

Statement of

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before the

**Subcommittee on Space and Aeronautics**  
**House Committee on Science**  
**U.S. House of Representatives**

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Chairman Calvert and Members of the Subcommittee:

Thank you for the opportunity to comment on the Future of aeronautics at NASA. For most of the past century, the U.S. has led the world in “pushing the edge of the aeronautics envelope” based, in part, on a strong national aeronautics research strategy. This has resulted in a vibrant aerospace industry and an unsurpassed air transportation system which has contributed materially to the Nation’s economic development, geographic structure and quality of life. The social and economic connectivity provided by our air transportation system can be seen in the density of aircraft trajectories over the U.S (Fig 1.).

**Figure 1. U.S. Air Traffic Density (Source: FAA ETMS Data)**

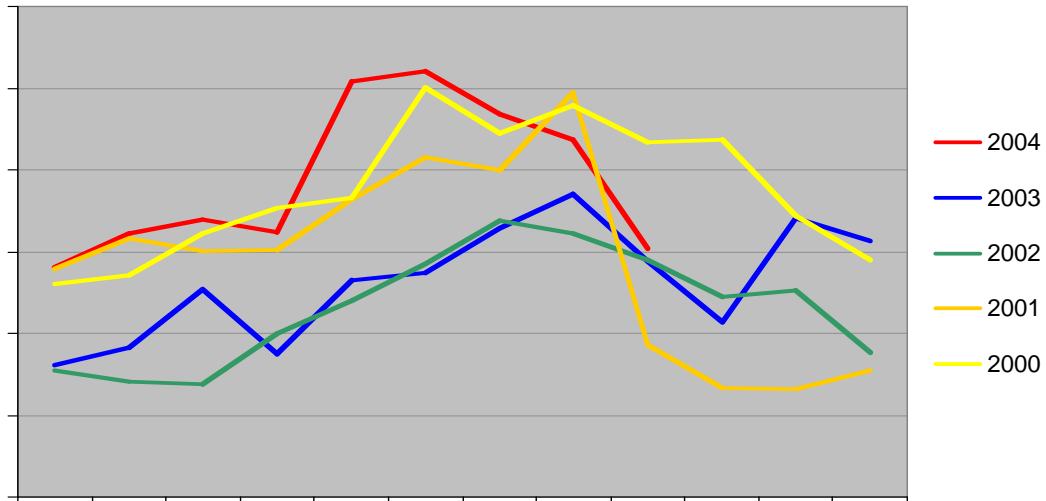
There are, however, indications that the U.S. preeminence in aerospace has declined. In part this is due to strategic investments other nations have made, and continue to make, in aeronautics research. These investments in programs and, more importantly, in people, have created a strong international civil aeronautics capability. In contrast the U.S. has systematically decreased its investment in civil aeronautics research over the past decade and has underinvested in fundamental and high risk research to develop the excitement knowledge and people to shape aeronautics in the future.

I will comment below on the specific questions which you have asked me to address.

**Over the next two decades, what are the main challenges facing the aeronautics industry and our aviation infrastructure? What are the Nation’s most pressing strategic needs in civil aeronautics?**

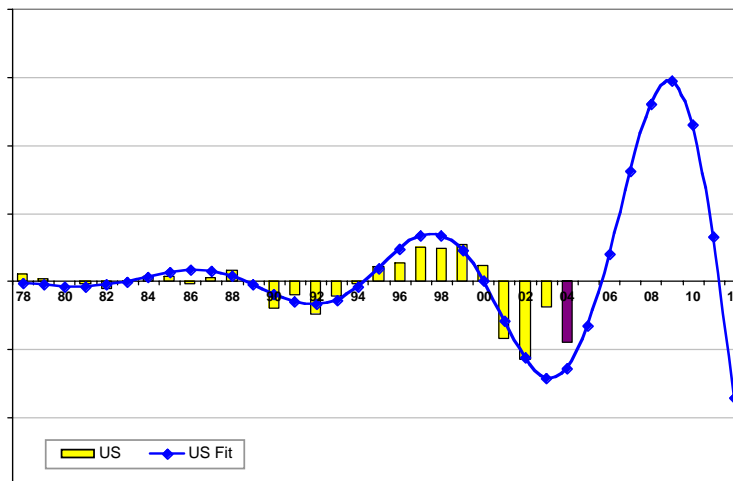
*National Airspace System Capacity* - Indications of the capacity problem can be seen in the delay data of Figure 2. Prior to September 11 2001, the system was approaching capacity limits at key airports and other points in the system. Nominal interruptions resulted due to weather or traffic congestion in non-linear propagation of delays and loss of reliability in the system. Delays were reduced after September 11 due primarily to reduced

traffic. However traffic has returned and delays in late 2004 have exceed historic levels. This pattern is expected to continue and it is likely that delays will reach crisis proportions within the ext few years. It is important to note that key airports in the system (e.g. LGA and ORD) have had a disproportional impact on national delays illustrating the importance of getting maximum capacity from our airports and reducing local environmental impacts to reduce local community opposition to airport capacity expansion.



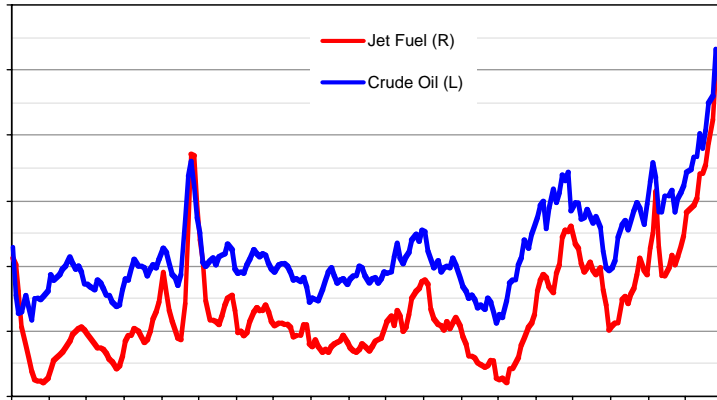
**Figure 2. Flight delays by month (Source: FAA OPSNET data)**

*Economic Stability* - The economic instability of the aeronautics industry can be seen in the aggregate profitability of the U.S. airlines (Fig. 3). The cyclic nature of the industry can be seen with the cycle period being approximately 11 years. Prior to deregulation of the industry in 1978 the Airline Industry was cyclic but profitable. After de-regulation the amplitude of the oscillation has increased. This pattern is also seen globally. It is unclear what will limit the growth of this instability, however the implications are significant both for the industry, the nation and the world.



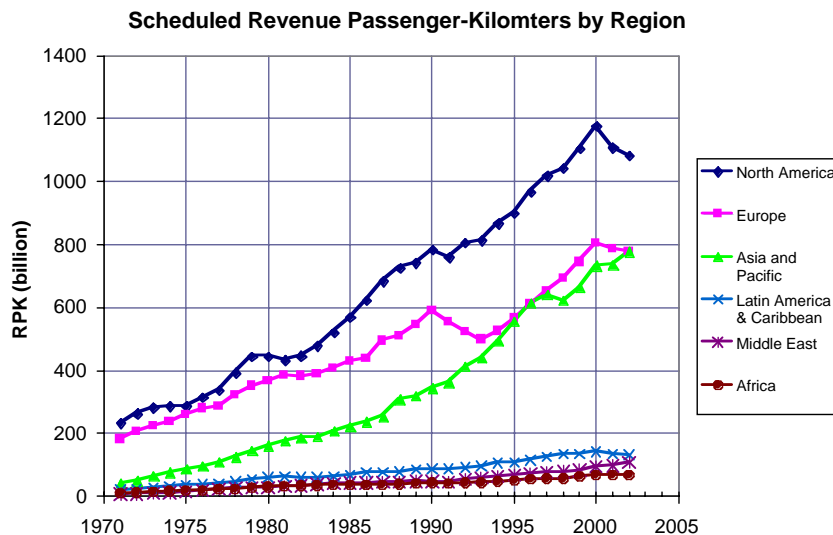
**Figure 3. Net Profit of U.S Airline Industry and Best Fit of Undamped Oscillation Model**

*Fuel* - Another challenge will be the price and availability of fuel. As can be seen in Fig 4 the price of fuel recently exceed \$50 per barrel. While this is partly due to short term issues it is expected that fuel prices will continue to rise as the rate of discovery of new fossil fuel sources slows. While this is a challenge, it is also a technical opportunity as it shifts the design criteria to value fuel efficiency.



**Figure 4. Oil and Jet Fuel Price Trends (Source: ATA)**

*International Competition and Markets* - International competition will also be a key challenge over the next few years. As noted above, international competition to U.S. manufactured aircraft and aeronautics technologies have increased and the historical U.S. leadership has diminished. However, the international markets represent the largest future opportunities for civil aeronautics products and systems. This can be seen in Figures 5 and 6 which show the rapid growth in passenger and freight traffic in North America, Europe, and Asia and the emergent potential of developing regions such as the Middle East, Latin America and Africa.



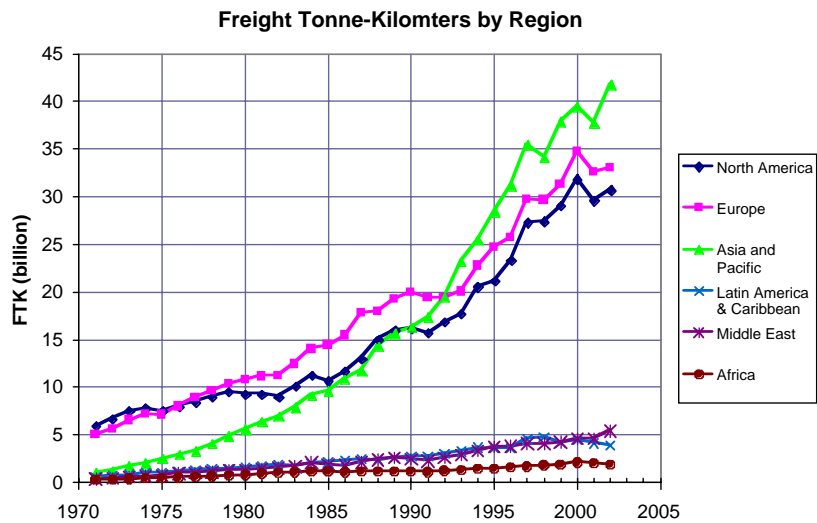
**Figure 5. Civil Passenger Traffic by Region (Source: ICAO)**

**Figure 6. Civil Freight Traffic by Region (Source: ICAO)**

*Environmental Impact* - Environmental issues will become increasingly important challenges to aviation as well as other segments of society. At the local level, noise and emissions make it difficult to add runway capacity to meet the traffic demand. On a global scale, increasing concerns regarding global warming will impose limits on high altitude emissions and aircraft contrails which impact the earth's radiative energy balance.

*Security and Public Health Threats* – The perception as aviation as a potential social threat mechanism could significantly constrain the potential benefits from aviation and the aeronautics industry. As important as the well publicized security concerns is the bio-propagation of natural health threats as illustrated by the reaction to the SARs virus in Asia. While these concerns are real the potential to overreact are significant.

*Information Technology and Complexity* - On the technology side, one of the key challenges will be dealing with complexity and criticality in Information Technology and



software systems which are an increasingly important part of all aerospace systems.

*Human Roles* - Defining the limits of automation and the role of the human will be a challenge for civil aviation. Unmanned Air Vehicles have demonstrated their capability in military applications and are emerging in civil aviation. The future role of humans both as operators and controllers will change and become an emergent issue

*Loss of Intellectual Capital* – Perhaps the most important challenge is the potential decline of intellectual capital in the U.S. Aeronautics enterprise. Much of the historical strength in aeronautics was due to the knowledge and expertise in our people. Currently we are not stimulating intellectual renewal at a pace which will maintain or increase the national capability to deal with the challenges ahead.

**What role do NASA's aeronautics programs and strategic plans have in fulfilling the Nation's strategic needs in civil aeronautics? How effective are NASA's programs in helping to ensure U.S. industrial competitiveness in civil aeronautics markets worldwide?**

There is clearly an urgent strategic need to invigorate aeronautics research in the U.S. to meet the challenges of the future. As the national agency for civil aeronautics research NASA should have a key role. However the lack of prioritization of aeronautics within NASA puts this at risk.

Given the limited budget for aeronautics, the aeronautics programs are generally aligned with a subset of the strategic needs but are unlikely to be as innovative or as effective as necessary to have a major impact on U.S industrial competitiveness in civil aeronautics.

I am somewhat concerned that budget pressure and internal evaluation metrics have created an environment where the aeronautics research efforts are too short term focused on products and programs and not enough on knowledge and capability which are the critical enablers for the long term competitiveness.

Regarding the 3 specific NASA Aeronautics Programs.

The *Airspace Systems Program* is well aligned with the future capacity challenges to the National Airspace System (NAS) although somewhat too focused on developing specific solutions rather than general capabilities which can be used to address future challenges as they emerge. It is important to recognize that NASA does not implement airspace systems and must work collaboratively with the FAA and other government agencies as well as industry and international agencies in order to be effective. To this end, I am encouraged by NASA's strong involvement with the Joint Program and Development Office (JPDO).

The *Aviation Safety and Security Program* supports the noble goal of increasing aviation safety. The safety element of the program is based on a well developed identification of key safety issues. The program appears to be open to innovation. The one area which appears underrepresented are issues related to critical software and complexity related emergent safety issues. I am less clear what the appropriate NASA role is in aviation security and am therefore concerned that the security element of the program may be diverting scarce resources from other efforts. Again, I am encouraged that the JPDO will be a mechanism to clarify the NASA role in aviation security.

The *Vehicle Systems Program* has been refocused around 4 technology demonstration projects (Subsonic Noise Reduction, Sonic Boom Reduction, Zero Emissions Aircraft, and High Altitude Long Duration Remotely Operated Aircraft). Each of these programs address expected future challenges and their priority has emerged from a collaborative interaction with industry. There is, however, a general concern that the focus on technology demonstrations comes at the expense of more fundamental research and core

technology development in vehicle systems and that the national competitiveness in aircraft technologies may atrophy as a result.

**What effect do you believe NASA's proposed budget (including proposed changes in funding, workforce, and operation of wind tunnels) will have on its ability to meet the nation's strategic needs in civil aeronautics?**

I am generally dismayed by the magnitude and trend of the proposed NASA aeronautics budget. It appears to reflect a lack of commitment of the agency to the future of aeronautics.

Given the reduced level of investment in the Aeronautics Theme, NASA has done a reasonable job at prioritizing facilities and has recognized the need to align its workforce to the challenges of the future. While there is clearly a need to reduce the number of NASA facilities, this must be done carefully and with a strategic national perspective. If done correctly the nation's future strategic needs will be met.

I am more concerned regarding the ability of NASA to maintain a talented and enthusiastic workforce with the skills and interest to meet the challenges in civil aeronautics. The workforce actions, appear to be motivated by budget pressures rather than strategic efforts at intellectual renewal. This coupled with a perception of declining NASA priority in aeronautics, can create an atmosphere where it is difficult to retain and attract the best and the brightest.

I am also concerned that the declining aeronautics budget coupled with fixed obligations and congressionally mandated earmarks have reduced the ability of the NASA aeronautics program to pursue innovative new ideas and emergent research needs.

**What steps should the government take to better address the Nation's strategic civil aeronautics needs? If continued research has an important role to play, what should be its priorities? How do you recommend NASA balance investment in evolutionary research against revolutionary, high-risk, high-payoff research?**

I believe that the Nation must recognize the civil and military importance of aeronautics and commit to maintaining the health and vitality of the national capability in aeronautics. A vital element of this capability is a healthy research program which builds core knowledge, stimulates innovation, builds intellectual capital, creates opportunity and solves emergent problems in the civil air transportation system.

I believe that NASA is most effective when it focuses on fundamental issues and longer term innovative research and hands off the results to industry or the operating agencies such as FAA to implement. To this end NASA must continue to build close ties to industry and other government agencies. The JPDO has the potential to be a conduit for this collaboration.

In terms of priority I would focus on building the knowledge base and national workforce to address the challenges to civil aeronautics identified above.

To this end, I would urge NASA to take more risks and to actively stimulate innovation. I would also urge NASA to increase the opportunity space in aeronautics for new faculty and students through an increased focus on small single investigator, projects or grants. The investment is not large but the potential for innovation and growth of the nations capability is huge.