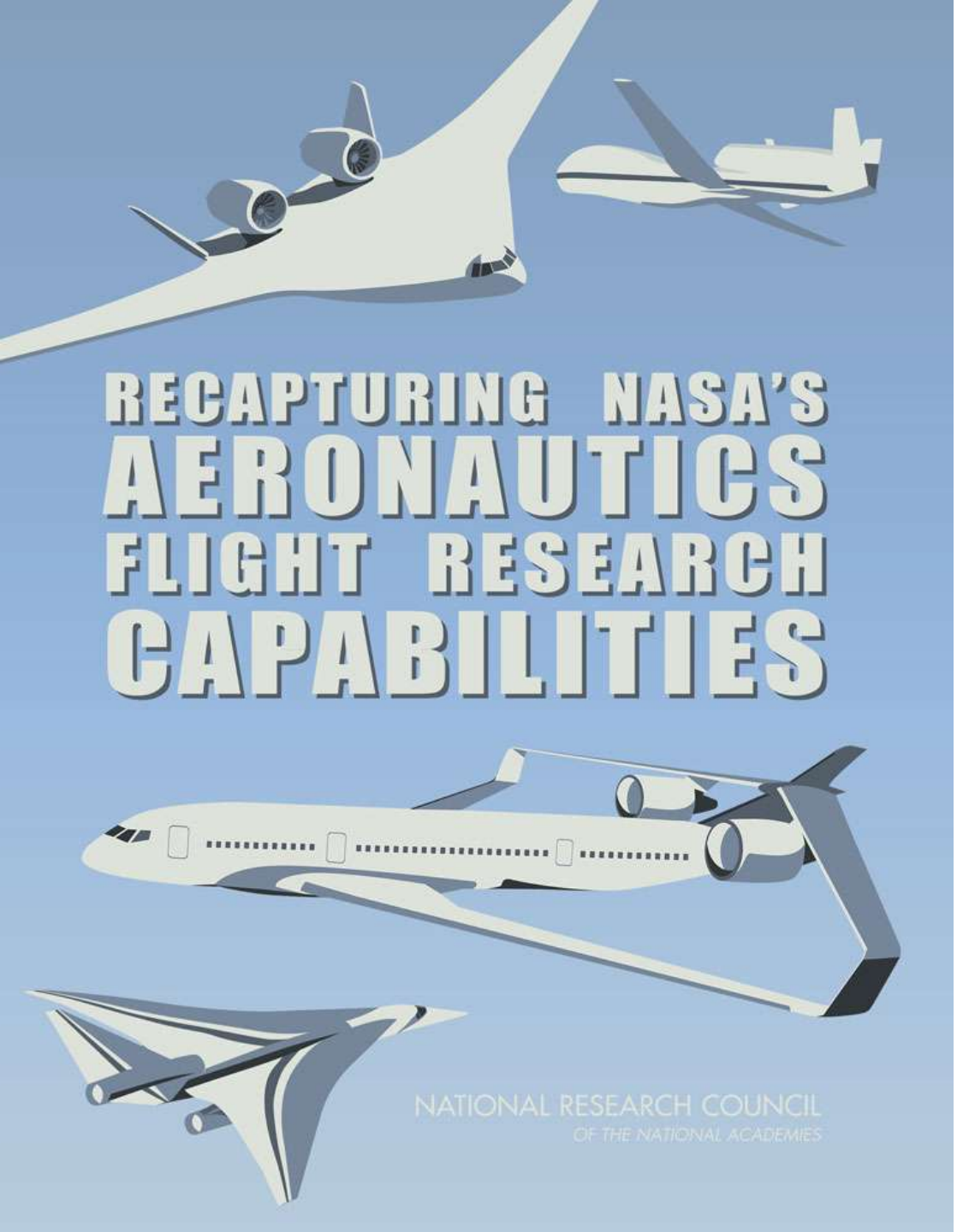

ASEB Briefing
April 5, 2012

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Committee to Assess NASA's Flight Research Capabilities

- **Mark Anderson**, Boeing Research and Technology
- **Neil A. Armstrong**, NAE, EDO Corporation (retired)
- **Edward J. Burnett**, Lockheed Martin Aeronautics Company
- **Inderjit Chopra**, University of Maryland, College Park
- **Richard S. Christiansen**, Sierra Lobo Inc.
- **Robert A. Cowart**, Gulfstream Aerospace Corporation
- **Wesley L. Harris**, NAE, Massachusetts Institute of Technology, *Chair*
- **John B. Hayhurst** , The Boeing Company (retired)
- **Timothy Lieuwen**, Georgia Institute of Technology
- **Ronald F. Probstein**, NAE, Massachusetts Institute of Technology
- **Eli Reshotko**, NAE, Case Western Reserve University
- **Rogers E. Smith**, Independent Consultant
- **John Tylko**, Aurora Flight Sciences Corporation
- **Randy Voland,** ACENT Laboratories, LLC
- **Deborah DeMania Whitis**, GE Aircraft Engines

NRC Study Director

- **Dwayne Day**

Previous Briefings

- U.S. Senate, Committee on Commerce, Science and Transportation, Subcommittee on Science and Space, Hart Senate Building, March 12, 2012
- U.S. House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Space & Aeronautics, Rayburn Building, March 12, 2012
- NASA Aeronautics Research Mission Directorate, March 14, 2012 [teleconference]

Statement of Task

An ad hoc committee will perform a study to assess and make recommendations about how best to integrate flight research into the current Aeronautics Research Mission Directorate's (ARMD) fundamental research activities and integrated systems research activities. In conducting the study and preparing its report the committee will undertake the following tasks:

- Within the set of goals and challenges being addressed by NASA's Aeronautics Research program, identify those challenges where research program success can be achieved most effectively through flight research (in addition to, or as opposed to, other analytical or experimental approaches)

- Identify any goals and challenges in the NASA Aeronautics program that may be limited due to an anticipated lack of available flight research capability

Statement of Task (cont.)

- Review the current portfolio of ARMD flight research activities and the flight research needs of ARMD's aeronautics program, and identify programmatic and research requirements gaps

- Review the capabilities and limitations of the current fleet of NASA aeronautics research aircraft in terms of their ability to meet the above requirements and gaps

- Consider how the research opportunities might be pursued in an economical, affordable, and technically rigorous way (for example, by partnering with the NASA Science Mission Directorate, other U.S. government agencies and departments, industry, the National Research Council of Canada (NRCC), and other international partners);

- Recommend how NASA might maintain a robust flight research program within defined budget scenarios.

Statement of Task (cont.)

The scope of this assessment includes all ARMD research, including where/how future flight testing can add value to (a) aeronautics research, (b) vehicle and vehicle subsystem/component technologies, (c) next generation air traffic management (NextGen) technologies and (d) technologies related to the safety of flight. The study should consider (1) the role of X-planes and/or demonstrator vehicles in aeronautics research and their potential to reduce the risks associated with technology maturation, performance, and deployment or insertion into flight vehicles and (2) the potential benefit of using unclassified flight research testbeds owned by other government agencies, industry, academia, and elsewhere. The budget scenarios for the committee's recommendations should include options such as (i) a baseline scenario that is bounded by the current ARMD budget outlook,(ii) an augmented scenario that represents a frugal approach to flight experimentation that meets programmatic goals but one that is not necessarily constrained by the present budget outlook, and (iii) a scenario that is unconstrained by the present budget outlook. It should also include a recommendation on the core components of a well-balanced (see Task 1), effective NASA Aeronautics program.

Emerging Themes

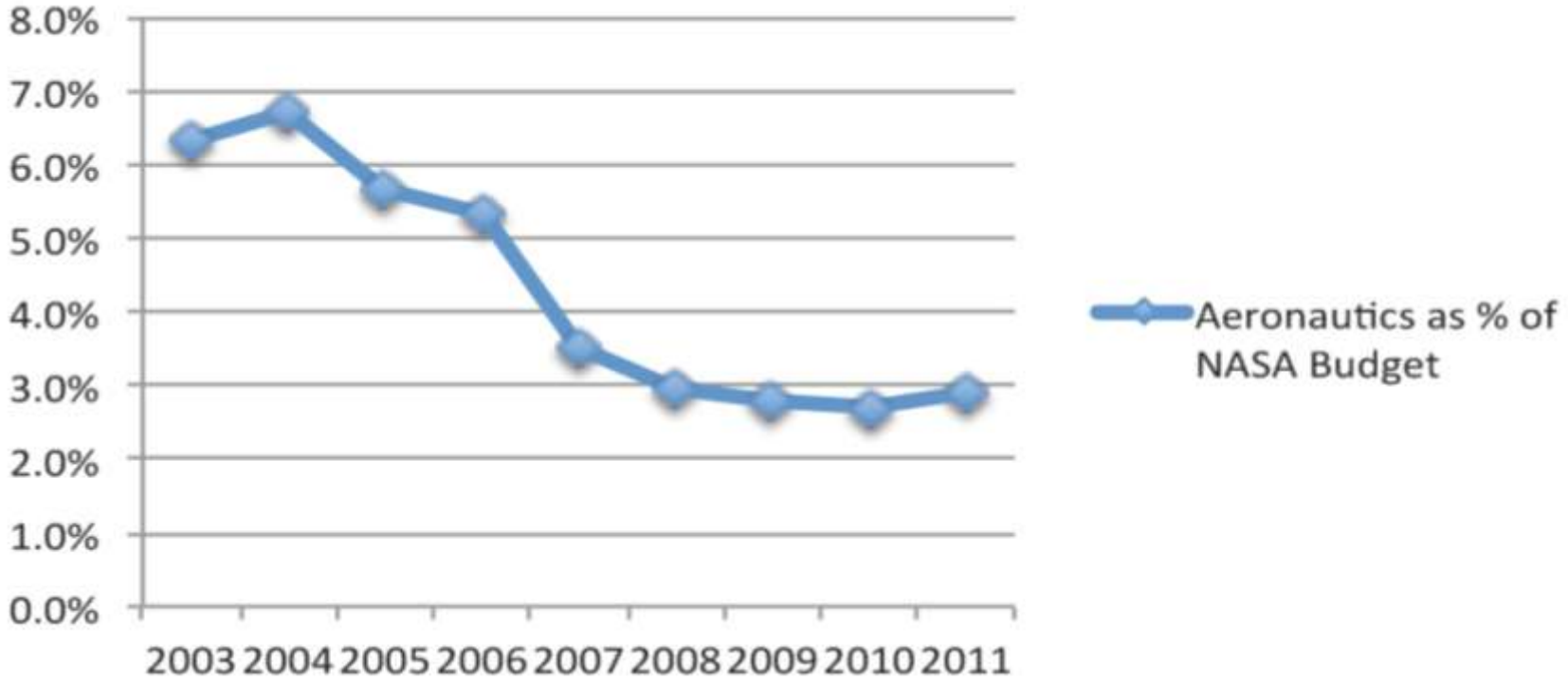
Aeronautical flight research is a useful, vital tool that enables successful development of aeronautical systems.

Aeronautical flight research does not merely come at the end of a research project, often it actually informs the direction of research and manufacturing.

Without rigorous aeronautical flight research, overall progress is delayed and waste of resources results.

Some Concerns

A. NASA's Aeronautics funding has dramatically shrunk, but workforce has not

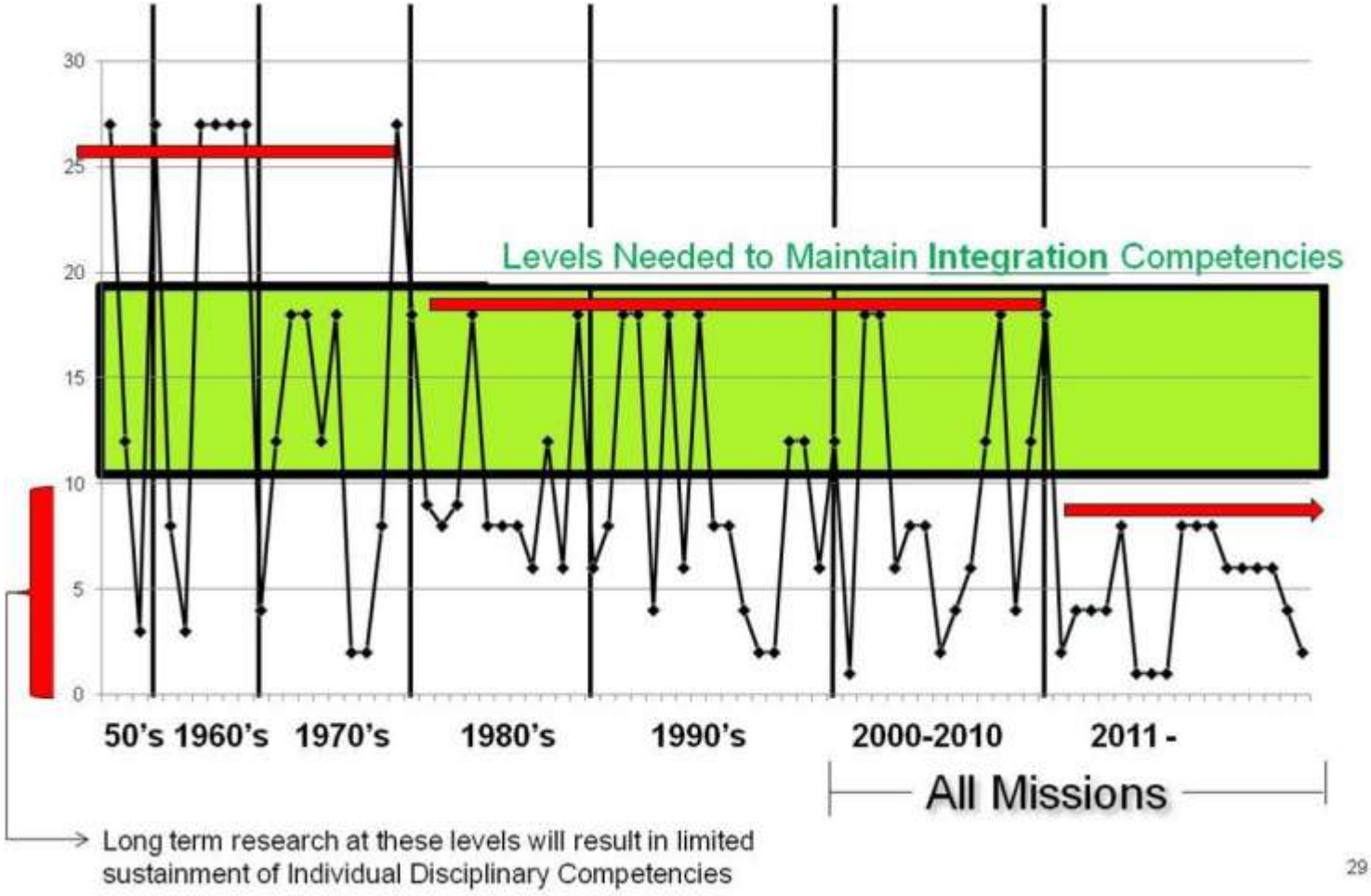


Aeronautics Research Mission Directorate Full Time Equivalents
(essentially full time employees, i.e., civil servants)

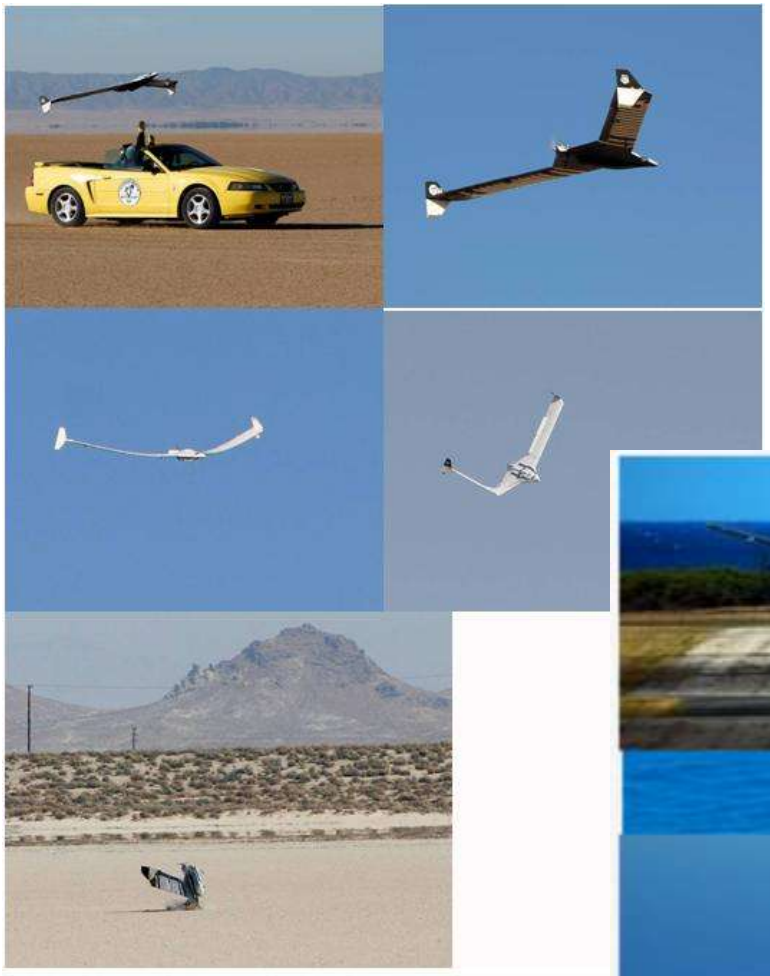
Year	2006	2007	2008	2009	2010	2011
Aero FTE	1,449.0	1,343.4	1,397.1	1,373.4	1,333.8	1,371.5

SOURCE: NASA

B. Aeronautics has become risk-averse and the projects less ambitious

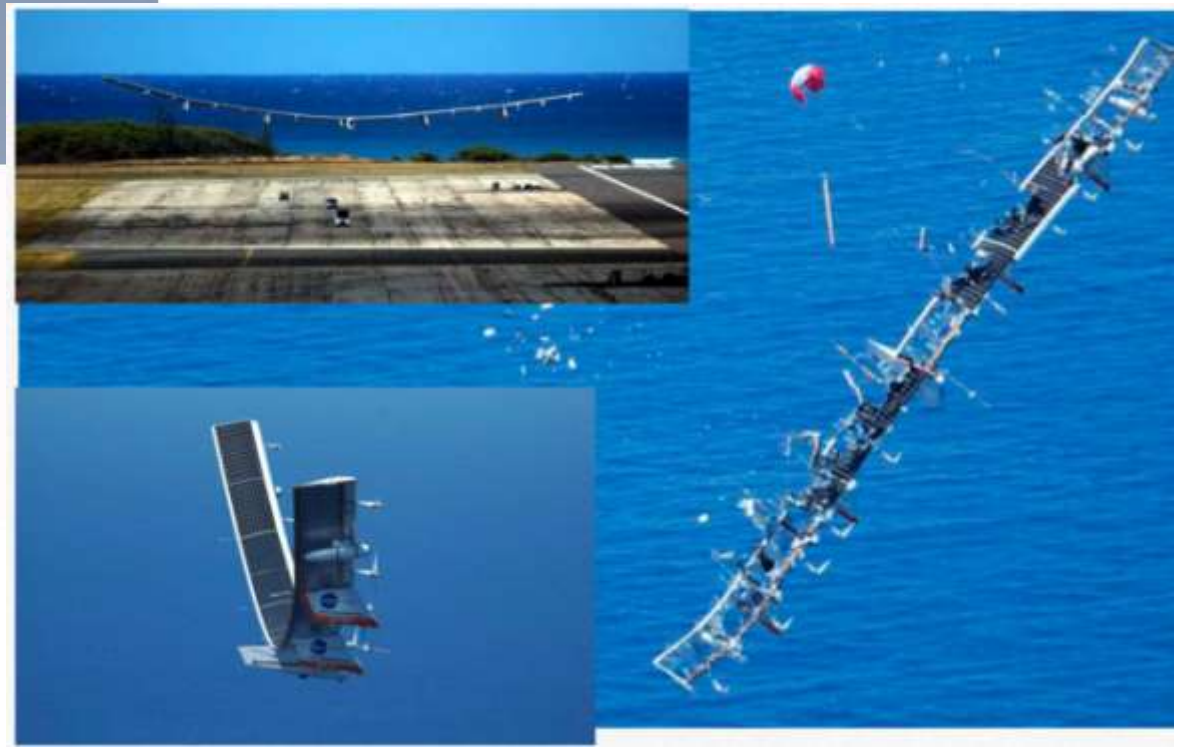


Effective flight research means breaking things, either accidentally or deliberately



Left: Air Force Research Laboratory's Multi-Utility Technology Testbed (MUTT) aircraft, built by Lockheed Martin. This vehicle was designed to test the limits of aircraft structures, including the point where the wings would flutter so much that they would break. The crash is therefore not an accident, but the end result of the test. This kind of flight research cannot be conducted with piloted vehicles. (Source: Jeff Beranek, Lockheed Martin.)

Below: Helios, the prototype of Pathfinder, in flight, and suffering a catastrophic failure in June 2003. Accidents like this are a normal part of flight research. They provide lessons on what does and does not work. (Source: NASA)



C. Insufficient strategic direction from Headquarters

D. Too many *little* projects chasing around not enough money

E. Too much micro-management from Headquarters

F. NASA doesn't really cooperate with other agencies to the extent it should

G. Flight research has essentially stopped at NASA

Findings and Recommendations: A Way Forward

Focus and Direction of NASA's Aeronautics Program

Recommendation: NASA should select and implement at any given time a small number (two to five) of focused, integrated, higher risk, higher payoff, and interdisciplinary programs. The committee has concluded that these priority focused efforts will require flight testing to advance useful knowledge and should therefore include a path to flight. Therefore, NASA should also develop cost-effective flight research vehicles to demonstrate innovative aerospace technology in flight. A new innovative air vehicle should be launched each year. The committee has concluded that to make meaningful progress in these programs the scope of activity on each vehicle research program would be of the order of $30 million to $50 million total per vehicle over a 3-year period—that is, $10 million to $15 million per vehicle per year. The priority focused programs should be drawn from the research areas identified by the 2006 NRC decadal survey of civil aeronautics, to achieve progress for fundamental aeronautics as well as other relevant related military requirements. To implement this recommendation without additional funding for ARMD, NASA should phase out the majority of its lower-priority aeronautics activities.

Focus and Direction of NASA's Aeronautics Program

Recommendation: NASA should ensure that each of its projects has a defined path to in-flight testing in an appropriate environment. These paths must include details of the vehicle to be used for the flight research, be it a modification to an existing testbed or a purpose-designed and built vehicle. The overall program must ensure that funding is available to complete the in-flight research portion of the project in a timely manner, either by appropriately using a sub-scale test vehicle or by dedicating major funding levels to a "flagship" effort.

Environmentally Responsible Aviation

- **Finding:** If NASA determines that progress in Environmentally Responsible Aviation is a priority, the agency could collaborate with the Department of Defense (DOD), the Federal Aviation Administration, other government agencies and industry on a subsonic experimental aircraft that would integrate multiple advanced aerodynamic, structural, and engine technologies. The most effective approach would be to ensure that the flight test program, while integrating multiple technologies, also be planned to test single objectives for each test. With a view to maximizing effectiveness, as these collaborations are carried out the distribution of research results and data cannot be limited to industry and academia and should be understandable, presentable, and accessible to a broad audience.

Supersonics

Finding: If NASA determines that progress in supersonics is a priority, then given the progress in low-boom technology that has been demonstrated over the past decade and in light of this research challenge being the principle remaining barrier to routine supersonic operations, NASA together with the FAA could proceed immediately with an integrated technology experimental aircraft program to validate low-boom acoustic ground signatures and establish a set of quantitative criteria for the sonic boom footprint over land.

Finding: If NASA determines that progress in supersonics is a priority, and recognizing that engine technology and propulsion integration remains the next critical investment barrier to progress in this field, NASA together with DOD could develop a robust technology maturation and flight validation program with key partners for fielding a product variable cycle engine and the integrated propulsion systems for supersonic flight.

Hypersonics

Finding: If NASA determines that progress in hypersonics research is a priority, then the agency could reform the hypersonics project on the specific goal of development and demonstration of the technologies for a hypersonic vehicle within 25 years to enable point-to-point flights from any point on Earth to any other point in a few hours. NASA could coordinate development plans with DARPA and other DOD organizations in order to make the program affordable and enhance its development.

Organization, Collaboration and Communication

Recommendation: NASA aeronautics should aggressively pursue collaboration with DOD, FAA, the U.S. aerospace industry, and international aeronautics research agencies. NASA should adopt management practices to facilitate effective collaboration and treat external organizations as customers and partners. NASA leadership should develop a formal process for regularly soliciting input from the U.S. aerospace industry and universities as well as key government agencies to assure the relevancy of its flight research programs to national needs.

Recommendation: NASA aeronautics should become the nation's repository of flight research data and flight test results and should make these archival data readily accessible to key stakeholders—the engineers and scientists in industry, academia, and other government agencies. NASA should also require principal investigators in flight research projects to publish their results and provide funding for them to do so.

Organization, Collaboration and Communication

Recommendation: NASA aeronautics leadership should study designating Dryden Flight Research Center as the primary flight research organization of NASA, with responsibility for the efficient use of NASA flight research aircraft, facilities, and other support resources. Dryden should adopt a customer-focused approach to flight research sponsored by NASA and external partners.

Q & A