NASA's Aeronautics R&D Program: Status and Issues

Statement of

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Mr. Chairman and members of the committee, thank you for the opportunity to testify on NASA's aeronautics research program. My name is Ilan Kroo. I teach at Stanford University and conduct research related to future aeronautical concepts. My familiarity with NASA's research program stems from work as a civil servant at NASA's Ames Research Center twenty years ago, continuing interactions with NASA during my research career at Stanford, and participation in several related studies by the National Research Council, including the Decadal Survey of Civil Aeronautics in 2006.

I will focus these comments on NASA's role in research to improve the safety and reduce the environmental impact of our future air transportation system, addressing questions posed in your letter of April 17, 2008.

What do you consider to be the most important challenges to be addressed if the nation is to sustain an efficient, environmentally compatible, and safe aviation system? What should NASA's role be in addressing these challenges?

The nation's air transportation system has been a critical engine for our economy and quality of life for many decades. In terms of cost, safety, and efficiency, commercial aircraft have made dramatic improvements over the last fifty years. However, the growing global demand for air travel, the constraints imposed on system capacity, and the impact of this growth on the environment have led us to a critical point in the evolution of aviation. Even now, issues with system capacity, the cost of fuel, and local environmental impact make it clear that it is not possible to sustain an acceptable system without significant technical advances. The greatest challenges will be to accommodate the anticipated two to threefold growth in air travel over the next twenty to thirty years without increasingly problematic local and global environmental impact. The growing diversity of air vehicles, from personal aircraft and light jets to regional jets and very large aircraft, potentially larger numbers of unmanned aircraft, and even supersonic aircraft make this challenge even more complex. Since these long-term issues cannot be solved by regulation alone and require the development of technologies that span multiple industries, the critical research is very appropriate for NASA to undertake. In many ways NASA is uniquely positioned to address some of these problems. No other agency or industry has the expertise and tools to study the impact of aviation on the global environment along with technologies that may be needed for future aircraft engines, airframes, and traffic management systems. Unfortunately the magnitude of the problem is great and growing, while NASA's aeronautics program is not.

The adverse impact of aviation on the environment has long been a concern, and that concern has recently expanded to include the impact of aviation on climate. What do you consider to be the most promising R&D avenues for addressing environmental concerns associated with aviation, and what should NASA's R&D priorities be in this area?

In many ways commercial aviation is a success story in terms of efficiency and environmental impact. A few decades ago fuel usage per passenger mile was about 70% greater than it is today and the next generation of aircraft should reduce fuel consumption by 20% compared with today's aircraft. A flight across the country in a Boeing 737-800 requires only about 29 gallons of fuel per person (a per-person mileage of about 80 miles per gallon).

However, trillions of passenger-miles are flown each year and traffic is expected to double over the next twenty years. So, although aviation currently accounts for only about 2-4% of human CO_2 emissions, its impact on the environment may be much greater in the future due to this projected growth, pollutants other than CO_2, and the disproportionate effect of emissions deposition at high altitude. In order to achieve a sustainable aviation system while accommodating increasing demand, dramatic improvements in aircraft efficiency are required. Unfortunately, most of the easy steps have been taken and further improvements require research into better modeling and design capabilities, new configuration concepts, and alternate fuels that are well-suited to aviation use. Many uncertainties remain about the effects of aviation on the atmosphere, and research is required to determine how to minimize the impact of air travel in the future. Nearer-term problems, aggravated by increasing demand and alleviated with some of the technology advances noted above, include local and regional environmental effects such as airport community noise and local air quality.

NASA's fundamental research work addresses some of these issues, but needs to be expanded and focused on the most promising technologies if it is to contribute in a significant way to solving these problems. Specific, aggressive, but rational targets for future aircraft noise and emissions should guide the research priorities for NASA's research. Challenging goals such as those described in the National Plan for Aeronautics R&D, published last December are clearly affecting NASA's research plans, but it is not clear how they can actually be achieved with the agency's current resources.

Will it be possible for a Next Generation Air Transportation System [NextGen] to meet anticipated demand without incurring additional environmental degradation? If so, how?

Some of the problems with increasing demand are obvious to travelers today, with flight delays and cancellations affecting the entire system. The importance of improved air traffic management to achieve a safe and efficient system, even as demand grows, is very clear. Perhaps less obvious is the role that future traffic management systems can play in reducing aviation's environmental footprint. Exploiting recent advances in reliable precision navigation to guide aircraft on routes that produce less noise, consume less fuel, or even to avoid regions with more sensitive atmospheric conditions may minimize both local and global environmental effects. Increased vehicle autonomy can enable real-time re-planning and more optimal flight paths without increasing pilot workload or compromising safety. NASA's fundamental work in this area is important but needs to progress to the next steps involving larger scale experiments and validation. Furthermore, although improved management of traffic is necessary in a next generation air transportation system, this alone will not be sufficient to meet the stringent environmental constraints that we expect in the future. Part of NASA's work in NextGen must be to combine new vehicle concepts that achieve unprecedented efficiency levels, with a traffic management system that can properly accommodate legacy aircraft and advanced designs that may fly at different altitudes and speeds. This has been recognized within NASA, but must be emphasized.

What does NASA need to do so that its aeronautics R&D activities can be effectively and more rapidly transitioned to the marketplace or to the public sector users, as the case may be?

In the past few years NASA has done a good job in defining a strong, fundamental research program within severely-limiting budget constraints. It has focused R&D activities on the kind of fundamental research that will be important for longer-term solutions. The next step is to understand how some of the most promising technologies can be integrated at the system level and transitioned from the lab to the user. These critical integration and validation projects will require close collaboration with industry and it is difficult to see how they can be undertaken with NASA's current level of investment in aeronautics.

Again, thank you Mr. Chairman, for the opportunity to testify.

Biographical Information

Dr. Ilan Kroo is a Professor of Aeronautics and Astronautics at Stanford University, where he directs the Aircraft Aerodynamics and Design Group. He received his Bachelor's degree in Physics from Stanford in 1978, and continued studies in Aeronautics, leading to a Ph.D. degree in 1983. Prior to joining the Stanford faculty, he was a Research Scientist in the Advanced Aerodynamic Concepts Branch at NASA's Ames Research Center in California. Dr. Kroo's research includes the application of new computational architectures for high-fidelity optimization and studies of unconventional configurations including new concepts for efficient subsonic and supersonic aircraft. Dr. Kroo is a Fellow of the AIAA, received the AIAA Lawrence Sperry Award in 1990, the Outstanding Teacher Award in 1994, and the Dryden Lectureship in Research in 2003. He is a member of the National Academy of Engineering and the Air Force Scientific Advisory Board and is Chief Scientist of the Aerion Corporation.