NIAR BREAKING THROUGH BARRIERS

2004 ANNUAL REPORT
NATIONAL INSTITUTE FOR AVIATION RESEARCH

A Kansas Technology Enterprise Corporation Center of Excellence

WICHITA STATE UNIVERSITY
Located on the Wichita State University campus, in a city recognized as the Air Capital of the World, NIAR integrates university, government and business entities in cooperative efforts to advance technologies for aviation and other industries. Our 120,000 square foot facilities are recognized internationally as a high-tech research and development, testing, certification and learning center.

Aviation has been in the Wichita community for many years, and since 1984, NIAR has been its pulse. Since that time, we have made a name for ourselves as one of the few state-of-the-art aviation research centers in the United States recognized for our contributions to aviation safety and performance.

As you explore our annual report, you will see that our role in the revamping of aircraft design and manufacturing will help the aviation industry meet their goal of making the skies friendlier and more cost-efficient.

MISSION

To conduct research, transfer technology and enhance education for the purpose of advancing the nation’s aviation industries that may benefit from aviation related technologies.
Dear Colleagues:

The past year at the National Institute for Aviation Research (NIAR) has been one of discovery and unparalleled progress. As the theme of our annual report indicates, we have broken through many barriers and shown that the combination of academia, industry and government can produce a true state-of-the-art aviation research facility. This collaboration has generated exciting renovations in two of our major laboratories and resulted in an innovative technology partnership that has greatly expanded our testing and research capabilities.

The Walter H. Beech Memorial Wind Tunnel underwent its first major renovation since its creation in 1949. The tunnel provides users with critical testing important to aircraft design and, although it has experienced small updates in the past, this major upgrade focused on the principal components resulting in a significantly improved facility. As this tunnel becomes operational and begins performing for the industry, Kansas and Wichita will become known as the location of the premier low-speed wind tunnel of its category in the nation. The second laboratory upgrade was the replacement of our horizontal crash system in the Crash Dynamics Laboratory. This upgrade and expansion gives NIAR the ability to become a world leader in the continual evolution of dynamic test requirements for aircraft occupant protection systems, as well as advanced systems for automotive applications. Both of these upgrades were made possible with state and federal support through the continued backing of NIAR by the Kansas State Legislature, KTEC, and the Kansas congressional delegations.

NIAR and WSU also embarked upon another enterprise in establishing the Aircraft Structural Testing and Evaluation Center. The center was created as part of an agreement with Raytheon Aircraft Company in which the Institute has occupied and is supplying testing services in the Full-Scale Structural Testing Laboratory at Raytheon’s manufacturing campus in Wichita, Kansas. Included in the center are 46,000 square feet of hangar space, access to an 8,000-foot runway and approximately $10 million in reliable test equipment. This laboratory strengthens NIAR’s structural testing and aircraft evaluation capabilities and allows us to offer expanded services to all aviation manufacturers and designers from around the world who utilize our research team. In addition to the acquired facilities, NIAR also gained 18 additional full-time staff members whose expertise in structural testing exceeds 300 years, making the laboratory one of the most experienced structural testing centers in the world.

The benefits gained from relationships such as these have led to the creation of centers of excellence, and this year provided two such examples. In 2004, we were proud to announce the establishment of two advanced materials-related centers of excellence sponsored and supported by the Federal Aviation Administration (FAA) and the National Aeronautics and Space Administration (NASA). The FAA Center of Excellence for Composites and Advanced Materials (CECAM) and the NASA National Center for Advanced Materials Performance (NCAMP) work together to promote technology integration that will achieve significant cost and cycle-time reductions in new material insertion as well as conducting basic and applied research within specific technology areas. These centers also facilitate growth in the use of advanced materials while supporting the safety and certification issues involved in airworthiness assurance.

The combination of these centers will benefit the aircraft industry in both advanced research and the demonstration of cost savings in advanced materials applications.

As NIAR looks to the future, support from federal and state governments is essential in helping the aviation industry remain competitive in the world market. This support will assist in the establishment of the Advanced Joining Laboratory during CY 2005, which allows the joining of aerodynamic structures without rivets, and will build the world’s 4th largest icing research facility at NIAR.

As advances in aircraft development will likely accelerate during the next decade, new emerging technologies will be applied to design and placed into production throughout the industry. Because of the close cooperative partnership of industry, government and academia, NIAR will continue to break through more barriers in its mission of conducting research, transferring technology and enhancing education directed toward the support of the nation’s aviation and non-aviation industries.

Please visit our website at www.niar.wichita.edu for additional information about our capabilities and resources.

Sincerely,

John S. Tomblin, PhD
Executive Director, NIAR
Sam Bloomfield Distinguished Professor of Aerospace Engineering
In addition to funding received through grants and contracts, NIAR appreciates the continued support from the state legislature and our congressional delegation. The interest and support of Senators Roberts and Brownback and Congressman Tiahrt have been especially helpful.
It has been quite a year for the Aerodynamic Laboratories, which incorporates the Walter H. Beech Memorial Wind Tunnel and the Flow Visualization Lab. Beginning last October, the wind tunnel underwent a $6 million upgrade. The following equipment was replaced as part of the upgrade:

- 2,500 horsepower fan
- Heat exchanger
- Flow conditioning equipment
- External balance

Airspeeds in excess of 230 mph have been observed with test section temperature below 95 degrees. Prior to the upgrades, the tunnel’s speed was confined to approximately 150 mph winds and its temperature could rise above 150 degrees.

These improvements have established the tunnel as the state-of-the-art wind tunnel of its class in North America.

The water tunnel has greatly expanded its testing areas with the addition of the following:

- Modern photo, video and lighting equipment
- Force measurement apparatus
- Survey probe

These upgrades have increased the labs capacity and enabled it to expand beyond flow visualization to measuring forces and survey wakes of models.

In the coming year, the Aerodynamics staff will bring the two labs into full operation, while polishing and perfecting their proficiency with the new systems. The staff is also in the early stages of implementing new technologies that will take the labs usability to a new level...stay tuned.
Over the last year, the Aging Aircraft Lab has greatly expanded its capabilities with its relocation to the Aircraft Structural Testing and Evaluation Center (ASTEC) at Raytheon Aircraft Co. This relocation allows the lab to take on full-scale investigations into industry’s growing fleet of aging aircraft.

As the age of our military and commercial fleets increases, the need to provide industry with information about the consequences of aging aircraft becomes more prevalent. With this in mind, the Aging Aircraft Lab has conducted numerous studies on some of the world’s most sought-after and well-known aircraft. Over the last two years, the lab has been engaged in several research projects:

- FAA teardown evaluation: Piper Navajo and Beechcraft 1900D
- B-52 wing sections
- B-52 flight control and landing gear assemblies
- C-5A major structural components
- C-130 center wing section
- F-16C static test article

### 2004 Projects:

**Research:** Completed aging studies for the FAA on two small commuter aircraft, the Cessna 402A and 402C.

**Objective:** Provide insight into the condition of a typical aged airplane and to determine whether a correlation exists between maintenance history and current condition from a safety of flight perspective.

**Research:** Conducted a comprehensive teardown and inspection on B-52 wing sections and major structural components on the C-5A aircraft.

**Objective:** To find any unexpected damage in inaccessible areas and examine areas with expected damage and confirm the extent of the damage.

**Research:** Conducted detailed disassembly and inspection of flight control and landing gear assemblies from a retired B-52G aircraft.

**Objective:** To determine condition of components and develop overhaul procedure for replacement of assemblies on active B-52H aircraft.

**05’ Research:** Programs will continue for the FAA, B-52 and C-5A with additional teardown and inspections proposed on C-130 and F-16 aircraft.
Icing research is an issue pertinent in all areas of aviation because it is a hazard on many levels. As one of the nation’s leading universities in aircraft icing research, the goal of NIAR’s Aircraft Icing Research Center is to conduct research that will contribute to the worldwide effort to reduce icing-related accidents.

As part of this continued effort, the center has established a working relationship with U.S., Canadian and European governments and universities.

It is through these relationships that NIAR is capable of maintaining its reputation in the icing industry and conducting a variety of research that will keep aircraft safe.

2004 Projects:

**Research:** Compilation of Experimental Water Droplet Impingement Data Obtained by WSU – FAA

**Research:** Experimental Investigation of Hot-Air Ice Protection Systems; NASA
**Objective:** Generate an extensive thermal database for code development and validation and to support the design of hot-air ice protection systems and develop a high precision wind tunnel model equipped with a hot-air ice protection system for testing in a large icing tunnel facility.

**Research:** SLD Impingement on Ice Shapes; FAA
**Objective:** Generate an experimental database of small and large droplet impingement on progressively larger LEWICE ice shapes for the validation of trajectory codes used in aircraft icing analyses.

**Research:** Simulated Icing Test Nozzle Design and Feasibility Study; NIS
**Objective:** Development of airborne spray systems capable of simulating SLD as well as Appendix C icing conditions.

**Research:** Development of a Reference LWC probe for Appendix C and SLD Conditions; FAA
**Objective:** Ensure that reliable measurements of LWC in icing tunnels can be obtained for SLD conditions.

**Research:** Computational Study of Large Droplet Dynamics in the Vicinity of an Airfoil; FAA
**Objective:** To conduct a complete literature review of droplet breakup studies and perform two-dimensional numerical simulations of small and large droplet breakup in the proximity of airfoils in support of future research to develop experimental data and simulation tools.

**Research:** Test Methods and Visualization Tools for Large Droplet Dynamics Experiments; NASA
**Objective:** To develop visualization method for investigating droplet splashing from an ice shape in a wind tunnel. This project will address the development of new or re-defined visualization methods that can provide quantitative information on the splashed droplet size, velocity and concentration in the future.

**Research:** Ice Particle Trajectory Program - ADMRC/NASA
**Objective:** To develop experimental and computational methodologies for determining the trajectories of ice particles shed from aircraft surfaces during icing encounters. The end goal will be the development of a simulation tool for use in aircraft icing certification.
Over the past year, the Composites and Advanced Materials Lab has begun work with NIAR's two newly established centers in advanced materials – the FAA Center of Excellence in Composites and Advanced Materials (CECAM) and the NASA National Center for Advanced Materials Performance (NCAMP). These centers provide the backbone of the research thrusts of the lab and provide support to the aircraft industry.

The lab has experienced some significant developments during the past year:

- Staff size has increased by approximately 75 percent; presently there are 7 full-time managers, 12 full-time engineering support staff and 46 undergraduate/graduate students working within the lab.
- Supported development and material characterization efforts of approximately 42 aerospace and non-aerospace related companies. These efforts included non-metallic as well as metallic advanced materials.
- Capability increased by the addition of a multi-axis ultrasonic inspection unit, scanning electron microscope, additional layup facilities, environmental chambers, thermal analysis equipment and various machining and measurement equipment.
- Published several FAA technical reports related to adhesive bonding, damage tolerance and material and process specification guidelines for composites.
- Sponsored two FAA workshops related to material and process specifications for liquid resin molding and adhesive bonding. These workshops were held in Chicago, IL and Seattle, WA, respectively.

2004 Projects:

**Research:** Repair of Composite Aircraft Structures

**Objective:** Answer not only the fundamental questions related to the proper repair methods/systems required to restore the aircraft part structural integrity, but also the question of how long the repair will last under the specified design conditions and what are the most critical factors affecting the static performance and the long-term durability of the repair.

**Research:** Design Philosophies for Structures Utilizing Metal and Composites with Large CTE Differences

**Objective:** Develop design data and design philosophies for accommodation of thermal effects within large aircraft composite/metallic assemblies.

**Research:** Aging of Composite Aircraft Structures

**Objective:** Investigate the aging aspects of composite, non-metallic structures which possess actual age and service history and provide airworthiness assurance of these composite components. These investigations will use a decommissioned 737 horizontal stabilizer and a Beechcraft Starship for the research.

**Research:** Adhesive Characterization and Element Testing of Fatigued and Damaged Bonded Joints

**Objective:** Identify characteristic responses of bonded structures to real world manufacturing and repair defects. The work will also establish guidelines for adhesive and process controls for bonded structures.

**Research:** Seat Cushion Component Test Validation

**Objective:** To develop and validate a component test method that can be used to certify cushions for 16-g seats. This investigation used a high-rate test machine on a wide variety of flotation and non-flotation materials developed for seat cushion component replacement.

**Research:** Full-Scale Fuselage Testing and Damage Tolerance

**Objective:** The development of the complete understanding of a number of characteristics of damage states of sandwich composites. This requires a full-scale test to assure that the conclusion drawn from the lower level testing applies at the full-scale level.
Lights, camera, action aren’t three words you would typically hear when thinking about a crash lab, but they are three of the most important components of the research that help determine what happens during a crash. It is the mission of the Crash Dynamics Lab to provide the highest level of professional testing services to its various clients and constituents.

In keeping with that philosophy, the Crash Dynamics Lab undertook a major systems renovation that raises the bar for its mission statement of providing clients with a state-of-the-art service center replete with technologically advanced test equipment to aid in the research, design, testing and certification of occupant protection systems.

The Crash Dynamics Lab is also capable of replicating any crash pulse upon a wide range of surrogate occupants, provide visual documentation of the crash simulation through high-speed, high-resolution color imagery and within minutes, present the video and instrumentation data for analysis.

This is all possible since the addition of the following upgrades:

- **MTS Model 888.20 Crash Simulator** capable of replicating a wide range of crash pulses of amplitudes up to 75 g.
- **High-resolution (1536x1024 pixels), high-speed (up to 10,000 frames per minute) video cameras** capable of operating both on and off the sled and of immediate playback of the crash simulation.
- **Wide range of surrogate occupants** to include Hybrid II 50th, Hybrid III FAA 50th, Hybrid III 50th (NHTSA), Hybrid III 95th, and a EuroSID II. The near future will see an expanded family of surrogates that will include the Hybrid III 5th Female and a range of infant and adolescent surrogates.
- **Data Acquisition System** capable of sampling rates up to 50K samples per second per channel. Immediate download of data for signal conditioning, post-processing and presentation.

THE CRASH DYNAMICS LAB HAS THE CAPABILITIES TO CONDUCT COST-EFFICIENT, SECURE AND PROPRIETARY TESTING FOR THE AVIATION AND AUTOMOTIVE INDUSTRY.

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During the past year the Ergonomics Lab has performed research in many different and diverse areas, all relating to the human body at work.

The effect of aging on the human body and its capabilities continues to be important from a functional and occupational standpoint. One of the areas addressed was the body’s reaction to exposure of vibration in an occupational setting. This area was investigated in the field setting during the use of heavy mobile construction equipment, as well as the vibration experienced in the upper extremity when riveting and using bucking bars in the aircraft manufacturing industry.

The lab has also continued to investigate muscle size aspects of the human body through magnetic resonance imaging, in addition to investigating the different design aspects of computer mouse input devices. Finally, the lab has initiated and will continue to perform workplace research on the practice of utilizing job rotation in a manufacturing setting in an effort to reduce occupational injuries.

### 2004 Projects:

<table>
<thead>
<tr>
<th>Research</th>
<th>Objective</th>
</tr>
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<tbody>
<tr>
<td>Balance of Elderly Independent Living Residents</td>
<td>Quantify balance and sway of independent living residents to identify measures for prediction of risk of falls.</td>
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<tr>
<td>Low Back Pain and Mobile Construction Equipment</td>
<td>Investigate the effect of a passive cyclic lumbar seat support on low back discomfort during the operation of large mobile construction equipment.</td>
</tr>
<tr>
<td>Job Rotation in the Manufacturing Sector</td>
<td>Determine the prevalence of use and objectives and benefits of job rotation.</td>
</tr>
<tr>
<td>Ergonomic Assessment of Riveting and use of Bucking Bars</td>
<td>Quantify the difference in grip force and vibration transmission to the hands of bucking bars of different materials for aircraft riveting.</td>
</tr>
<tr>
<td>Torso Muscle Quantification for Biomechanical Modeling</td>
<td>Quantify the distance of the female rectus abdominis muscle from the spine in an upright standing posture, compared to that from lying supine.</td>
</tr>
<tr>
<td>Ergonomic Assessment of Five Different Computer Input Devices</td>
<td>Quantify the shoulder and forearm muscle activity and posture when using different mouse designs for computer input.</td>
</tr>
</tbody>
</table>

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Since the creation of the Fatigue & Fracture Lab in November 2003, it has seen tremendous growth. The lab currently houses 15 servo-hydraulic load frames for durability and damage tolerance testing along with advanced equipment for monitoring crack growth and compliance changes in both metallic and non-metallic materials.

The mission of the Fatigue and Fracture Lab is to test the endurance of materials subjected to fatigue under cyclic loading. Fatigue experiments are conducted to generate S-N curves and/or fatigue crack propagation data to help assess the fatigue characteristics of materials to be used in metal and composite structures or to quantify fatigue damage accumulation and residual fatigue life in older aircraft.

2004 Projects:

**Research:** Data and Methodologies for Structural Life Evaluation of Small Airplanes
**Objective:** To develop a structural fatigue life evaluation methodology for small airplanes. The methodology provides a direct approach that takes into consideration individual structural details and full-scale structural complexities to generate an effective stress concentration factor.

**Research:** Friction Stir Welding of Aluminum Alloys
**Objective:** Friction stir welding is a relatively new process to weld aluminum. The static, fatigue & fracture properties along with the effects of corrosion on the weld nugget are being investigated for several Al alloys used by the aircraft industry.

**Research:** Fatigue Crack Growth Testing to Quantify the Effects of Shot Peening for Metallic Rotorcraft Components
**Objective:** To support the FAA in extending the rotorcraft damage tolerance (RCDT) methodology to apply to rotorcraft components in which shot peening or other surface treatments have been made to suppress fatigue crack growth (FCG).

**Research:** Fabrication, Testing and Analysis of Carbon/Glass Hybrid Composites
**Objective:** To fabricate, test and analyze anisotropic hybrid laminate configurations, representative of laminates used in wind turbine blade applications, manufactured using a vacuum-assisted resin transfer molding process.

**Research:** Effects of Dents on Fatigue Life of Aluminum Alloys
**Objective:** To investigate the effect on fatigue life and crack growth of the dents and processes to rework the dents commonly used by the aircraft industry.
In an innovative technology arrangement between industry and academia, the National Institute for Aviation Research has obtained the Full-Scale Structural Testing Lab located at Raytheon Aircraft’s manufacturing campus in Wichita, Kan. The arrangement was announced on Sept. 24, 2004, with the occupation beginning immediately.

This lab is the Institute’s Aircraft Structural Testing and Evaluation Center (ASTEC), which provides research and testing services to other aircraft manufacturers as well as governmental agencies.

Included in the Aircraft Structural Testing and Evaluation Center are:
- 46,000 square feet of hangar space
- Access to an 8,000-foot runway
- Approximately $10 million in reliable test equipment

Raytheon Aircraft was the Institute’s launch customer. The lab provides structural testing for Raytheon Aircraft’s entire product range, including current work on the Hawker Horizon fatigue and static tests.

With these additional substantial test facilities from Raytheon Aircraft, NIAR’s structural testing and aircraft evaluation capabilities are strengthened. The Institute now offers expanded services to the leading aviation manufacturers and designers from around the world who utilize the NIAR research team.

The innovative arrangement allows NIAR to establish a national center for full-scale testing services to the broader aviation community.

**Focus Areas:**
- Full-Scale and Component Testing, such as static, durability and damage tolerance testing
- Pressure Cyclic Testing
- Hail Strike Testing
- Drop Tower for Landing Gear Testing
- Coupon Test Lab
- Aircraft and Component Instrumentation Lab
- Tireburst/Explosive Effects

**Annual Summary**

While most analytical tools are unable to predict a structure’s reaction to loading and environmental conditions, the testing center can assess structural performance and durability by performing full-scale static and fatigue tests.
Annual Summary

By studying how humans accomplish work-related tasks, the Human Factors Lab is capable of applying knowledge of a person's sensory and cognitive processes to the design of products and systems. Through this relationship, businesses and individuals learn more about how certain tasks are accomplished and how they can be improved.

Over the past year, the lab has continued to work with the aviation industry and local businesses on how to improve their efficiency.

Specifically, in 2004, the lab continued its work with aviation technical writing groups at four aircraft manufacturers to research ways in which reliability of maintenance documentation may be improved. Also in 2004, two FAA-funded projects have been completed, three are near completion, and two are scheduled for completion in fall 2005.

Focus Areas:
- Aviation Maintenance
- Pilot Information Management
- Multi-Tasking Performance

Completed FAA Projects for 2004

Objective: To compare techniques that manufacturers can use to improve the quality of the maintenance documentation developed by technical writing groups.

Research: Evaluation Toolbox for Aviation Technical Writers.
Objective: To develop an aid for writers to evaluate the usability of aviation maintenance documentation -- from the initial development stage through the final pre-publication stage.

Flight Training Completed Project for 2004

Research: Review of the FAA/Industry Training Standards (FITS) Program: Program tasks, goals and pilot training initiatives
Objective: To review the current state of research and technology needed to support the goals of the FITS program. This information can be used by the FAA to identify research areas that would aid achievement of FITS’ goals.
Over the last year, the Structures Lab has expanded its capabilities by adding two additional ARAMIS photogrammetry full-field strain measurement systems with higher data acquisition capabilities and a laser extensometer for non-contact strain measurements. A custom designed 600-kip structural test frame and a two 67-kip MTS electromechanical load frames were also added to strengthen test capabilities.

The Structures Lab staff works with federal agencies as well as general aviation, commercial and military companies to conduct research on advanced materials. This facility is equipped with a variety of servo-hydraulic load frames to perform static and spectrum fatigue tests in temperatures ranging from -100°F to 600°F. During the past year, numerous composite material qualifications were accomplished and a number of specialized test procedures were developed for various customers.

2004 Projects:

| Research | laminate statistical design allowable generation for fiber reinforced composite materials |
| Objective | recommend a reduced laminate qualification test matrix and statistical methodology for inclusion into military handbook 17 and publish a FAA guideline and methodology document |
| Research | damage tolerance of laminated composites and adhesive joints |
| Objective | generate adhesive design allowables and effects of defects data for adhesive joints |
| Research | design & analysis for braided composite material |
| Objective | generate design allowables for tri-axial braided composite and develop a design and analysis methodology for braided structures |
| Research | crashworthiness of composite fuselage structures |
| Objective | experimental investigation of the high-strain rate effects on the mechanical properties of laminated composites |
VIRTUAL REALITY

Annual Summary

Since early 2003, the Virtual Reality Center (VRC) has steadily increased its capabilities with acquisition of several devices and customization of commercial software which address conception to engineering to manufacturing phases in aircraft development cycle.

Throughout the past year the VRC has updated equipment and infrastructure. Infrastructure improvements include customization and fine-tuning software integration of virtual reality input/output devices (head-mounted displays, motion trackers, gloves and sound system) and remote collaboration.

2004 Projects:

**Research**: Completed a comprehensive VR simulation involving WSU Psychology Dept. and Cessna.
**Objective**: Evaluate level of effectiveness of VR in assembly and disassembly tasks by using PTC Division Reality.

**Research**: Provided technical support and real-time database preparation for WSU Industrial Engineering Dept and Aerospace Dept. projects.
**Objective**: Database simplification and VR visualization involving National Science Foundation projects.

**Research**: Conducted tests to evaluate run-time systems and provided technical support to Cessna Virtual Reality Center.
**Objective**: Evaluate & improve visualization performance in SGI Onyx servers to virtual prototyping design reviews using Dassault Systems Enovia DMU.

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In 2004, the CAD/CAM Lab provided 54 CATIA V5 courses to approximately 600 students. In addition, the lab provided on-site training to companies and has provided curriculum to a number of schools and companies. The lab continues to expand its curriculum by working on new courses and is starting to develop ENOVIA courses as well.

The CAD/CAM Lab offers a number of courses for industry employees and WSU students. Some of the classes offered include: CATIA V5 Part Design & Sketcher, Assembly Design, Drafting, Wireframe & Surfaces, Fitting Simulation & Kinematics, Prismatic Machining, and Surface Machining.

Courses in Development:
- CATIA V5 Functional Tolerancing & Annotation
- CATIA V5 Stress Analysis
- ENOVIA Assembly

On-site training provided to:
- Rocketplane Limited Inc.
- GKN Aerospace
- Cessna
- Boeing Wichita

On-site support provided to:
- Cessna

Curriculum acquired by:
- Airbus North America
- Boeing Wichita
- Boeing Corporate
- Cessna
- V5 Engineering
- ZTM Inc.
- Schoolcraft College
- ITT Technical Institute
- Global Engineering and Technology

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Annual Summary

Over the last year, the Research Machine Shop has continued working its magic providing quality machine shop support for research activity at WSU, NIAR and more.

The shop has conducted a multitude of different research projects since its establishment in 1944. They aided in the construction of the first Walter H. Beech Wind Tunnel and played a similar role today in the tunnel’s first major upgrade.

Beyond WSU and NIAR, the machine shop also takes on the needs of industry clients. The same is true for today; with many completed and ongoing projects aiding in the improvement of the aviation industry.

2004 Projects:

<table>
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<tr>
<th>Task</th>
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<tbody>
<tr>
<td>Designed and produced four wind tunnel models for research related to severe weather safety</td>
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<tr>
<td>Machined several small projects for the WSU Chemistry department</td>
</tr>
<tr>
<td>Machined parts to upgrade a machine for the NIAR Composites Lab</td>
</tr>
<tr>
<td>Machined parts for a very large test frame designed to load to failure test panels provided by Boeing</td>
</tr>
<tr>
<td>Worked several small projects to support Lightning Protection and Electro-magnetic Research for composite aircraft</td>
</tr>
<tr>
<td>Machined anti-buckling fixtures for materials testing</td>
</tr>
<tr>
<td>Worked projects for research related to optimizing piccolo tube deicing systems for aircraft</td>
</tr>
<tr>
<td>Designed and modified a NACA 23012 model so it can be installed in the WSU wind tunnel for aircraft icing research</td>
</tr>
<tr>
<td>Made and/or modified several tools for Aging Aircraft research</td>
</tr>
<tr>
<td>Provided support for Friction Stir Welding research</td>
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<tr>
<td>Provided support for the major upgrade of the WSU wind tunnel</td>
</tr>
<tr>
<td>Produced a form die for Koch-Glitch Co.</td>
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</tbody>
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Art Porter
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The Visual Technology Lab (VTL) is the creative arm of the Institute. Their abilities led to the production of two animations that won them two Addy Awards from the Advertising Federation of Wichita. The VTL crew was honored with two “Best of Show” awards for their development of “Rally the Fans for WSU Basketball” and a commercial for Legacy Bank.

Because the enrollment of 3D Camp! has nearly doubled over the last year, the lab has made a few substantial changes to the organization and requirements of the Maya classes they offer.

2005 Fall semester modifications:
• Semester long Maya classes split into one credit hour modules that will be five weeks long.
• Introduction to Maya will be supplanted by: Introduction to 3D graphics, Modeling 1, and Animation 1
• Introduction to Maya will be divided into: Modeling 2, Animation 2, and Lighting and Texturing.

2004 Projects:
Produced animated elements for a number of projects lead by the Media Resources Center, including graphic elements used in the play “Wings,” based on events that lead up to the Brown v Board of Education decision, and performed on the anniversary of the decision in Topeka, Kansas

Provided additional support graphics for the Athletic Department to be displayed on the Koch Arena Scoreboard

Provided animation elements, the Target© dog, animated charts, store openings and more for Target, Inc.

Created the animated gorilla used in TV ads announcing the new Downing Gorilla exhibit at the Sedgwick County Zoo

Produced animated elements for the Downtown Arena “Vote Yeah” campaign

Provided graphics for BG Products marketing communications

Provided animation elements used in Feist Communications ads
**FAA Airworthiness Assurance Center of Excellence**

**AACE mission**...to work in partnership with academia, industry and government to provide timely, cost-effective, validated, advanced technologies and a skilled workforce to improve airworthiness assurance over the short, mid and long-term. It will maintain a repository of knowledge and build a talent pool which will improve aviation safety and strengthen the competitive position of the U.S. aviation industry.

The FAA established the Airworthiness Assurance Center of Excellence (AACE) in September 1997. NIAR is a core member of AACE, along with 29 other universities.

The AACE team is designed to address the full spectrum of research, from basic research through applied research, validation and technology transfer. This unique center has attracted research in the areas of aviation safety, including composites and advanced materials, crashworthiness, icing, aging aircraft and many more.

**2004 Projects:**

<table>
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<th>Project Description</th>
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<tr>
<td>Testing Full-Scale Composite Sandwich Fuselage Panels</td>
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<tr>
<td>Adhesive Characterization and Element Testing of Fatigued and Damaged Bonded Joints</td>
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<tr>
<td>Laminate Statistical Allowable Generation for Fiber Reinforced Composite Materials</td>
</tr>
<tr>
<td>Dynamic Seat Cushion Replacement for Aircraft</td>
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<tr>
<td>Implementing Usability Techniques in the Development of Aviation Maintenance Manuals</td>
</tr>
<tr>
<td>Experimental Study of Super-Cooled Large Droplet (SLD) Impingement Effects</td>
</tr>
<tr>
<td>Exploring Critical Flight Conditions, Controller Modes and Parameter Estimation for Adaptable Flight Controls in General Aviation Aircraft</td>
</tr>
<tr>
<td>Continued Electromagnetic Protection Integrity of Aircraft and Systems Phase III</td>
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<tr>
<td>Validation of the NIAR Head Injury Criteria Testing for Part 23/24 Applications</td>
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<tr>
<td>Aircraft Seat Certification</td>
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<td>Development of a De Facto Standard for Tool Calibration Program</td>
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<tr>
<td>Evaluation of Airworthiness for Aging Small Airplanes</td>
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<td>Data and Methodologies for Structural Life Evaluation of Small Airplanes</td>
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<td>Fatigue Crack Growth Testing to Quantify the Effects of Shot Peening for Metallic Rotorcraft Components</td>
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<tr>
<td>Statistical Loads Database Development</td>
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<tr>
<td>Aging of Composite Aircraft Structure: Decommissioned Boeing 737 Tail</td>
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<tr>
<td>Continued Electromagnetic Protection Integrity for Aircraft and Systems - Phase IV</td>
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<tr>
<td>Identifying Techniques for Improving the Reliability of Aviation Maintenance Manuals</td>
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CECAM mission...to provide the nation with a center for the validation and quality assurance of composites and advanced materials to be applied in the construction of large commercial transport aircraft through (1) research, testing, certification and technology transfer; (2) coordination and cooperation with the FAA, large commercial transport aircraft manufacturers, materials suppliers and airline companies; and (3) education of the aircraft manufacturing and maintenance workforces.

NIAR was designated as a Center of Excellence for Composites and Advanced Materials (CECAM) in December 2003. NIAR will focus primarily on the safety and certification of emerging applications of composites and advanced materials in commercial transport aircraft.

CECAM is composed of an academic team of universities that complement each other’s interests and expertise in research areas associated with advanced materials. The center is led by Wichita State University with core members from Northwestern University, Purdue University, Tuskegee University, University of Delaware and University of California at Los Angeles.

Objective:
Perform basic and applied research within specific technology areas and facilitate growth and education of the use of advanced materials with emphasis on the needs of the large transport aircraft industry while supporting the safety and certification issues involved with airworthiness assurance.

2004 Projects:

**Wichita State University**
- Aging of Composite Aircraft Structures: Beechcraft Starship Teardown
- Production Control Effect on Composite Material Quality and Stability
- Crashworthiness of Composites - Material Dynamic Properties
- Effect of Repair Procedures Applied to Composite Airframe Structures
- Surfaces for Subsequent Adhesive Bonding
- Quality Assurance Methods for Fiber Reinforced Composites
- Evaluation of Friction Stir Welding Process and Properties for Aircraft Application
- Production Control Effect on Composite Material Quality and Stability
- Methods for the Evaluation of the Fitness of Fiber Reinforced Composites

**Northwestern University**
- Structure Health Monitoring for Life Management of Aircraft

**University of California at Los Angeles**
- Damage Tolerance and Durability of Fiber Metal Laminates for Aircraft Structures

**Purdue University**
- Damage Tolerance and Durability of Adhesively Bonded Composite Structures

**Tuskegee University**
- Nanophased Skin-Stringer Assembly for Aircraft Structures

**University of Delaware**
- VARTM Variability and Substantiation
CGAR mission...to enhance aviation-related research, education, technology transfer and utilization in mission critical areas; to respond to the research interest and needs of the aviation industry through synergistic relationships developed between academia, industry and government.

In April 2001, NIAR became a core member of the FAA Center of Excellence for General Aviation (CGAR).

The three major criteria of success are:

1. The ability of the Center to provide national leadership in resolving air transportation problems.
2. The ability to disseminate results through a continuing education program.
3. The ability to create self-sufficiency so the Center is not reliant upon funding support from the Federal Aviation Administration.

Participating universities include Wichita State University, Embry-Riddle Aeronautical University, the University of North Dakota, Florida A & M University and University of Alaska. Embry-Riddle is the lead university and handles the management of the organization. NIAR has a leadership role in composite materials and crashworthiness in this center. However, all universities are viewed as equal contributors to research activities.

2004 Projects:

Review of the FITS Program: Program Tasks, Goals and Pilot Training Initiatives
NCAMP mission... to provide the nation with a center for the validation and quality assurance of composites and advanced materials to be applied in the commercial and military aviation industry through (a) data-sharing among multiple users, (b) statistical continuity from one length-scale to another and (c) reduced testing via increased capability and use of numerical/analytical simulation tools.

Over the next decade, composites and advanced materials will be rapidly emerging, finding applications in design and finding their way into production lines throughout the aircraft industry. It is their superior strength and stiffness properties that have made them the structural material of choice for many aerospace applications.

In recent years, NASA, industry and the FAA have worked together to develop cost-effective methods of qualifying materials by sharing a central material qualification database, such as Military Handbook 17 and the database formed in the NASA Advanced General Aviation Transport Experiments (AGATE) program.

It is for this purpose that the National Center for Advanced Materials Performance (NCAMP) was developed. The concept behind this center of excellence was developed by NIAR in August 2004. The establishment of NCAMP will provide the nation with a localized center for composite and advanced material validation and quality assurance. The goal of NCAMP research is to integrate the technology into actual aircraft and industry practice.

Objectives:

- Increase the efficiency of advanced material implementation into new aircraft models and at the same time decrease the cost of these materials.
- Facilitate growth of the use of advanced materials in aircraft application while addressing safety and certification issues to ensure airworthiness assurance and safety.
- Examine old guidance materials related to advanced materials and determine their relevance with respect to new advances in technology.
- Promote the cost-effective use of composites and advanced materials to reduce the aircraft Direct Operating Costs (DOC).
- Integrate the results of research performed within NCAMP to form a basis for standard engineering practice and training within the advanced materials aircraft community and assist in creating relevant policy and guidance materials.

NCAMP's technical approach consists of five tasks that will be coordinated to provide the aviation industry with the most up-to-date solutions for the application of advanced materials into product integration and to eliminate redundancies in the current process. This will make the composite materials as attractive to industry as current metallic materials.

Technical Tasks:

- Providing Statistical Materials Management and Control
- Accelerating Advanced Materials Usage Program
- Using a Materials Scaling and Building Block Approach
- Applying Advanced Materials Processing Technology

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The Aircraft Design & Manufacturing Research Center (ADMRC) was established in October 1995 as a state-industry-university partnership. Envisioned was a consortium of university and industry partners who, working together would apply their collective expertise to address the technology needs of aircraft manufacturers and subcontractors.

ADMRC combines the talents and support of Boeing, Bombardier, Cessna and Raytheon, along with a substantial number of small businesses, university researchers from Wichita State University as well as the University of Kansas, Kansas State University and Pittsburg State. Together, faculty members and researchers can focus on industry problems in Kansas.

ADMRC, partially funded by the Kansas Technology Enterprise Corporation (KTEC), continues to be a very successful state-university-industry partnership. It is recognized nationally as a model for cooperative research.

2004 Projects:

**Wichita State University**
- Hot Air Anti-Icing Research Program
- High-Speed Friction Stir Welding
- Ice Particle Trajectory Program
- Rapid Fabrication of Modular Composite Lay-up Tools
- Virtual Reality System with Haptic/Auditory Devices for Assembly and Maintenance Training and Certification

**Kansas State University**
- Effects of Cladding and Anodizing on the Fatigue Behavior of Varying Gage Aluminum Sheet

**University of Kansas**
- Aircraft Interior Noise Reduction Studies for Composite Sandwich Panels
The NIAR/Industry/State research (NIS) program was created by the State Legislature in FY 2004 to support the Kansas aviation manufacturing industries’ efforts to compete in the global technological environment.

While this research program is operated through the National Institute for Aviation Research, all research projects are identified and selected by an executive committee composed of representatives from Boeing, Bombardier-Learjet, Cessna and Raytheon. WSU’s associate vice president for research, the executive director of NIAR, and the dean of the College of Engineering serve in a project management capacity with respect to university policies and procedures.

The first year of the program was funded in the amount of $1 million dollars which supported 10 research programs for 12 months. The results of these FY 2004 programs are documented in final reports to be shared and utilized by the entire Kansas aviation industry.

The second year of funding (FY 2005) was approved by the State Legislature in the amount of $2 million.

<table>
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<tr>
<th>2004 Projects:</th>
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<tr>
<td>Simulated Icing Test Nozzle Design and Feasibility Study</td>
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<tr>
<td>Paint Thickness Measurement over Composites</td>
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<tr>
<td>Network-based Aviation Security</td>
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<tr>
<td>Carbon Tri-axial Braid Material Qualification</td>
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<td>Assessment of Load Distributions in Composite Panels with Semi-Parasitic Acoustic Treatments</td>
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<tr>
<td>Development of Design Philosophies for Large Bonded and Fastened Assemblies Containing Metals and Composites with Large CTE Differences</td>
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<tr>
<td>Lightning Protection of Composite Aircraft</td>
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<tr>
<td>Cabin Acoustics</td>
</tr>
<tr>
<td>Friction Stir Welding and Laser Welding Feasibility Study</td>
</tr>
<tr>
<td>Analysis of a Tri-axial Braided Composite Structure with a Constant Cross Section</td>
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</table>
Our diversity ranges from our ethnicity to our education degrees, with individuals from 17 different countries contributing to 21 different research and development areas within NIAR. These employees are the reason we are capable of meeting the changing needs of aviation and non-aviation businesses.

Combined, they have helped NIAR rank 7th among the nation’s prestigious universities in research and development expenditures in aerospace research according to FY 02 data from the National Science Foundation.

They have also produced over 70 Publications, 63 of which were published in journals; made 65 presentations at national and international conferences; and produced 10 technical reports.
Mid-American Manufacturing Technology Center (MAMTC)

The Mid-American Manufacturing Technology Center (MAMTC) was created in 1991 when the Kansas Technology Enterprise Corporation (KTEC) was awarded a contract from the National Institute of Standards and Technology (NIST) to become part of the Manufacturing Extension Partnership (MEP) Program. MAMTC currently has 20 offices located in Kansas, Colorado and Wyoming.

The Wichita Regional MAMTC office is partnered with Wichita State University and is directed by Elaine Hanna. MAMTC is a non-profit organization designed to improve the competitiveness of small and medium-sized manufacturers by providing assistance in the areas of engineering design and testing, operations, quality systems management and marketing. It also provides seminars, industry roundtables and demonstrations of interest to the local manufacturing community.

Economic Impact of Wichita Regional MAMTC FY 2004

Clients served ..............................................................218
Increased sales ..........................................................$36,538,400
Costs saved ............................................................ $1,175,000
Capital spending ...................................................... $2,099,252
Jobs Created/Retained ................................................138

Small Business Development Center (SBDC)

The Wichita regional Small Business Development Center (SBDC) was established in October 1983 and is affiliated with MAMTC. SBDC provides free individual consultation services and affordable training to assist with business starts and to support business expansion growth for small business owners and entrepreneurs in a 24 county region in north and south central Kansas.

Economic Impact of Wichita Regional SBDC CY 2003

Clients served .........................................................920
Workshops Offered ..................................................46
Workshop Attendees .................................................737
New businesses started ..............................................66
Full-time jobs created ..............................................176
Part-time jobs created ..............................................134
Full-time jobs retained ..............................................209
Part-time jobs retained ..............................................231
New sales generated ................................................$14,600,000
Economy investments ..............................................$1,300,000
Secured 85 loans .................................................... $6,200,000

SBDC Clients Experienced
Job growth 2002 - 2003 ..............................................47.6%
compared to...
Job growth Kansas Business 2002 - 2003 .............1.1%
Sales growth 2002 - 2003 ..........................................42.2%
compared to...
Sales growth Kansas Business 2002 - 2003 ...........1.7%
TOGETHER WITH OUR CLIENTS, NIAR HAS COLLABORATED WITH INDUSTRY, GOVERNMENT AND OTHER ACADEMIC INSTITUTIONS TO SUPPORT THE ECONOMIC VITALITY AND FUTURE OF THE AVIATION INDUSTRY.
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As the official home of the National Institute for Aviation Research, the campus of Wichita State University is the perfect setting to foster top-notch education, cutting-edge research, and the people who make it happen.

WSU's sprawling 330 acres, boasting one of the largest university sculpture collections in the nation, is located within the city of Wichita, Kan., known as the “Air Capital of the World.” Each year almost 15,000 students from 48 states and more than 100 countries come to Wichita to study as Wichita State Shockers within the University’s six colleges.

In addition to its main campus, Wichita State features three full-service satellite facilities located throughout the city. And, as the state of Kansas’ only metropolitan university, WSU offers its students a virtually endless array of opportunities ranging from the availability of experts in practically every industry to one of the region’s largest cooperative education internship programs.

All of this, combined with the people and expertise of NIAR, makes the WSU community one of true Thinkers, Doers, Movers and Shockers.
NATIONAL INSTITUTE FOR AVIATION RESEARCH
A Kansas Technology Enterprise Corporation
Center of Excellence

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NIAR - BREAKING THROUGH BARRIERS

The National Institute for Aviation Research is funded in part by the Kansas Technology Enterprise Corporation. NIAR is an unincorporated division of Wichita State University, which is a state owned entity separately managed and distinct from Kansas Technology Enterprises Corporation.

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