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U.S. Senate Commerce Committee**

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Mr. Chairman and members of the Subcommittee, I appreciate the opportunity to share my observations and vision on the future of the United States Aerospace Industry with you today. My comments this afternoon will focus on the role of academia in partnership with government and industry and how that effective collaboration can propel the future of the United States Aerospace Industry.

**AVIATION AND THE GLOBAL ECONOMY**

The United States has been the world leader in aviation throughout the 20<sup>th</sup> Century. America's aviation industry has designed and built commercial, general aviation, and military aircraft used around the world, with exports resulting in a net favorable trade balance. Today the aviation industry competes in a global economic environment that is far different from that of the past. New challenges to our leadership are arising from aircraft manufacturers in Europe, the Pacific Rim, and Brazil. For example, the commercial airplane industry must now compete against the European Union (13 countries). The balance of trade in the aviation industry has shrunk from \$41 billion in 1998 to \$26 billion in 2001. Furthermore, new foreign government-supported research and test facilities, particularly in Europe, are attracting business from United States aircraft companies because of availability, quality of results, rapid response, and low costs.

To address this competition, the nation's research and development base for aircraft design and manufacturing must be expanded with support from the federal government in partnership with industry. The need for federal support of new research and test facilities and equipment is as acute as it is for basic and applied research. It is only through research and the application of new technology in aerodynamics, materials and structures, and aviation safety that the U.S. will maintain its leadership position in aviation throughout the 21<sup>st</sup> Century.

According to the Milken Institute's report of July 1999, entitled *America's High-Tech Economy*, Wichita, Kansas ranks 19<sup>th</sup> in the nation among high-tech metropolitan areas because of the city's high concentration of aviation industry. Wichita is second in the nation among aircraft and parts metros on the same basis. Prior to September 11, 2001, Boeing, Bombardier-Learjet, Cessna Aircraft, and Raytheon Aircraft provided more than 43,000 jobs and a \$2.1 billion annual payroll to the Kansas economy. The public is returning to commercial aviation as the only viable choice for long-distance travel, and

both commercial and general aviation are expected to recover from the recent economic downturn.

While the four major aviation manufacturers dominate employment in south central Kansas, there are 1,800 smaller manufacturing shops in the 13-county region surrounding Wichita. In addition, economists estimate that there are 2.6 jobs outside aerospace for every direct job within aerospace.

## **WICHITA STATE UNIVERSITY AND THE NATIONAL INSTITUTE FOR AVIATION RESEARCH**

Wichita State University (WSU) is located in the metropolitan setting of Wichita, Kansas and has partnered with local industry for the past 65 years. According to the National Science Foundation, WSU ranked seventh in the nation in aerospace research expenditures in 2000. The National Institute for Aviation Research (NIAR) was established on campus in 1985 to help address the aviation industry's research needs and has become a model for federal-state-industry-university partnerships.

NIAR is designated as a Kansas Technology Enterprise Corporation (KTEC) Center of Excellence, and is a partner in two FAA centers, the Airworthiness Assurance Center of Excellence and the Center of Excellence for General Aviation Research. The Institute was the recipient of the 2001 FAA Excellence in Research Award for its continuing contributions to aviation research, and its ability to partner with industry, academia, and government. NIAR, through its ties with industry, other universities, KTEC, and federal agencies provides an ideal focus for federal and state support to accomplish mutual goals for world leadership in aviation.

NIAR's mission is to conduct research, transfer technology, and enhance education for the purpose of advancing the nation's aviation industries. Located in a cluster of aviation industries, the Institute must be able to meet the research, testing, and technology transfer needs of these industries and the federal agencies that support aviation and establish certification regulations for the industry. With the assistance of an industry advisory board consisting of vice presidents of engineering of the local aviation manufacturers, NIAR has established thrust areas that are of primary importance to the industries, and plans to upgrade and expand its capabilities within these thrust areas. The thrust areas are as follows:

- Aerodynamics
- Aging Aircraft
- Composites & Advanced Materials
- Crashworthiness
- Icing
- Manufacturing
- Structures
- Virtual Reality

## **PARTNERSHIPS WITH INDUSTRY AND GOVERNMENT**

Permit me to review some of the Institute's previous success stories which involved forming a strong collaboration between academia, industry and government. One of the most successful partnerships developed as a result of NASA's focus on general aviation. The Advanced General Aviation Transport Experiment (AGATE) was a NASA cost-sharing partnership with industry to create the technological basis for revitalization of the general aviation industry in the United States. The goal of the program was to develop affordable new technology as well as the industry standards and certification methods for airframe, cockpit and flight training systems for next generation single pilot, 4-6 place, near all-weather light airplanes. I was chairman of the advanced materials working group from 1994 until the program ended in 2001.

During this time, the partnership with academia, industry, the FAA, and NASA helped establish certification standards for composite materials that revolutionized the way in which they are certified and used on aircraft by creating a series of composite material databases. Through these shared databases, a manufacturer can select an approved composite material system to fabricate parts and perform a smaller subset of testing for a specific application. Through the joint collaboration of two government agencies, the FAA and NASA, we were able to reduce the time required for certification of new composite materials by a factor of four and the cost of certification by a factor of ten. This model of composite material incorporation in applications and products has recently been adopted in the commercial transport and military aerospace industry as well.

Typically, each company desiring to use a composite material in a product design must conduct a qualification process for the material in order to verify its properties and characteristics. Even for identical material systems, each company usually selects a different "customized" qualification process leading to a very detailed and expensive procedure for each company. This cost increases further as other procedures must be established for structural testing, manufacturing control and repair procedures.

Thus, most programs are limited to using materials previously qualified for other programs which leads to using older, out-dated material and not taking advantage of the latest technology and material advances in the industry. A solution to this problem, as witnessed by the AGATE program is to establish a national localized center for composite material validation and quality assurance.

It is also worthwhile to note the paradigm shift that occurred as part of the AGATE program. Typically, one would think it better to spend federal research and development funding on larger commercial or military programs to advance the state-of-the-art. However, from collaboration with industry, government and academia, the AGATE program was able to achieve a paradigm shift by spending fewer research dollars in the general aviation market and applying the technology to large commercial transport and military programs. This is the case of small aircraft technology "spinning up" into large, complex aircraft designs and providing more cost-effective ways to achieve advanced performance as well as reduced costs. The application and transfer of these advanced

technologies are easier and faster in the general aviation and business jet community than in the large transport and military community.

Currently, Raytheon Aircraft Company is applying these advanced composite technologies on a new line of business jets, one of which is already certified and being produced. Cessna Aircraft Company, even in the present economic hardship of the aerospace world, announced at the National Business Aircraft Association meeting in September that it would be producing three new business jets. Using new technologies in applications that improve product performance and safety is essential in the 21<sup>st</sup> century's global market.

Another important research area in the aerospace industry is aircraft crashworthiness. In a 1995 aircraft market survey, analysts determined that safety is the primary concern among of general aviation aircraft pilots and passengers. For pilots, the level of safety offered by the aircraft was said to be the primary decision factor when purchasing a light airplane. For potential pilots (the "latent market" for airplanes and flight services), a lack of safety was the primary reason for not piloting light airplanes. And for potential passengers, a perceived lack of safety was the primary reason for not wanting to travel in light airplanes. The respondents of this survey were not given a definition of the term safety; they were allowed to use their own definition in formulating their response. Even though there were nearly as many concepts defining safety as there were people surveyed, safety can be broadly categorized into two areas. The first is control and minimization of factors that cause accidents, or accident prevention. The second is control and minimization of the factors that cause injury once an accident occurs, or injury mitigation. Designing for crashworthiness addresses this second category of safety.

Customer concern over the safety of general aviation aircraft is warranted, to some extent. Although declining, the accident rate of general aviation aircraft remains relatively high and the average number of general aviation accident-related fatalities remains significantly higher than other forms of air transportation. If general aviation or air transportation is to grow significantly and become the alternative to the hub and spoke air transportation system that the Commission report envisions, perceived and real safety must improve. The latent market (people interested in general aviation but not currently using it) will not participate without a stronger perception of safety. The general public has come to expect crash safety in their cars, and will likely demand the same from light airplanes.

Furthermore, crash safety at aviation velocities has been demonstrated in racecars and in full-scale small airplane and helicopter tests. While many of the improvements in overall safety should come from accident prevention through such areas as enhancements in the airspace infrastructure, flight systems, training, etc., the automotive experience has shown that privately owned and operated vehicles will continue to crash. A zero accident rate is not likely. The automotive industry has accepted this reality and designed crashworthiness into its cars; consequently, thousands of lives are saved each year. By designing crashworthiness into light airplanes, general aviation can see similar results. NIAR is currently working with the FAA, NASA and the aerospace industry to develop

and validate the analytical tools necessary to incorporate crashworthiness features into aircraft during the concept phase of development.

One of the most successful crashworthiness stories occurred just three months ago in Texas where a pilot in a Cirrus Design SR22 lost control of his aircraft mid-flight due to an aileron failure. Typically, this would have resulted in a fatality but instead resulted in an uninjured pilot who was able to walk away from the crash. Using a ballistic recovery parachute, which is a relatively new technology for small aircraft and was developed in a partnership with the FAA and the NASA-SBIR program, the pilot was able to safely deploy the parachute over an unpopulated area and turn an otherwise fatal event into an unfortunate accident.

In-flight icing also has a significant impact on the safety, operation, development and certification of helicopters and fixed-wing aircraft. In addition, icing hampers the operation of Unmanned Aerial Vehicles used for commercial and military applications. Recent accidents, such as the American Eagle ATR-72 in Roselawn, Indiana, in October 1994, and the Delta Connection (Comair) Embraer 120, near Ida, Michigan, in January 1997, which resulted in 97 fatalities, show that icing continues to be a serious safety concern. In fact since 1986, more than 300 fatalities have been attributed to icing-related airline accidents. Furthermore, the costs associated with aircraft design, testing and certification for icing are very high, especially for general aviation aircraft manufacturers. These costs are typically in the range of \$5 to \$10 million for a business jet aircraft. Research is needed to enhance aircraft safety and to reduce aircraft icing design and certification costs.

Wichita State University is currently one of the leading universities in the U.S. in aircraft icing research and continues to collaborate with government and industry to enhance aircraft safety and utility and to provide industry with the tools needed for reducing aircraft development and certification costs. During the last 20 years, researchers at WSU have been conducted more than 18 collaborative icing research programs involving NASA, FAA and the aviation industry. A number of these research efforts were in direct response to the 1997 NASA Aviation Safety Program, of which the goal is to reduce the aviation fatal accident rate by a factor of 10 by the year 2022. Collaborative icing research programs have resulted in a number of products ranging from aircraft ice protection systems, databases for aircraft design and certification, aircraft test methodologies, simulation tools for aircraft design, and pilot training aids.

As noted in the Commission report, human factors research must be a continued consideration. The Institute is presently focused on investigating ways to improve maintenance documentation available to personnel. Maintenance errors have been identified as a major contributing cause in approximately 12% of major aircraft accidents. The perception was that maintenance manuals are laden with errors. However, results from a study funded by the FAA Airworthiness Assurance Center of Excellence (AACE) showed that airline companies adequately provide valid and appropriate content. The problem lies in the cumbersome way in which the material is presented. Manuals should be prepared in a more “user-friendly” format, allowing ease in finding the relevant

technical documentation and improved sequencing of information for complex maintenance procedures. Technical writers must be familiar with how aviation maintenance is performed in order to effectively describe complex procedures.

One of the unexpected outcomes the human factors research program was the development of an education program to offer an Associate of Arts degree specializing in *aviation* technical writing. This new program at Wichita State University is designed to provide students with special aviation training so they can better understand how to effectively communicate maintenance instruction in the manuals. The program was created through a joint effort of WSU, the Wichita Area Chamber of Commerce and the Wichita Area Technical College (WATC). Local aviation manufacturers including Cessna, Raytheon and Bombardier, supported the program through research and program development that designed the curriculum and coursework.

In another collaborative effort, the Institute and Boeing Commercial Airplanes - Wichita Division are currently in the process of completing research on the effects of manufacturing defects on composite nacelle structure. This program was successful in reducing the cost of repairs and improving the first pass yield. It has also provided a substantial database for assessing damage that occurs in the fleet.

A relatively new quality assurance inspection technology has been investigated in the research and appears attractive for in-process manufacturing inspection. Further research aimed at facilitating the technique for use in aircraft production may result in a small business opportunity for producing associated equipment.

Another important area that requires serious investigation is the current aging aircraft problem. Economic and market conditions of present-day airline companies are requiring the use of commercial and military airplanes far beyond their original design life expectancies. The general aviation fleet consists of more than 215,000 aircraft, of which more than 25,000 are over 50 years of age and are still flying and being resold. This aging airplane concern is being amplified as more airline companies use aged aircraft and rely on standard inspection practices for a guarantee of airworthiness assurance. NIAR recently opened a new laboratory that will focus on the integrity and aging aspects of small airplanes in commuter service. With funding through the FAA Airworthiness Assurance Center of Excellence and in partnership with several original equipment manufacturers and airline companies, this new laboratory will explore aging concerns in the commuter aircraft fleet and establish guidance to ensure that current maintenance programs of small general aviation airplanes are providing acceptable levels of continued airworthiness.

## **COMMISSION REPORT ON THE FUTURE OF THE AEROSPACE INDUSTRY**

In conclusion, I know we all agree that the future of aerospace is critical to national security, transportation mobility and freedom, economic well-being and quality of life for the American people. The Commission's sense of urgency to address the needs of the

aerospace industry cannot be ignored. America's leadership in aerospace is becoming threatened.

On December 17<sup>th</sup>, 1903, the brothers Wilbur and Orville Wright flew their Wright Flyer from level ground under engine power alone and made aviation history for the United States. It would be historically appropriate if the world dominance of the United States Aerospace Industry could be assured for the next 100 years through new and dynamic federal programs and policies.

I would like to thank you for the opportunity to testify today. I would be happy to answer any questions you might have.