WSU’s National Institute for Aviation Research Provides Services Based on Needs of Wichita Aviation Industry

Tom Aldag
National Institute for Aviation Research, Wichita State University, Wichita, Kansas

The National Institute for Aviation Research (NIAR) at Wichita State University is a unique state-of-the-art facility that provides research, design, testing, certification and educational services to the aviation industry, non-aviation clients, government agencies and educational entities. It is the largest academic aviation R&D institution in the United States. With 135,000 square feet of laboratory space, NIAR is home to more than a dozen laboratories that specialize in advanced joining and processing; aerodynamics, aging aircraft, composites and advanced materials; crash dynamics, environmental testing, fatigue & fracture, full-scale structural testing, human factors, structures, virtual reality, CAD/CAM and computational mechanics. Despite the current economic downturn, research at NIAR is thriving and expected to continue to do so.

Key words: Advanced materials; aerodynamics; aerospace; aging aircraft; Beech Wind Tunnel; certification; development; testing; structural and mechanical performance; research; simulation.

Wichita State University (WSU) has been intimately linked with the Wichita aviation industry for more than 60 years. Early partnerships with local aircraft manufacturers led to the development of a successful business model now utilized by WSU’s National Institute for Aviation Research.

In the late 1940s, WSU partnered with Walter H. Beech, former president of Beech Aircraft Company, and Dwane L. Wallace, former president of Cessna Aircraft Company, to develop and construct a low-speed wind tunnel for mutual use. The Walter H. Beech Memorial Wind Tunnel still exists (Figure 1) and is now a part of WSU’s National Institute for Aviation Research (NIAR) (Figure 2). The tunnel has undergone modernizations throughout history; most recently, a $7 million overhaul transformed it into a state-of-the-art research facility.

Based on the wind tunnel’s early success in partnering with local industry, NIAR was founded in 1985 to provide research, transfer technology, and enhance education for the purpose of advancing the nation’s aviation industries, and this mission is at the heart of its success as a research institution. NIAR bases its operations on suggestions from an Industry Advisory Council comprised of the engineering vice presidents of local manufacturers including Boeing, Bombardier Learjet, Cessna, Hawker Beechcraft, and Spirit AeroSystems. Suggestions from this council allow NIAR to determine in which types of technologies, equipment, research, and laboratories the institute should invest. The council also works...
ment. This technology is expanding as the analysis software becomes more capable. The ability to perform simulations increases the number of scenarios that can be investigated without destroying hardware. Increasing scenario simulation, along with test validation of the models, increases confidence and decreases liability in designs.

**Crash Dynamics Laboratory**

The Crash Dynamics Laboratory provides research, testing, and certification of aircraft and nonaviation components under dynamic impact (simulated crash) conditions. The driving force of the lab is an accelerator sled system manufactured by MTI, one of only two in North America. This state-of-the-art system provides a repeatable test platform with easy acceleration profile changes based on customer need. Seat safety is an active area of research and certification and will continue to be important in all areas of transportation. Research in other areas, such as blast response and mass transit safety, is expected to increase in the future.

**Environmental Testing Laboratory**

The Environmental Testing Laboratory provides the aviation testing capabilities needed to meet environmental standards requested by Federal Aviation Administration technical standard orders using RTCA/DO-160 as a reference. As more electronics are used in aircraft and as critical systems become more integrated, the need for this type of testing will increase.

**Full-Scale Structural Testing Laboratory**

The Full-Scale Structural Testing Laboratory provides assessments of structural performance and durability of commercial and military aircraft by performing full-scale structural testing and research activities. This necessary step in the research and development process will continue as new aircraft are designed and certified. This lab can also support research and development for wind turbine and related projects, which is a quickly growing industry.

**Mechanical Test Laboratory**

The Mechanical Test Laboratory conducts static and fatigue experiments to generate material strength allowables and evaluates the endurance of materials subjected to cyclic loading. The laboratory supports both metal and composite testing and research. As new materials are introduced in airframe structures, full characterization of their properties is necessary. The continued development of new materials will ensure a full test schedule for this lab.

**Figure 3.** Typical aircraft manufacturer laboratory utilization usage.

**The NIAR Model**

The NIAR model works because of the cyclic nature of the aircraft manufacturing industry (Figure 3). The typical aircraft development cycle ranges from one to five years, and sometimes longer (Figure 4). During gaps in development cycles, it is common for these companies to lose skilled workers to other projects. At the same time, investment in new lab equipment is low, often resulting in outdated equipment. With four original equipment manufacturers (OEMs) and nearly 200 Tier 2 suppliers in the Wichita area that need similar research, NIAR is able to maintain state-of-the-art equipment, technology, and skilled workers by combining these diverse development cycles (Figure 5).

NIAR also keeps these laboratories busy with research for government agencies such as the Federal Aviation Administration, the U.S. Air Force, and the National Transportation Safety Board. Furthermore, several of the laboratories are able to provide nonaviation companies with necessary services. For example, the wind tunnel has hosted a downhill skier, Olympic cyclist, curbside dumpster, snowmobiles, motorcycles, and car toppers, just to name a few. And the Crash Dynamics Lab has performed research and testing for mass transit bus crashworthiness and child safety seats.

**Figure 4.** Aircraft development cycle lengths (single company).
closely with NIAR at the state level to help secure funding for selected investments.

NIAR is home to the following laboratories that offer services to the aviation industry, nonaviation companies, government agencies, and other educational entities. These laboratories operate on a contractual basis with defined rates for commercially and federally funded projects. Most of these contracts include nondisclosure agreements in order to protect proprietary information. The focus of the Wichita aviation industry is mostly airframe design, manufacturing, and systems integration. Thus, most of NIAR's laboratories focus on airframe advancements rather than engine technology or avionics.

**Advanced Joining & Processing Laboratory outlook**

The Advanced Joining & Processing Laboratory identifies and addresses needs in friction stir welding, friction stir processing, and friction stir spot welding. The team provides knowledge, expertise, and experience to solve industry challenges from concept through production implementation. The lab's future looks promising as additional opportunities emerge to incorporate the technology on aircraft components and other structures by joining high-strength aluminum that previously had to be riveted or bonded.

**Aerodynamics Laboratory**

The Aerodynamics Laboratory consists of a flow visualization wind tunnel and the premier 7-foot and 10-foot Walter H. Beech Memorial Wind Tunnel. The lab also has access to WSU's 3-foot × 4-foot subsonic wind tunnel and two small supersonic wind tunnels. The lab continues to diversify its client base to include not only aircraft manufacturers, but other industries such as all-terrain vehicle and wind turbine blade manufacturers. In the future, we expect more research on efficiency improvements through better aerodynamic designs. This is especially relevant given the need to conserve fuel in air and ground vehicles. Wind energy research and development is also expected to expand and benefit from wind tunnel technology.

**Aging Aircraft Laboratory**

The Aging Aircraft Laboratory supports the federal government and the aviation industry with investigations into the effects of age on commercial and military aircraft. The demand for aging investigations continues to rise as the fleet ages, getting pushed to their life limits and beyond. Safely extending airframe lives and identifying critical structures is a way to optimize resources. In this economy, as budgets tighten, more research in this area is expected.

**CAD/CAM Laboratory**

The CAD/CAM Laboratory provides training and course manuals for CATIA V5 computer-aided design software, the design standard in aerospace. Design and analysis capabilities continue to expand, and integration is becoming more important in the design process. For example, engineers can now draft and perform structural analysis on the same model. The software capabilities continue to expand; therefore continued training is necessary for engineers to utilize the software to its full potential.

**Composites & Advanced Materials Laboratory**

Researchers and technicians in the Composites and Advanced Materials Laboratory perform lay-up and bonding operations to understand the effects of heat, moisture, contamination, and repairs on advanced materials. The lab also provides regularly scheduled hands-on training workshops in composites and repairs on advanced materials. The lab also provides regular scheduled hands-on training workshops in composites and repairs on advanced materials. As more composites are used, it is crucial to understand the effects of process variables during manufacture as well as their effects during field repair. Composite research, especially in the areas of new material development and repair, will be robust for many years.

**Computational Mechanics Laboratory**

In the Computational Mechanics Laboratory, research is focused on the development and application of numerical methods in the areas of crashworthiness, injury biomechanics, aircraft structures, numerical optimization techniques, and virtual product develop-
NIAR's strategy to fulfill industry need has proven successful through ups and downs in the aviation industry. In fact, NIAR's operating budget has steadily increased from $11.2 million in 1998 to $35.8 million in 2008. Even during downturns in the economy, research and development (R&D) tends to thrive. Most companies realize that they have to be poised for turnarounds, so they continue to invest in R&D and new product development. Many of our laboratory schedules are currently full and we are optimistic that this trend will continue.

Tom Aldag joined NIAR as director of research and development in 2007. He specializes in new materials and fabrication methods, and syncing NIAR's research and development capabilities with government and industry needs. He has also recently started collaborating with local surgeons on a wide variety of new product designs. Aldag has 25 years of airframe structural design experience and 13 years of composite structure design experience within the aviation industry. He was most recently director of propeller products engineering for Cessna Aircraft. In this capacity, he managed four engineering departments covering eight production aircraft models, McCauley propellers, and legacy aircraft. Aldag graduated from Wichita State University in 1983 with a Bachelors degree in Aeronautical Engineering. He is a Six Sigma Greenbelt, has a mini-MBA from Wichita State, and is a 2000+ hour pilot and flight instructor. E-mail: thomas.aldag@wichita.edu