"Institute for Aviation Research" booklet, circa 1990-1992

INSTITUTE FOR AVIATION RESEARCH

THE WICHITA STATE UNIVERSITY

Wichita State's Institute for Aviation Research is an interdisciplinary campus-based facility with specialized laboratories for support of the aviation industry.

THE INSTITUTE

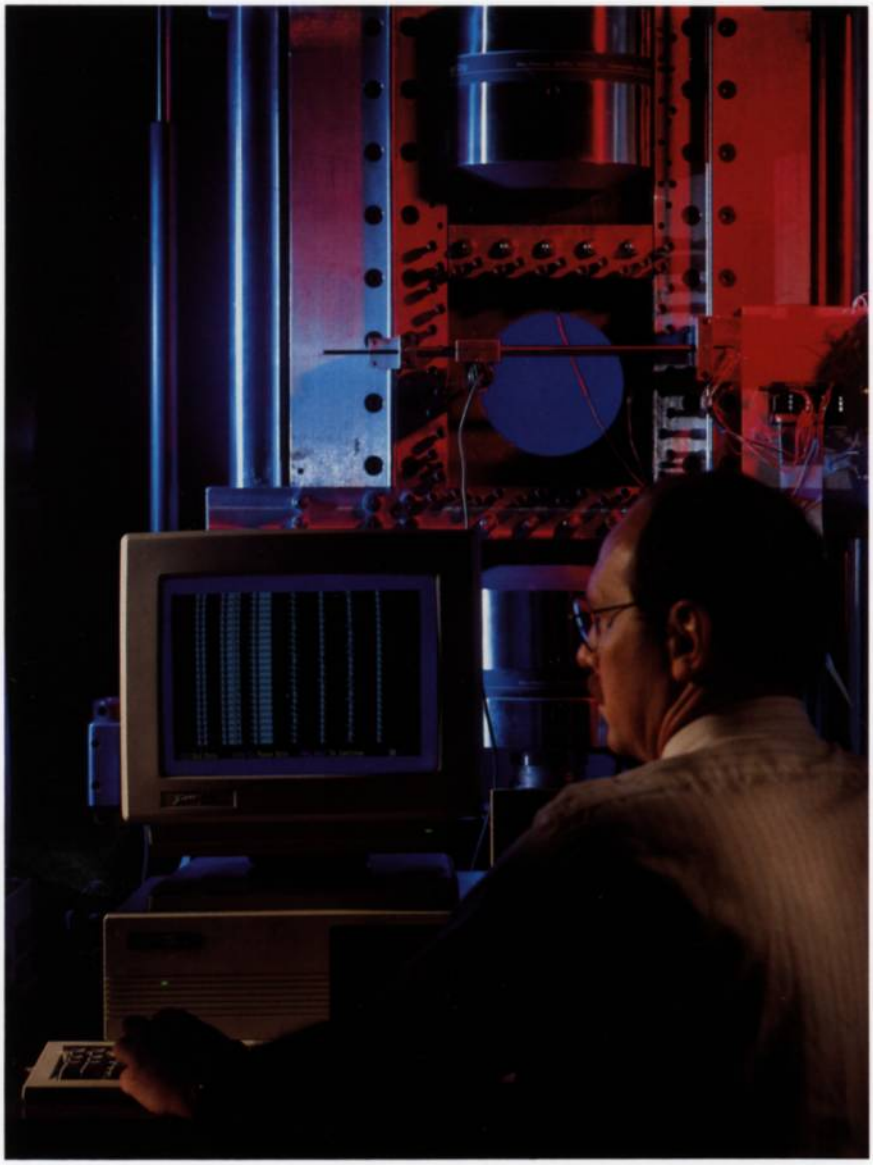
The Institute for Aviation Research, a Kansas Center of Excellence established at The Wichita State University, supports the aviation industry through research which advances fundamental science and technology in selected areas of importance to aviation. The Aviation Institute is the culmination of more than fifty years of aviation-related studies at Wichita State.

Goals of the institute center on research, education, training and timely transfer of new technology among the appropriate industries and governmental agencies. Specifically, the institute is:

- Discovering and transmitting new knowledge related to the design, manufacture, performance and safe operation of aircraft
- Promoting advanced planning for technologies needed in the future
- Providing an environment for multidisciplinary activities among University research faculty, government and industry professionals
- Enhancing the undergraduate and graduate education of science and engineering students.

In response to industry and government, the Aviation Institute is currently performing research in:

- advanced materials and structures
- aerodynamics and propulsion
- aircraft deicing
- stall-spin resistance and other high angle of attack behavior
- advanced manufacturing technology, producibility and quality control
- software reliability for embedded aircraft computer systems
- management and human factors issues in aviation.



A 55-kip MTS testing machine, along with custom fixtures and data acquisition systems, is used to determine buckling characteristics of composite panels.

The Aviation Institute supplies the space, equipment, investigators and administrative support conducive to research through five centers:

- Aviation Safety
- Basic and Applied Research
- Productivity Enhancement
- Aviation Education and Training
- Management and Human Resource Development.

Research at the centers capitalizes on the interdisciplinary strength and energy available in the University. Chemists and aeronautical and mechanical engineers collaborate concerning composite materials. Human factors engineers and psychologists work together on human factors in aviation. Computer scientists and industrial engineers cooperate to validate computer integrated manufacturing systems. Specialists in labor economics, management and personnel work collectively on the business and labor problems of the aviation industry.

Faculty investigators significantly involved in the institute's work have been identified as associates. These associates, who form research teams drawn from many academic departments, are widely published and have been organizational leaders and presenters at technical conferences throughout the world.

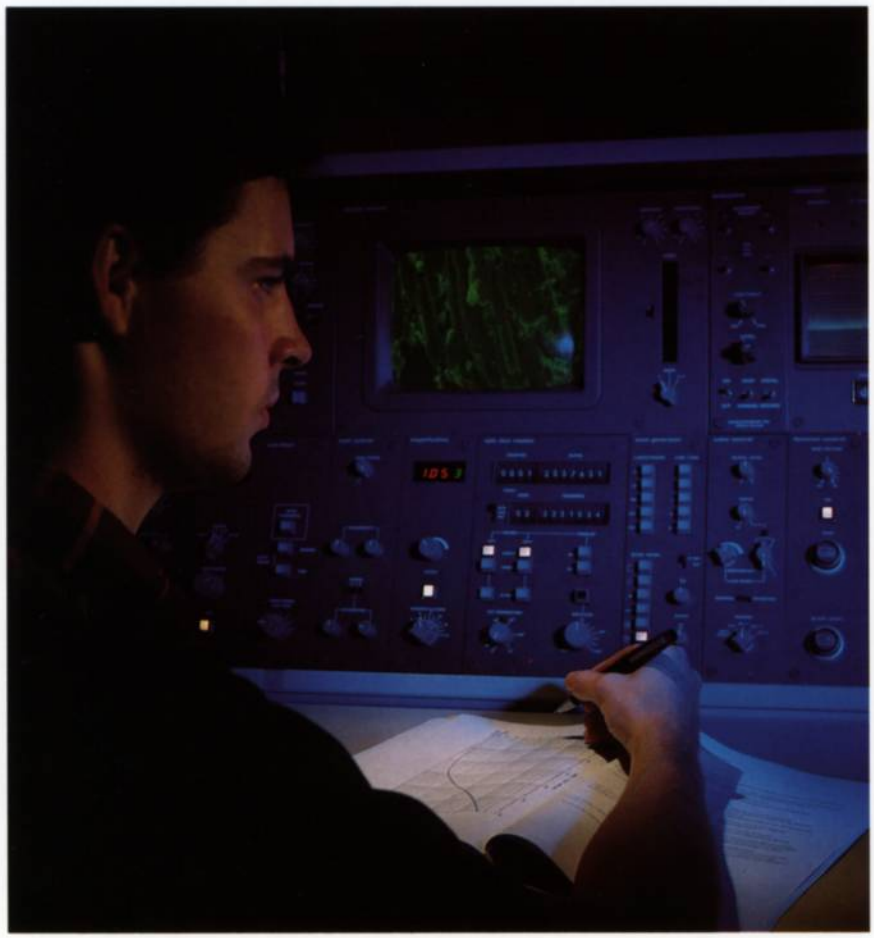
Propulsion research includes an experimental test rig with laser velocimetry, an example of concurrent computational and experimental investigations of airflows in aircraft engine inlets.

RESEARCH

The array of investigations varies with the changing needs of the industry; present projects are briefly described below.

The properties of metals, alloys and composite materials are studied in a well-equipped advanced materials laboratory. Fundamental studies are being conducted on the influence of strain-rate hardening on the formability of selected aluminum-lithium alloys which show promise for aircraft structural applications. An experimental study examines the macrostructural effects of solid particle erosion of composite materials; graphite, Kevlar and glass-reinforced epoxy are the primary systems. Erosion damage morphology of steady-state eroded surfaces and single-impact events are being investigated by optical and SEM measurements.

Safety issues under study include a new method of ice removal from aircraft. This electro-impulse system requires less energy and is more effective than current methods, and imposes no aerodynamic drag penalty. Experimental crashworthiness studies to determine the energy absorbing characteristics and post-failure integrity of composite materials will use a horizontal dynamic sled facility. A computational crash dynamics study is directed toward a theoretical capability to predict the response of aircraft and occupants to dynamic crash loads. This information will be essential in the design of crashworthy airplanes made from aluminum or new lightweight composite materials.



Equipment presently in use for materials research at the Institute for Aviation Research includes a scanning electron microscope and a transmission electron microscope.

Ongoing stall/spin flight research includes the use of a flow-visualization water tunnel to develop methods for acquiring more complete high angle of attack aerodynamic data than presently exists for most aircraft types. Also a special purpose flight simulator is being used to investigate methods for reducing aircraft accidents associated with stalls and spins. The research will aid the development of aircraft with improved stall characteristics, reduced spin tendencies and more adequate pilot warning of incipient stall or spin conditions.

Propulsion investigations include concurrent computational and experimental investigations of flows in aircraft engine inlets. Analyses, conducted with a partially parabolized Navier-Stokes computer code, provide a new and more precise methodology for designing the inlet ducts for air-breathing engine and ventilating systems. Other studies include development of a microcomputer-based computational code for rapid analysis and optimization of diesel engines with turbo-supercharging. Future aircraft, surface vehicles and stationary power plants will benefit from engines of lighter weight and higher efficiency which are the goals of such studies.

University researchers from several disciplines are cooperating with representatives from the materials manufacturing industry to study high temperature superconductors. The project involves technology monitoring and magnetic and thermal property testing of new compounds being proposed as candidates for high-temperature superconductors and exploration of fabrication technologies required to commercialize these materials.

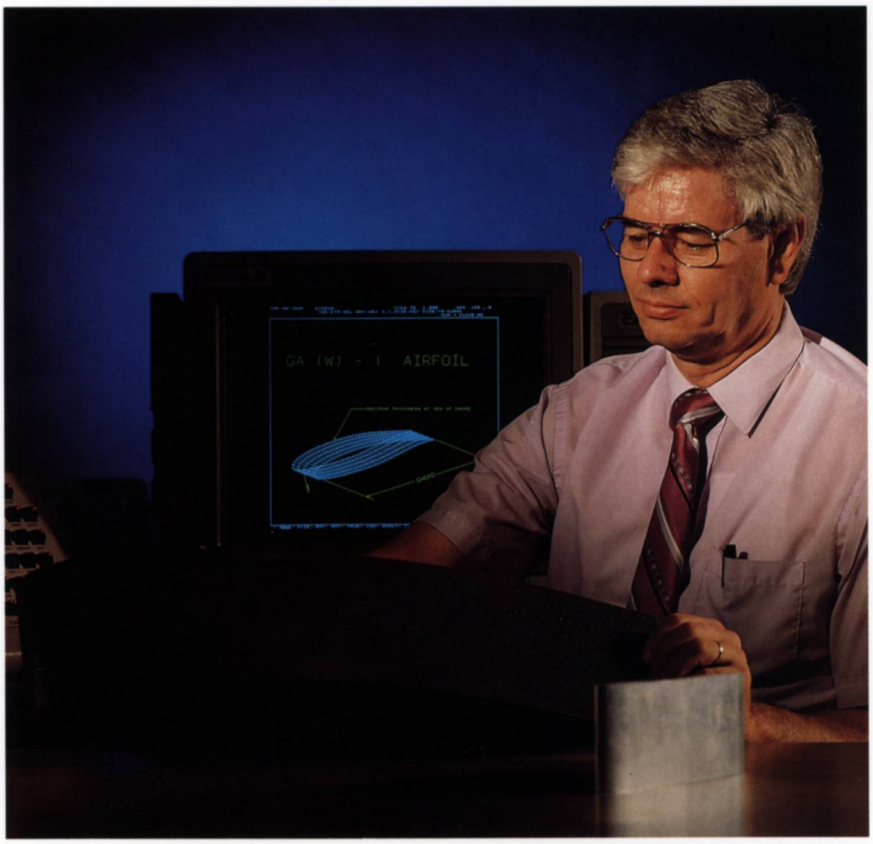
The two-foot by three-foot flow-visualization water tunnel enables research associates to conduct advanced aerodynamic studies.

Research is extensive in the areas of composite materials and composite structures. Effects of severe environmental conditions are being studied on the delamination resistance, fatigue and fracture properties of advanced fiber reinforcements, such as glass, graphite and Kevlar in epoxy, PEEK or bismaleimide matrix systems.

Analytical predictions of the damping characteristics of composite materials are being experimentally verified to establish the bounds of a design methodology for estimating the vibratory damping energy dissipation in composite materials. The influence of in-service environments on the impact resistance of composite materials is being assessed. This is accomplished through the use of ultrasonic C-scans of the material for fault detection. Coupons are also tested for strength and stiffness after impact and environmental exposure.

Studies concerning the producibility of composite structures are conducted with industry. The focus of this work is on tooling and processing for high temperature application. Development of economic production methods is vital to the profitable use of composite materials in the aviation industry.

This partial list of current research projects illustrates the capacity of the Aviation Institute to respond to the research needs of the rapidly changing aviation industry.



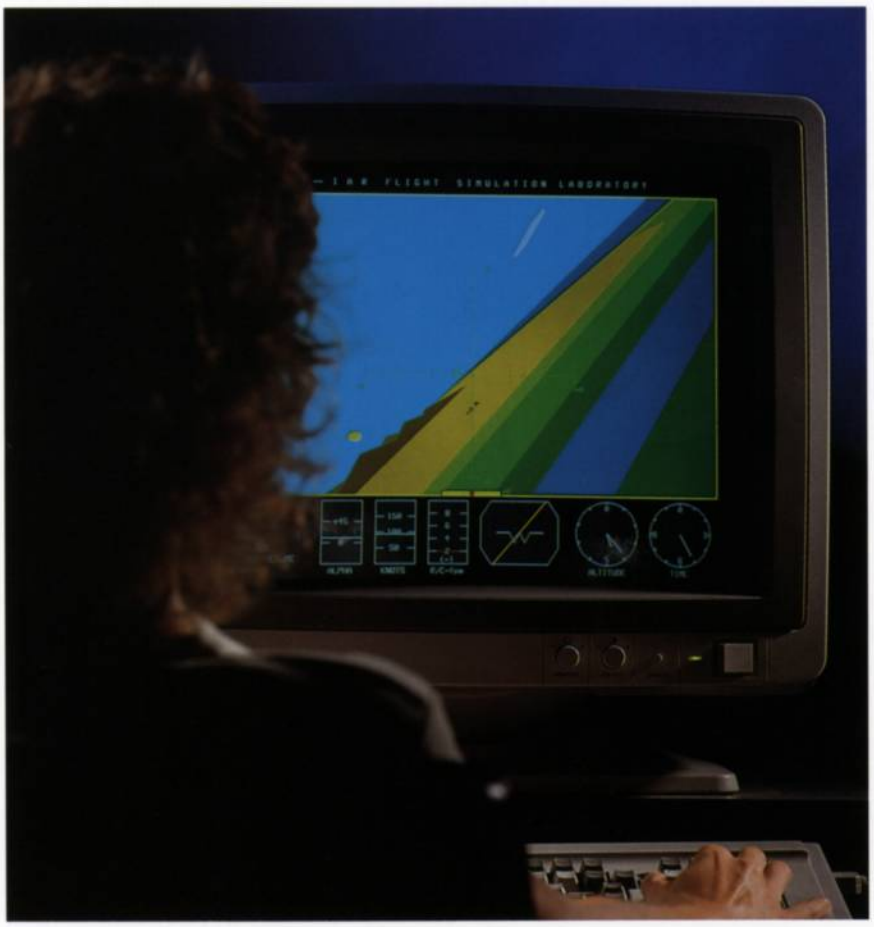
Composite materials are examined with regard to design, manufacturing and performance.

FACILITIES

The Institute for Aviation Research is near the existing engineering laboratories in Wallace Hall. The floor plan of the $7 million building is organized to include a high bay area with a ceiling height of 60 feet for crashworthiness and other studies, and can easily be reconfigured as research requirements change. The 74,000 square foot building is designed specifically for research activities, including a more conventional three-story portion for other specialized labs, offices and conference rooms. The Aviation Institute is connected to the University's Computing Center with a high-speed data networking system.

Present facilities--seven wind tunnels, water tunnel, structural testing lab, composite structures lab and a CAD/CAM lab--are equipped with the latest available research equipment necessary for aviation-related studies, including:

- flight simulator with a high performance graphics system
- scanning electron microscope
- transmission electron microscope
- X-ray double crystal diffractometer
- laser velocimetry system
- programmable oven
- dynamic physical and ultrasonic testing machines
- autoclave (240 psi and 800^{O}F)
- hydraulic press
- VAX 8650 system to complement the University's IBM 3081-D16 mainframe computing system.



Stall/spin flight research utilizes a special purpose flight simulator.

Equipment planned for the new facility includes:

- a crash sled, a motion analyzer, anthropomorphic dummies and a laboratory management system for dynamic testing
- high-resolution graphics terminals for computer-aided design, engineering and manufacturing
- an autoclave (400 psi and 1000^{o}F) and other equipment for materials research.

THE WICHITA STATE UNIVERSITY

The only urban university in the Kansas Board of Regents' system, Wichita State is located in the largest business and industrial center in the state. Currently, Wichita State has a student body of more than 17,000, including 3,700 graduate students, who pursue educational interests in engineering, business, fine arts, health professions and the liberal arts and sciences. Graduate programs lead to master's degrees in 40 areas, to specialist degrees in two education-related fields, and to doctoral degrees in communicative disorders and sciences, chemistry, engineering and applied mathematics.

Visitors to Wichita State find a campus alive with construction--planned, in process and newly completed--including expansion of Ablah Library, the building to house the Institute for Aviation Research, a Center for Entrepreneurship, an alumni center/endowment association complex and a new math/science classroom and laboratory building.

The Aviation Institute is located on the campus of The Wichita State University, an urban university with 17,000 students in Wichita, Kansas.

CITY

The Institute for Aviation Research is in Wichita, Kansas--the heart of the aviation industry, with leaders like Beech, Boeing, Cessna and Learjet established here. With the present industries and a strong aviation history that includes such earlier companies as Stearman, Travel Air and Swallow, Wichita is known as the "Air Capital of the World." Almost one-fourth of the work force in Wichita, a metropolitan area of approximately 400,000, is employed in aviation-related jobs.

The location in Wichita, combined with the strength of a campus known for its ongoing work in aviation research, makes Wichita State's Aviation Institute truly a Center of Excellence.

New research ideas and challenges emerge daily, and the Aviation Institute is ready to respond. The research capabilities are numerous--and vital to serving the needs of the aviation industry.

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