JIAFS

Joint Institute for Advancement of Flight Sciences

The Nation's needs in the advancement of science, engineering, and technology can best be achieved by coordinated, cooperative efforts to bring together the Federal Government, Private Enterprise, Research Centers, and the Universities.

NASA
National Aeronautics and Space Administration

National Aeronautics and Space Administration
Langley Research Center
Hampton, Virginia
and
George Washington University
School of Engineering and Applied Science
Washington, D.C.

JIAFS

The Joint Institute for Advancement of Flight Sciences

- increases the nation's research and engineering capabilities in the fields of Acoustics, Aeronautics , Environmental Modeling, Materials Science, and Structures and Dynamics
- brings together researchers and scholars for the exchange of ideas and findings
- enables researchers and students to utilize the extensive equipment and facilities at the NASA-Langley Research Center
- trains graduate students and professional engineers

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ILLUSTRATIONS

JOINT INSTITUTE FOR ADVANCEMENT OF FLIGHT SCIENCES (JIAFS)

BACKGROUND

The National Aeronautics and Space Administration's Langley Research Center joined with the George Washington University's School of Engineering and Applied Science in 1971 to create the Joint Institute for Acoustics and Flight Science* (JIAFS). This jointly operated institute is dedicated to increasing the nation's research and engineering capabilities in relevant technical fields such as Acoustics, Aeronautics, Environmental Modeling, Materials Science, and Structures and Dynamics.

The Institute, which is located at the NASA-Langley Research Center, Hampton, Virginia, is dedicated to the advanced training of students and professional engineers in the fields mentioned above and other relevant areas. JIAFS also serves to provide a center for advanced research by bringing together researchers and scholars from these fields for the exchange of ideas and findings. Furthermore, it is also the purpose of the Institute to provide the necessary facilities for qualified researchers and scholars who want to engage in research work in these areas.

The technical background of JIAFS is substantially based upon established research and educational programs in Acoustics, and Flight Sciences (now Aeronautics). In September 1968, a full-residence degree program was initiated at the NASA-Langley Research Center by the School of Engineering and Applied Science. This graduate program resulted from extensive discussions between NASA-Langley personnel and the School of Engineering and Applied Science faculty and a comprehensive examination of NASA-Langley interests and needs. The enrollment in this program has steadily increased since 1968 and reached a total of 150 students in September 1978.

A graduate research and educational program in Acoustics was established in January 1970, as a pilot project for resident graduate training at the NASA-Langley Research Center. In this project a group was formed of five Research Assistants and one full- and one part-time Research Professor to participate in acoustics research supporting national programs to alleviate noise and to provide a technical base for acceptable acoustics design of noise resistant structures, aircraft, space vehicles, power-generating machinery, and ground-transportation systems.

Similar research and educational programs in Flight Sciences (now Aeronautics) and Computer-aided Structural Design (now Structures and Dynamics) were established in January 1971, and January 1972, respectively. Expansion of the research and educational programs into several other disciplines has continued with the establishment of the Environment Modeling Program in 1974 and the Materials Science Program in 1975.

The staff of the Institute currently includes scientists and engineers from NASA-Langley Research Center and faculty members of the George Washington University's School of Engineering and Applied Science, and visiting members from other universities, research laboratories and industry. In addition, under the research and education program, about 80 Graduate Research Scholar Assistantships and 120 graduate degrees have been awarded in these areas of study.

The research opportunities offered in the Institute uniquely combine the academic resources of the university and the professional staff and the extensive scientific and engineering equipment and facilities at the NASA-Langley Research Center. Visiting research scientists and engineers also have the opportunity to associate closely with NASA-Langley scientists and engineers, faculty and research staff from George Washington Uni-

*In 1976 the name was changed to Joint Institute for Advancement of Flight Sciences to reflect more accurately the extensive research activities of JIAFS.

versity, and other visiting members who are working on related problems.

The Director of the Institute is John E. Duberg, Associate Director of the Langley Research Center, and the Co-director is Harold Liebowitz, Dean of the George Washington University's School of Engineering and Applied Science. The scientific community consists of permanent members, visiting members, and an Advisory Committee. The members of the Advisory Committee review JIAFS research programs and make such recommendations as they deem necessary. Permanent members are faculty and staff who actively participate in research and educational programs of the Institute. The Joint Institute for Advancement of Flight Sciences is affiliated with the Department of Civil, Mechanical and Environmental Engineering at the School of Engineering and Applied Science, George Washington University.

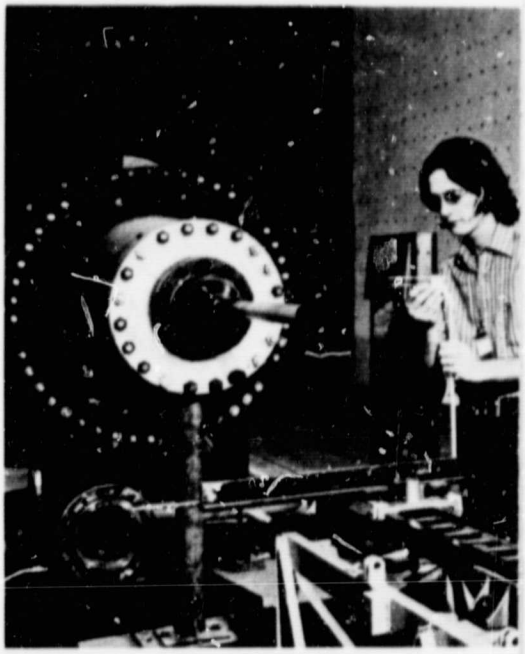


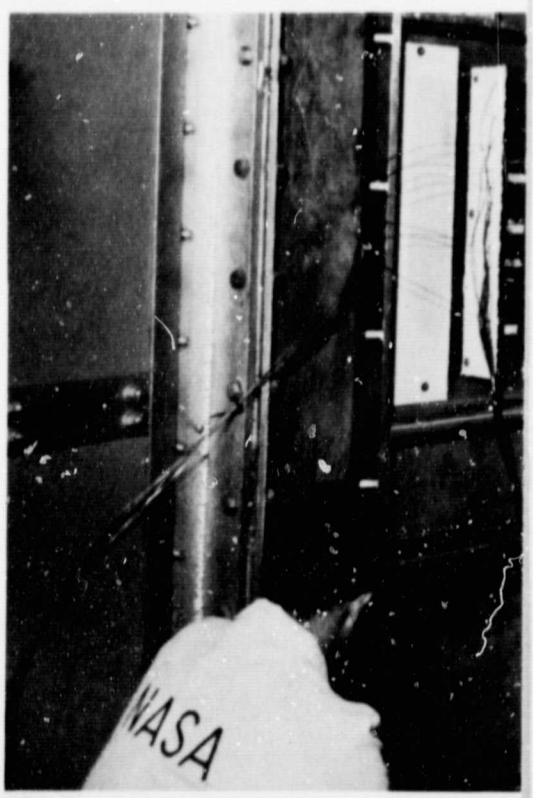
Figure 1—Jet Noise Research

RESEARCH AT JIAFS

The present research activities of the Institute are directed toward problems in acoustics, aeronautics, environmental modeling, materials science, and structures and dynamics. The area of research at JIAFS are continually expanding and currently fall into the following categories.

ACOUSTICS RESEARCH

Research in aeroacoustics in JIAFS began in 1970 in rotor noise (e.g., see references A-101, 102).* This research has continued to be one of the major activities in the Institute (A-117, 132, 154, 185). The interaction of sound and structural vibration and the effects of flow/surface interactions on noise generation and propagation have been basic areas of research in acoustics. Since 1971 JIAFS has contributed numerous articles to this technical literature (A-104, 124, 129, 139, 144, 151, 173, 180, 183). Jet



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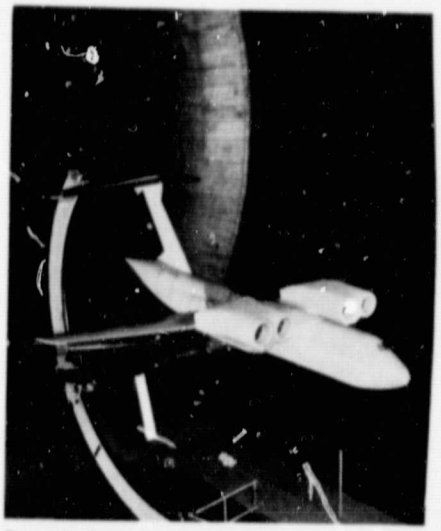

Figure 2—Research on Powered Lift Configurations

Figure 4—Augmentor Wing Setup in Anechoic Chamber

Figure 3—Structural Response Studies in Acoustic Research

noise research has been conducted in JIAFS since 1971 (A-109, 114, 135, 149). Research in duct acoustics began in 1973. (A-113, 142, 157, 165, 166, 171, 174, 181, 186, 189). Research in the areas of sound propagation (A-116, 182, 190), mathematical techniques (A-162, 164, 169, 176) and effects of noise on people (A-121, 137, 175, 179) has been conducted in JIAFS since 1973. Some current research activities are:

Jet Noise. Noise produced by the exhaust flows of gas turbine engines may be the controlling component in the fly-over noise signature of many future aircraft. Theoretical and experimental studies are currently being conducted to identify the noise generating mechanisms in the jet, to develop a valid physical model of the flow field of the jet and its associated acoustic field, and to study methods of controlling or suppressing the radiated noise.

Duct Acoustics. A study of nonlinear effects on sound propagating in a variable area duct which carries a near-sonic mean flow is being made. An understanding of these effects is practically important because of their potential to attenuate a significant part of the upstream propagating sound in a jet engine inlet. Several significant advances in the analysis have been made and have been reported in a series of recent papers.

Theoretical investigations of sound radiation from ducts using various new methods such as a statistical analysis and a hyperboloidal wave function expansion have been conducted. Sound propagation in ducts with variable cross sections is being studied.

Sound Propagation. A new procedure is being deveolped for calculating sound fields in a moving inhomogeneous medium, particularly in connection with propagation of aircraft noise in the atmosphere. Current models used in conjunction with existing and proposed federal regulations are based upon an extremely simplified approximate technique. The theory being developed in the present project has been shown to give a vast improvement in accuracy with a relatively small increase in computational effort.

Sound Radiation from the Trailing-Edge of an Isolated Airfoil. The dominance of noise radiation from an isolated airfoil, at least over certain frequency ranges, may be found in propellers, helicopter rotors, fans in turbofan engines and, more recently, non-propulsive components in aircraft. Experiments recently conducted by JIAFS in the Anechoic Flow Facility using a symmetrical N4CA63-012 airfoil suggest that the isolated airfoil trailing edge noise production process is related to the convection of large scale eddies in the boundary layer and their convection past the trailing edge.

USB Flap Noise Reduction Through Mean Flow Modification. Interaction of the large scale disturbance convected in the free shear layer of the wall jet flow with the flap trailing edge has been shown to play a key role in the production of USB flap noise. Mean flow modification was achieved by means of fine wire mesh screens inserted within the nozzle. Based on the experimental data gathered, it is concluded that USB flap noise reduction through mean flow modification is a useful concept and further study is needed to optimize the amount of noise reduction.

Rotating Blade Noise. The principal accomplishment of JIAFS work on prediction of the noise of high speed rotating blades (helicopter rotors and propeller) is the development of equations which are suitable for numerical calculation. Several computer programs based on these equations are currently available. As a result of this research, blade thickness noise has been shown to be an important component of the noise of high speed rotating blades. Present work consists of prediction of the noise of a propfan which has an unconventional blade design and operating conditions. Current theoretical work is mainly on

the inclusion of the nonlinear effects in the vicinity of helicopter rotor and propeller blades which are believed to be important for some range of tip speed.

Computational Fluidynamics. Current research includes the development of computer codes to model the complete flow field around an airfoil in motion. This effort is intended as input to a noise prediction program.

AERONAUTICS RESEARCH

When the JIAFS aeronautics program was initiated in 1971, special emphasis was given to research dealing with powered-lift concepts, including externally blown flaps, upper surface blown flaps, and spanwise blowing (e.g. see references FS-104, 107, 108, 110, 112, 114, 115, 118, 119, and 126 and Theses 1, 3, 5, 6, and 12)*. In 1976, this research was extended to include a comprehensive study of ground effects on powered-lift turbofan STOL aircraft (FS-120 and 128). Another early research area in the program dealt with problems associated with wing tip trailing vortices. This work led to three publications (FS-101, 106 and 109). Research was started in the areas of dynamic stability in 1972 (FS-111, 113 and 118, and Thesis 2) and low speed aerodynamics in 1974 (FS-105 and 117 and Theses 7 and 10). An extensive stall-spin research program was initiated in 1974, starting first with fighter aircraft (Theses 4, 8, 9, and 11) and later extending to general aviation aircraft (Thesis 14). Research in the area of flight dynamics with emphasis on flight test data analysis based on system identification was begun in 1976 (FS-123, 125, and 129). Wind tunnel tests of a two bladed rotor with tip blowing to reduce rotor noise were conducted at the University of Maryland wind tunnel in 1977 (FS-130). Some current research activities are:

Powered-Lift Concepts. Experimental and analytical studies are being conducted on powered-lift concepts for improving aircraft maneuverability at high angles of attack. Two of the more promising concepts under consideration are spanwise blowing and vectored thrust.

Stall/Spin Characteristics of General Aviation Aircraft. Investigations of the stall/spin characteristics of general aviation aircraft are being carried out by analytical methods and by experimenal techniques that include both full-scale airplane flight testing and dynamic model flight testing. The effects of systematic changes in tail configuration and other design features will be determined.

Propulsion Aerodynamics. An experimental investigation is being conducted to determine the effects of nozzle sidewall geometry and other pertinent parameters on the thrust and vectoring performance of non-axisymmetric convergent-divergent nozzles.

Transonic Aerodynamics. Research is being carried out in the 1/3-meter Transonic Cryogenic Tunnel in preparation for the research program in the National Transonic Facility (NTF) now under construction. Studies are being made of facility operating problems in the cryogenic mode with gaseous nitrogen as the test medium. One of these studies involves the use of a passive-suction sidewall boundary layer control system for two-dimensional testing in the tunnel.

Canard Aircraft Stability and Control. An analytical and experimental investigation of canard aircraft stability and control is being carried out which will involve both wind tunnel and flight research studies of a canard airplane and small-scale models. Emphasis is on the high angle of attack conditions where stalling occurs on either the wing or canard surface. A special small-scale wind tunnel test rig is being used to study the longitudinal dynamics under these conditions.

Flight Dynamics Research. Flight

*All references in this section are listed in the section on publications.

characteristics of current aircraft are being determined by a complete and accurate analysis of experimental test data. Improvements are being made in methods of flight test data analysis based on system identification. These methods are being applied to real flight data. Research includes the assessment of the accuracy of identified aerodynamic derivatives, identification of aircraft parameters in the frequency domain and under the effect of turbulence, and the verification of an optimal input used for aircraft identification. The application includes the measurement of aerodynamic characteristics of a general aviation aircraft. These measurements will be extended into higher angle-of-attack and spin flight regimes.

ENVIRONMENTAL MODELING RESEARCH

Research in environmental modeling in JIAFS began in 1974 in the area of direct solution methods for the radiative transfer problem (e.g., see EM-101, 102, 105).* Recently, the numerical methods developed at JIAFS have also been directed to the

*All references in this section are listed in the section on publications.

Figure 5—Investigating Stall/Spin Characteristics of Aircraft Using Radio Controlled Drop Models

problem of remote sensing (inversion) in multiple scattering atmospheres (EM-127) and to the problem of providing quantitative assistance in the design of instrument systems for remote sensing (EM-141). Research has continued on the interaction of clouds and radiation. Beginning in 1975 studies showed that finite horizontal size could markedly affect the reflection properties of clouds (EM-106, 112), and in 1978 studies showed that radiative heat losses from cloud tops could strongly influence the growth rates of cloud droplets (EM-140, 142, 143). JIAFS has also investigated various problems on the interaction of the earth's general circulation and pollution dispersion and energy balance (EM-103, 107, 109, 110, 111, 116, 131, 133, 134). Some current research activities are:

Atmospheric Heating and Radiative Transport Models. Solar and infrared radiative transport models have been developed and are being used in one-, two-, and three-dimensional models of the earth's atmosphere. The development of these models emphasized in efficiency, as well as accuracy, so that they may be included in dynamics models. The models developed for the infrared have established the current state-of-the-art.

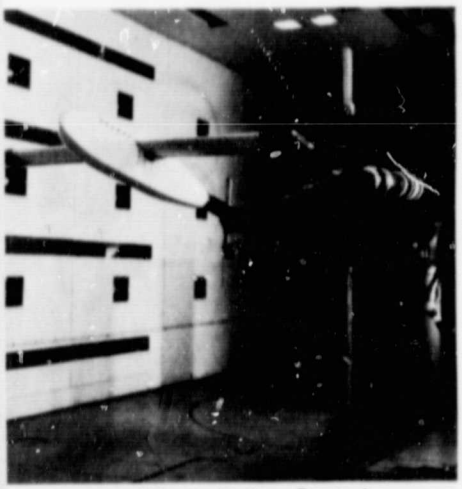

Figure 6—Wing-tip Vortices Research in V/STOL Tunnel

Figure 7—Determining Handling Qualities for STOL IN 30 x 60 ft. Tunnel

Stratospheric Models. Single and multi-dimensional models of the stratosphere have been developed and are being used to conduct impact studies and to gain a fundamental understanding of important stratospheric phenomena. The completed codes allow the user to investigate the interactions among the dynamics, chemistry, and radiative transport in a self-consistent fashion.

Solution Techniques for the Radiative Transport Equation. Solution techniques for the radiative transfer problem in scattering, emitting, and absorbing media are being investigated for both planar and nonplanar geometries. Pioneering work has been done on such problems as the reflection from cylindrical clouds and the effect on the albedo of a broken cloud layer.

Atmospheric Energetics. The spectral study of atmospheric energetics is being undertaken by two methods; the diagnostic calculation of various energy variables using atmospheric data, and a numerical study using a two-layer quasigeostrophic model. A three-dimensional stratospheric circulation model is being developed to test the dynamical response and pollutant transport for various perturbations.

Passive Remote Sensing. Methods of extracting useful information from radiation fields are being developed to allow retrieval of concentration profiles from radiation received by satellites or aircraft, allowing for multiple scattering in optically inhomogeneous atmospheres.

Cloud-Radiation Interaction. Cloud droplets have been shown to grow an order of magnitude more rapidly than predicted by classical theories when they are allowed to radiate to outer space. Such an effect could have significant implications for both the earth's climate and interpretation of reflected and emitted radiation. Research is underway on the effects of the changed growth rates upon macroscopic cloud properties.

Photochemistry and Transport of Trace Chemicals in the Upper Atmosphere. The threats to the earth's ozone shield from pollutants caused by man's industrial activities have received considerable national attention recently. Research efforts at The George Washington University in this area have been devoted to bridging the gap between the one-dimensional photochemically-oriented models which grossly over-simplify the complexities of atmospheric transport and the three-dimensional general circulation models which are computationally expensive to run and are still in an incomplete stage of development. Three different models of this research have been developed, and the results of this investigation are used to make comparisons with experimental data.

Models for the Prediction of the Onset and Behavior of Severe Storms. Mesoscale numerical models for the prediction of severe storm activities using storm weather data for diagnostic and prognostic studies have been developed and are being tested and refined. The studies investigate the initial imbalances responsible for severe storm generation and are being used to develop microscale models to imbed within the mesoscale model.

Regional Tropospheric Model. A multi-box model is being developed to simulate the transport and chemical kinetics occurring in the lower troposphere. It will be validated with field measurement data and used to study the production of secondary pollutants in the troposhere downwind of urban complexes.

MATERIALS SCIENCE RESEARCH

Research at JIAFS in computer simulation of defects in solids began in 1975. Work has continued in the areas of atomic scale analysis of brittle fracture (e.g. see references MS-101, MS-104, MS-109) and dislocation structure (MS-102, 103, 107, 108)*. Research on metal-matrix com-

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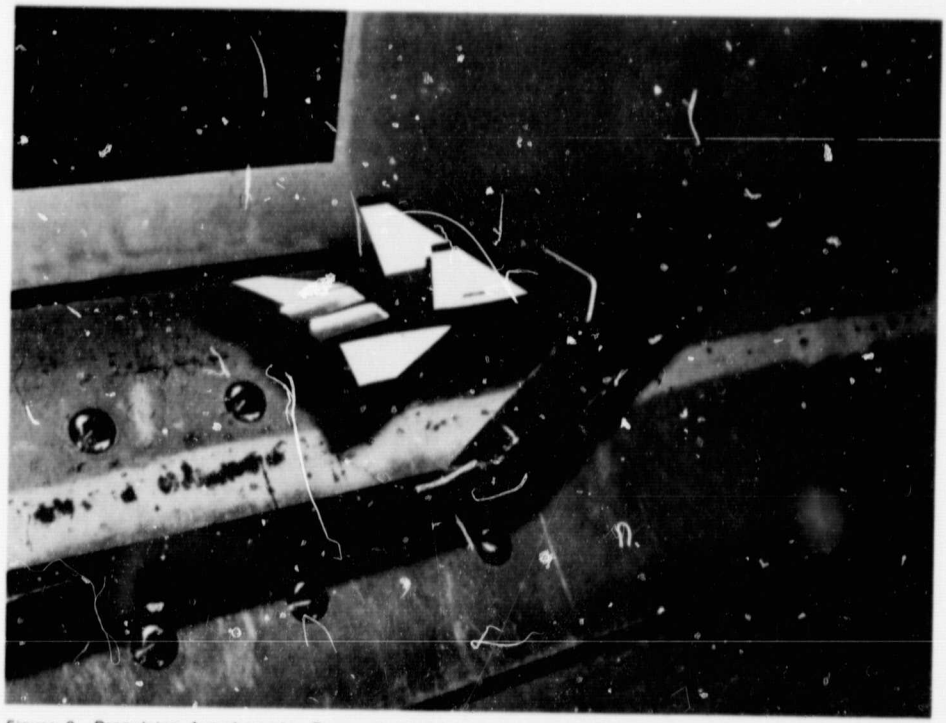

Figure 8—Propulsion Aerodynamics Research Model in 16-Foot Transonic Tunnel

Figure 9—General Aviation Airplane and Small Scale Models Used in Stall/Spin Research

posites has been in progress at JIAFS since 1974 (MS-110) as well as related work on diffusion in multi-component systems (MS-105). Polymer-based composites represent an important area of research recently initiated at JIAFS (MS-106). Some current research activities are:

Metal Matrix Composites: This area is concerned with: the characterization of fatigue and creep properties of composites at elevated temperatures, including modes of failure and types of degradation; the use of x-ray microradiography to monitor filament breakage during testing; the analysis effects of different filament configurations and matrix alloys; the measurement of degradation of mechanical properties of composites under varying temperature/environmental conditions; the correlation of measured changes in mechanical properties with changes in microstructure; the analytical modeling of diffusion and reaction controlled modifications in structure at interfaces in multiphase binary systems; and the use of sacrificial interfacial coatings to limit high temperature reactions in titanium matrix composites.

Environmental Effects on Polymer Materials: Composite and neat resin polymer materials are being investigated for their absorption of and chemical interaction with moisture for different temperature/relative humidity environments. The experimental data will be compared with theoretical diffusion model results to study the absorption processes. Parameter values from the absorption experiments are to be correlated with results from analytical experiments to identify the interaction chemistry. The moisture absorption data will also be correlated with data from mechanical tests (elastic moduli, ultimate strengths) to determine the degradative effect of the environment on the materials.

The effects of ultra-violet electron bombardment on the mechanical properties of graphite-polyimide composites is another area under investigation.

The effects of various variables (NaCl concentration, gases, and fiber-resin pairs) on composite/metal galvanic corrosion is being studied. Metal and composite electrode kinetics will be determined in order to assist in developing corrosion prevention measures.

Creep: This effort will develop the technology required for the use of metallic materials in applications where high temperature creep behavior is a design characteristic, using steady state and cyclic (load-temperature) testing of materials, particularly superalloys, and their correlation. Methodology to predict both static and cyclic creep behavior of metallic materials is being developed. An effort is being made to isolate critical factors in creep behavior, including the microstructural level.

Stress Corrosion: This phenomenon is highly material/environmental dependent. Research efforts include experiments to test the sensitivity of materials to stress corrosion cracking; analysis of surfaces before and after failure to better characterize the failure mechanism; development of a theoretical basis to predict stress corrosion behavior; development of techniques to protect materials from stress corrosion; and assessment of standard fracture testing procedures when evaluating stress corrosion susceptibility.

Graphite Fiber Technology: Develop technology to both increase and decrease electrical conductivity of graphite fibers by orders of magnitude using heat treatments and selected impurity concentrations; enhance thermal stability of graphite fibers by isolating catalytic impurities; identifying inhibitors, develop simple processes to remove the former and introduce the latter.

Solid State Physics—Mechanical Properties. The theoretical program is concerned with the application of solid state physics to the study of mechanisms which control the mechanical properties of materials. Many of these mechanisms are

Figure 10—Aircraft Noise Reduction Laboratory NASA-Langley

Figure 11—V/STOL Wind Tunnel

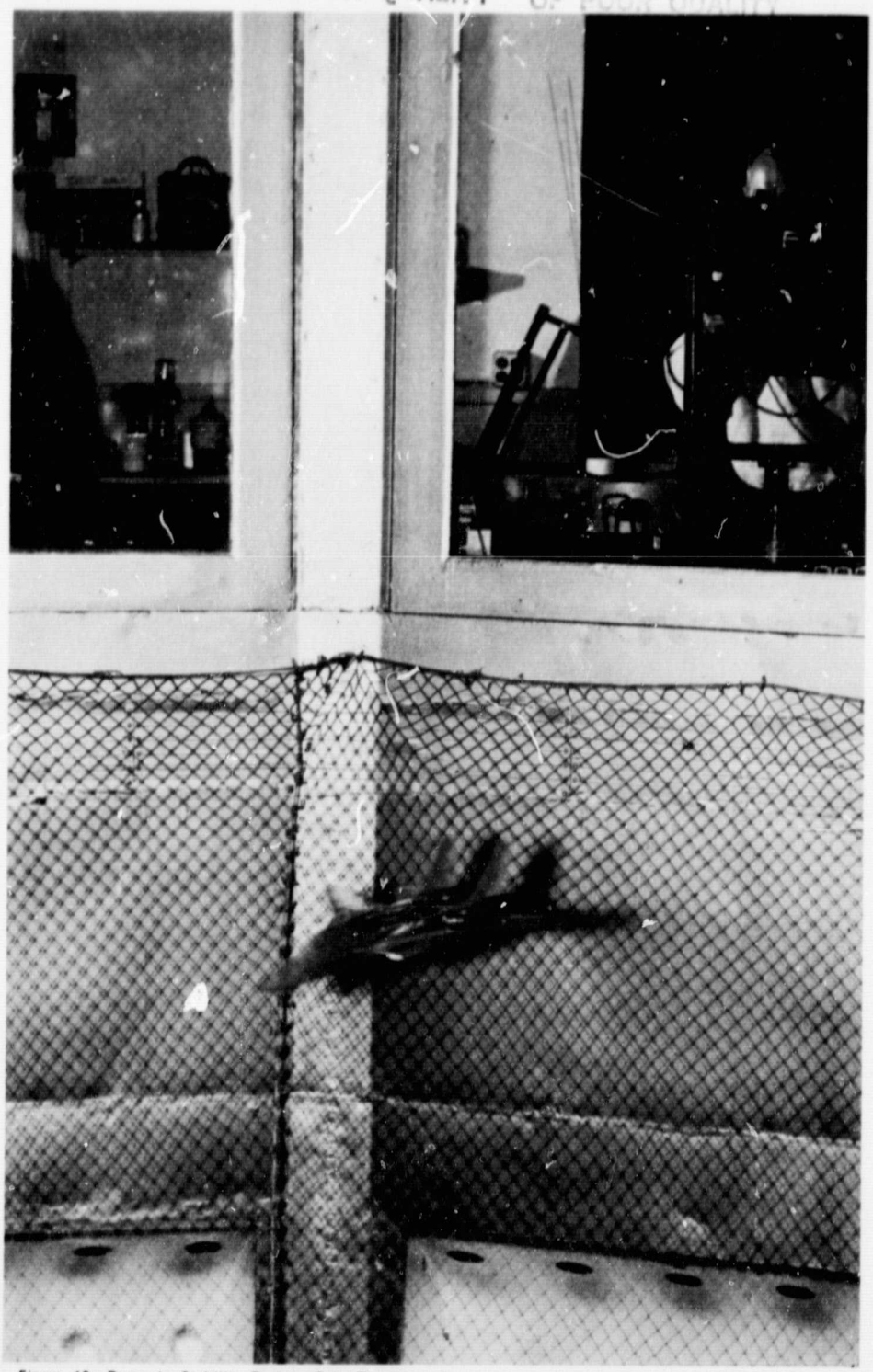

Figure 12—Dynamic Stability Test in Spin Tunnel

strongly influenced by phenomena occurring on an atomic scale. The behavior of microstructure in certain critical regions, such as a crack tip or dislocation core, has been simulated with a computer model. The model employs the lattice statics method generalized to include anharmonic effects. Considerable attention has been paid to deriving reliable interatomic potentials. At present, pseudopotential theory has been used for simple metallic systems and efforts are underway to apply methods from quantum chemistry in ceramic systems. Interatomic potentials for transition metals and alloys have been extracted by systematically inverting experimental phonon spectra obtained from inelastic phonon data. Some specific research projects include screw dislocation core structure and Peierl's barrier in FCC metals; lattice trapping and crack propagation kinetics in brittle materials; and transition metal ion absorption and migration on alkalai halide surfaces.

STRUCTURES AND DYNAMICS RESEARCH

Research in Structures and Dynamics in JIAFS began in 1972 in computerized structural analysis and design. This research has continued to be among the major activities of the Institute. The different aspects of study in the area of computerized structural analysis and design have included: improved finite difference and finite element discretization procedures, design-oriented approximate methods of analysis and data management of large engineering software systems. Several publications have been contributed by JIAFS members in these areas (see, e.g. SD-105, 113, 115, 120, 122, 126, 127, 132 and 138).* In 1974, a research project was initiated to study the impact of new computing systems (with special emphasis on pipeline and minicomputers) on the solution strategies for structural problems (SD-118, 124, 152, 161 and 163). Research in the area of

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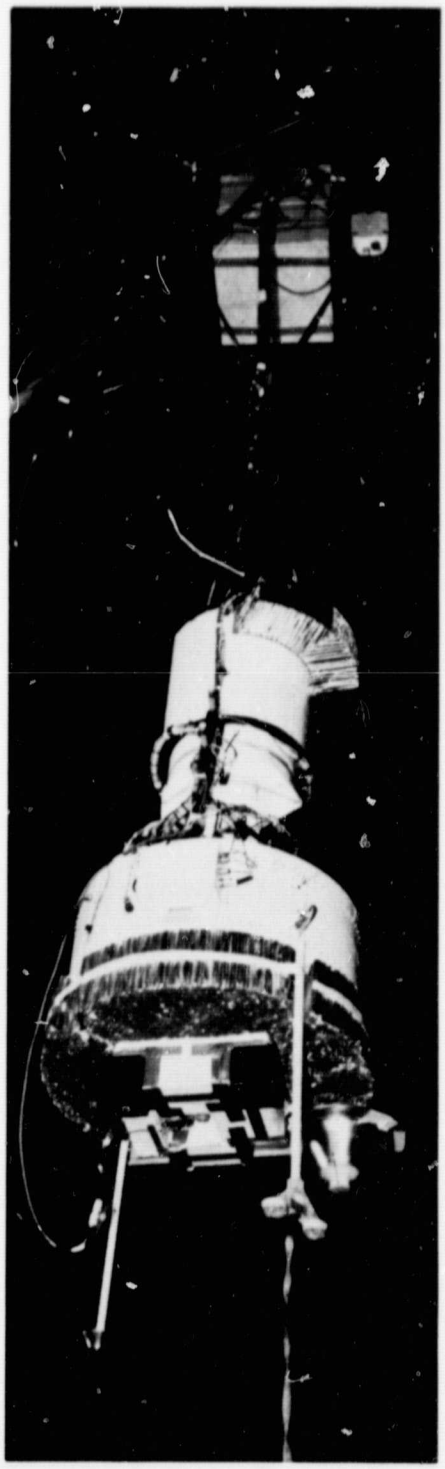

Figure 13—Low Atmosphere Composition and Temperature Experiment Instrument

nonlinear static analysis of structures has been conducted in JIAFS since 1974 (see SD-106, 137 and 147). This research activity has expanded in 1978 to include development of efficient computational procedures for the solution of large-scale nonlinear static and dynamic structural problems (see SD-166 and 169). Research in the area of mechanics of fibrous composite structures has been conducted in JIAFS since 1973 (see, e.g. SD-108, 116, 121, 131, 141 and 142). During the years 1976 and 1977, research was conducted on nonlinear effects in aircraft response to atmospheric turbulence and dynamics of rotating systems (see SD-143 145, 151, 155, 156, 157, 164 and 165). In 1977 a study was initiated on efficient analysis techniques for large repetitive lattice structures subjected to static, dynamic and termal loads. Applications are made to large-area space structures such as space solar power stations, large space mirrors, antennas, and power systems for supporting space operations (see SD-146, 153, 159 and 168).

Solution Strategies for Structural Problems on New Computing Systems. The impact of major hardware features and current and planned software of new computing systems on solution strategies of structural problems is studied. The computing systems considered include CDC STAR-100, minicomputers, microprocessors and array processors. A research-oriented pilot finite element program, which exploits the major features of STAR 100 computer, has been developed. This program is currently used to investigate the efficiency of various numerical procedures on pipeline computers. Also, work is being done to identify areas in finite element systems where micro-processors can be used most effectively. The long-range objective of this research is to produce guidelines for the design of future large scale structural analysis programs in a distributed computing environment where independent calculations are performed on different machines (e.g., vector computers, minicomputers and microprocessors).

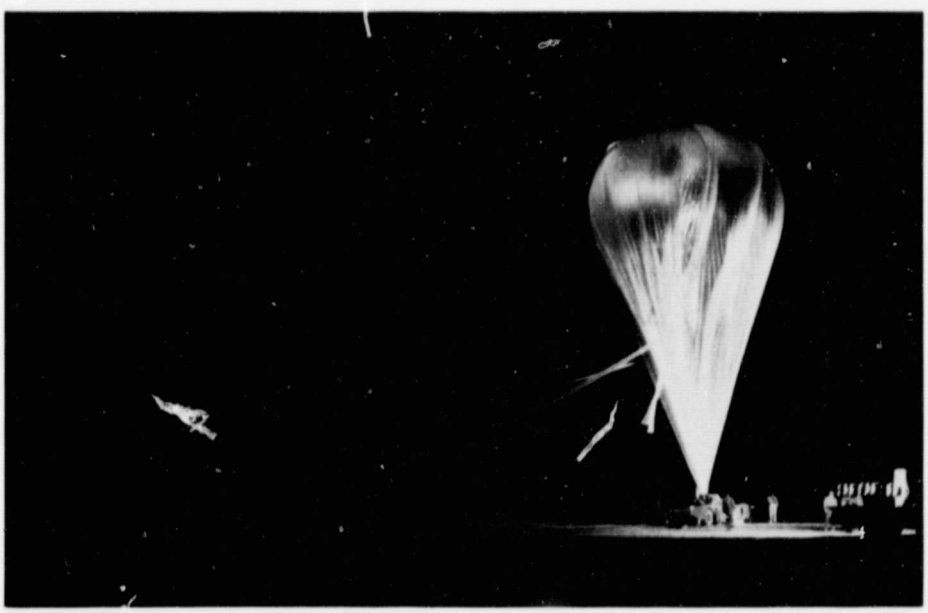

Figure 14—Balloon Launch of a Prototype LACATE Instrument

Analysis and Design of Large Repetitive Lattice Structures. This research is concerned with the analysis and design of large-area lattice structures subjected to static and dynamic loadings. Among the different topics investigated are development of rational classical and multipolar continuum models to simulate the response of the lattice structure and the optimization of lattice structures with controlled deformations. Applications are made to large-area space structures such as space solar power stations, large space mirrors, antennas, and power systems for supporting space operations.

Improved Numerical Procedures for Nonlinear and Dynamic Problems. Improvements are sought in the finite element and finite difference methods for solution of large nonlinear and dynamic structural mechanics problems and application of these techniques to study the behavior of structural components made of contemporary fibrous composites. Among the different topics investigated are the use of hybrid finite element, Rayleigh-Ritz, perturbation methods and the application of adaptive control techniques to improve the computational efficiency of nonlinear dynamic analsis.

Nonlinear Composite Shell Analysis. This area includes evaluation of different formulations of nonlinear shell problems, study of the effects of transverse shear deformation and anisotropic material behavior on the response of the shell as well as on the accuracy of various finite-difference and finite element models, and efficient techniques for predicting the nonlinear and dynamic response of laminated composite shells in the presence of discontinuities, cutouts, flaws, branches and other hardware features.

Design-Oriented Approximate Methods of Analysis. Efficient algorithms are being developed which are tailored especially for repetitive analysis required in the automated (optimum) structual design of large structural systems. Current work is focused on the effective application of multigrad methods wherein hierarchy of coarse and fine finite element grids are used in an adaptive manner to speed the computations.

Advanced Optimization Techniques in Structural Design. This research area includes development and use of optimization algorithms for large structural design problems subject to realistic constraints. Gradient-based optimization techniques are used in conjunction with efficient, rapid reanalysis procedures for large-scale problems. The study also includes the effective use of interactive graphics to facilitate man-machine interaction in the design process.

Analysis and Design of Composite Structures for High Temperature Applications. The objective of this research is to develop efficient techniques for determining the temperature distributions and thermal stresses in structures made of fibrous composite materials. Also, work is directed towards predicting the failure mechanims of composite structural components subjected to combined thermal and mechanical loadings.

Large Deformation Plastic Analysis of Structures. This research is concerned with large deformation plastic analysis of structures subjected to dynamic loading. Current work is directed towards effective ways of modeling the post-impact response of large complex structures and the evaluation of crashworthiness of aircraft structures.

Structures Modules in Large Engineering Design Software Systems. This study aims at defining the methodology and capabilities for self-contained structures modules and submodules, and their interface with other modules in large engineering design software systems. Special emphasis is placed on the data access requirements and the standards for information definition and transfer required for the structures modules and submodules. The ultimate goal of the research is to set specifications for the

design and organization of structures modules in large engineering design systems.

Flutter and Unsteady Loads. This area includes development and verification of analytical and numerical methods for predicting airload distributions on oscillating or impulsively moving lifting surfaces and wing-body combinations. These aerodynamic forces are required for analysis of flutter and dynamic response to gusts and turbulence and are basic to successful use of active control techniques for flutter and gust alleviation. Emphasis is on the transonic to low supersonic speed range and on the effects of moving leading-edge and/or trailing-edge control surfaces in any speed range.

Active Controls and Aeroelasticity. The use of active controls on aircraft has been shown to yield significant improvements in flutter speed, ride quality, performance and aircraft life. Experimental and theoretical investigations are conducted on control-surface configurations, control laws, sensor arrangements, and feedback systems. The objective of this research is to broaden the understanding of active control systems, enhance their usefulness, and ultimately, facilitate their routine use in aircraft design.

Rotor Dynamics. The purpose of this research is the development of tools for evaluating the dynamic and areoelastic response characteristics of rotorcraft. The program involves analytical and experimental investigation of topics such as rotor aeroelastic stability, blade loads, fuselage vibrations, vibration isolators and absorbers, and rotor unsteady aerodynamics.

RESEARCH FACILITIES

The research facilities of the Langley Research Center are available to members of the Institute on a scheduled basis. Some of these laboratories are:

Acoustics Research Facilities
Research facilities in acoustics are centered in the new aircraft noise reduction laboratory at Langley Research Center. This Laboratory serves as a focal point in the federal government for all research and development activities relating to the alleviation of noise from air and high speed ground transportation vehicles. Some of the principal facilities serving the acoustics research group are:

Anechoic Chamber
The anechoic chamber has internal dimensions 20 ft. x 30 ft. x 30 ft. measured from wedge tip to wedge tip. It has a low cut-off frequency of 80 Hz. The chamber is capable of providing high mass flow air with controlled temperature. It can be used as an anechoic wind tunnel for studying the noise characteristics of moving bodies.

Reverberation Chamber
The reverberation room has internal dimensions of 20 ft. x 28 ft. x 14 ft. with splayed walls to increase the room diffusivity. The reverberation time of the room is 8 seconds which gives a low cut-off of 50 Hz. The chamber is equipped with humidity control and high mass flow capacity.

Flow Duct Acoustics Facility
The facility consists of a four foot diameter duct section linking the anechoic chamber and the reverberation chamber. It is used to study sound attenuating materials under realistic vehicle engine environments.

Acoustic Physics Laboratories
Various facilities for basic physical measurement on noise suppression materials used in vehicle engine inlets and exhaust environments.

Simulation Laboratory
Interior and exterior simulation capacity to study human reaction to noise.

Various additional facilities at Langley Research Center also are available to the acoustics research group. Among these are an outdoor rotor tower for studies on reduction of helicopter noise and additional anechoic and reverberation chambers.

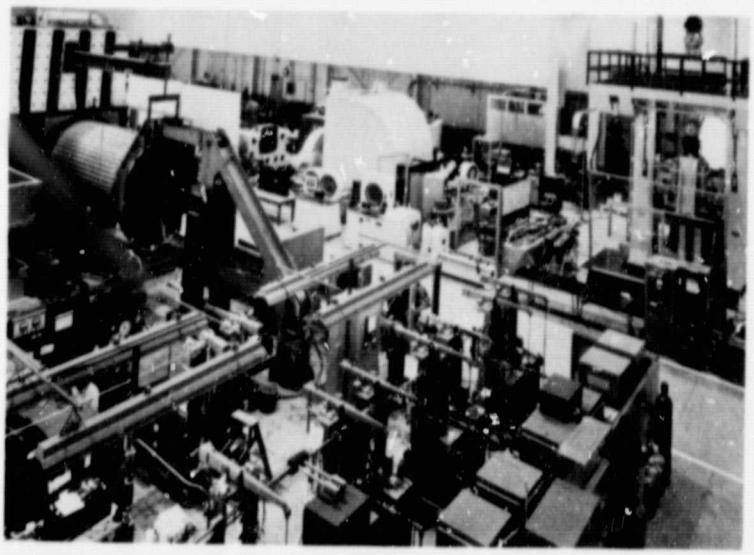

Figure 15—Materials Research Laboratory

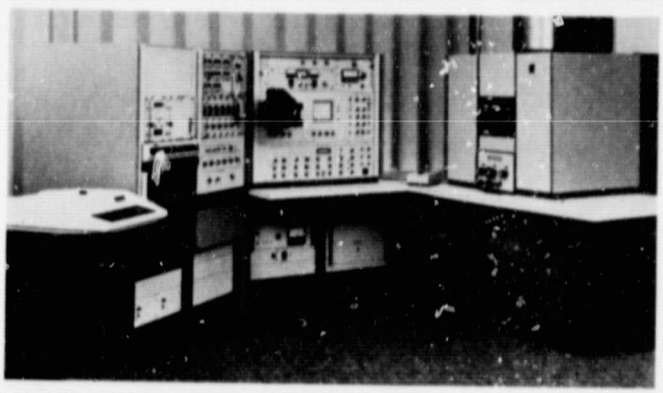

Figure 16—Electronic Microprobe for Materials Science Research

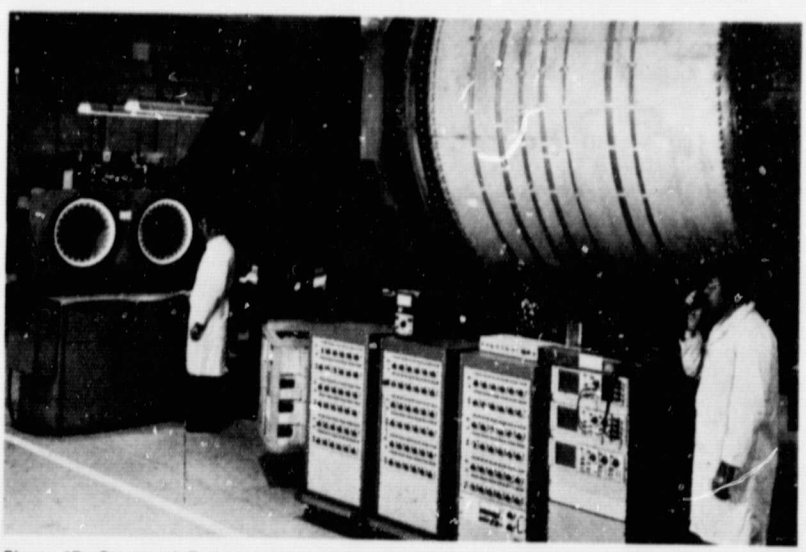

Figure 17—Structural Research Laboratory

Aeronautics Research Facilities

V/STOL Tunnel

V/STOL tunnel is a low speed facility with unique capabilities for solving problems of Vertical and Short Takeoff Landing aircraft as well as conventional aircraft, especially at or near the ground. It has a test section measuring 14½ x 21¾ feet, the side and top walls which are removable to permit closed, semi-open or open throat operation. The test section floor can be replaced by a moving belt ground plane to simulate the motion of the ground relative to an aircraft. Testing speeds may be varied up to 230 miles per hour.

High Speed 7 x 10 Foot Tunnel

facility which provides high speed stability and control, and performance data on advanced aircraft concepts. Some of the earliest systematic studies of the characteristics of wings in the difficult transonic speed regime were performed in this facility.

6 In. x 28 In. Transonic Tunnel

The Langley 6" x 28" transonic tunnel is a two dimensional facility with solid parallel walls and slotted top and bottom walls to permit testing up to a Mach number of 1.2. It is used primarily in airfoil research with a typical airfoil having a chord of 6 in. and completely spanning the 6 in. width of the tunnel. Running time varies from 30 to 300 seconds, depending on the Mach number and stagnation pressure.

Full Scale Tunnel

Langley's full scale tunnel is the second largest wind tunnel in the United States. It has a test section 30 ft. high by 60 ft. wide and 56 ft. long with a speed range from 25 to 110 miles per hour. It is used in studies of full scale general aviation aircraft, helicopters, powered lift models, supersonic aircraft models, and free flying dynamic models.

20 Foot Spin Tunnel

The Langley 20 ft. spin tunnel is a unique vertical wind tunnel used for investigation of spin characteristics of aircraft and descent characteristics of spacecraft recovery devices. The tunnel has a speed range up to 90 ft. per second and the speed can be changed very rapidly to accommodate free spinning dynamic models.

Low Turbulence Pressure Tunnel

The low turbulence pressure tunnel is a low speed continuous flow facility with a test section three feet wide by 7½ feet high. Air pressure in the tunnel can be varied from 0.3 to 10 atmospheres to provide a large range of test Reynolds number. Tests on complete models and on two dimensional airfoil models are conducted over a Mach number range from 0.10 to 0.40.

Flight Research Facilities

Langley's flight research facilities include a large aircraft hangar with associated research equipment, a sophisticated flight data acquisition system, and a number of aircraft for research support. In addition, Langley has available the extensive flight research facilities at Wallops Flight Center for research flying that requires more unrestricted airspace than is available at Langley.

⅓-Meter Transonic Cryogenic Tunnel

The ⅓-meter transonic cryogenic tunnel is the pilot tunnel for the National Transonic Facility (NTF) now under construction. It is used primarily for working out of some of the operational problems of cryogenic testing expected with the NTF but has also proved to be a useful general research facility for other studies.

16-Foot Transonic Tunnel

The Langley 16-foot transonic tunnel is used primarily for investigations of propulsion aerodynamics, including studies of turbofan engine nozzle geometry, interference effects of the engine exhaust on the airframe, and powered-lift schemes designed to improve maneuverability at high angles of attack.

Environmental Modeling Facilities

The research areas require the use of high-speed digital computers for data input from satellite programs, and

Figure 18—Model Test in Transonic Dynamics Tunnel

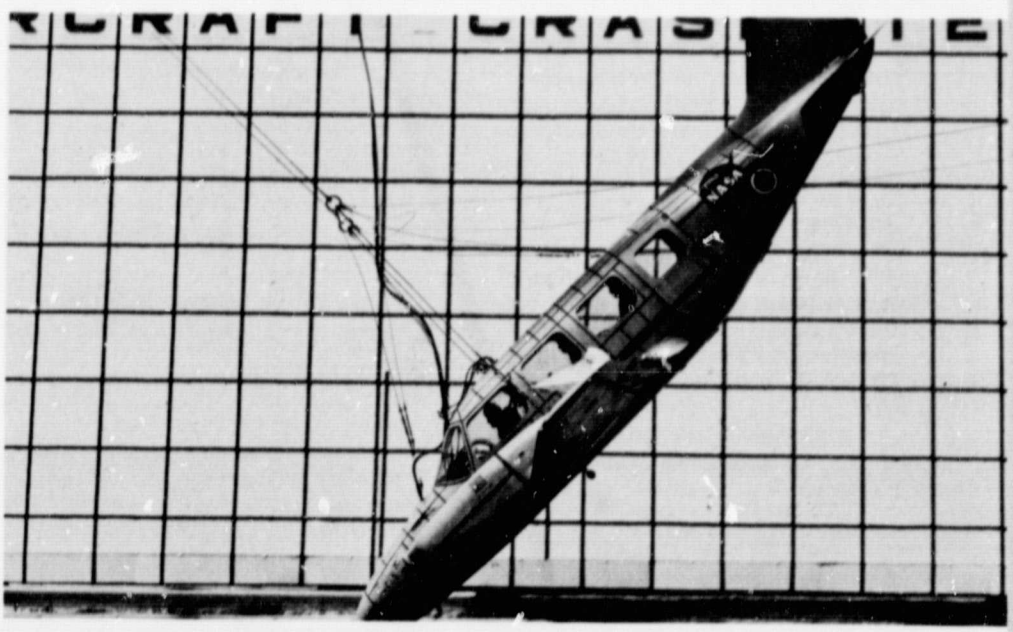

Figure 19—Crash-worthiness Test at the Crash Test Facility

the NASA-Langley Research Center's computational facilities (see Computation Facilities) which are excellent for the research concerned.

Materials Science Facilities

The materials science facility includes a variety of equipment for materials preparation, characterization and analysis. The metallurgical laboratory includes a scanning electron microscope, a transmission electron microscope, and an electron probe analyzer, in addition to a range of optical microscopes. The X-ray facility provides support for single crystal and powder X-ray methods. A variety of mechanical test apparatus is available including a computer controlled multi-parameter apparatus for combined load temperature and pressure variation.

Structures and Dynamics Facilities

Structural Research Laboratory

The structural research laboratory contains a wide variety of testing machines for advanced structural research which includes 1,200,000-lb. and a number of smaller axial compression-tension machines; Instron machine with strain-rate control; large 6-component combined loading testing machine, automatic data recording and data reduction system; large 10,000 KVA radiant lamp type heating system with programmable control for the temperature. In addition, creep testing machines, vacuum chambers, electron microscope, and metallurgical laboratory are available.

Transonic Dynamic Wind Tunnel

This wind tunnel has unique capabilities for investigation of aeroelastic phenomena such as flutter, buffeting, gust loads and rotor dynamics. Special features of the facility include a variable density test medium of either air or freon-12, Mach number range from low subsonic to 1.2, and computer controlled data acquisition system.

Aircraft Crash Facility

Simulates crash of full-scale aircraft under controlled conditions. Simulation is accomplished by swinging the aircraft by cables, pendulum style, into the ground from a structural A-frame approximately 400 feet long and 240 feet high. The length of the swing cables regulates the aircraft impact angle from 0° (level) to approximately 60°. Impact velocity can be varied up to approximately 65 mph, governed by the pull-back height. Variations of aircraft pitch, roll, and yaw can be obtained by changes in the aircraft suspension harness attached to the swing cables. The impact runway is made of concrete. Maximum allowable weight of aircraft is 30,000 pounds with limitations that might be imposed by other dynamic parameters.

Computational Facilities

The extensive computational facilities at NASA-Langley are available for use by members of the Institute. These facilities currently include two CDC-6600 and two CDC-6400 computers operating under a CDC SCOPE-based operating system to provide batch service. A CDC CYBER 173 and a CDC CYBER 175 operating under the CDC NOS system provide time sharing and central/remote batch service. A CDC STAR-100 computer system is available for use in a single user mode. Tentative NASA planning anticipates a gradual transition of the batch machines to the time sharing mode and the possible addition of another CDC CYBER 175. Remote job entry terminals and interactive terminals are available at research locations throughout the center. Students in most of the programs have access to the interactive and remote batch terminals at NASA. An AG-60 plasma panel interactive terminal is now being built at Langley and is expected to become operational in the near future.

Library Facilities

Members of JIAFS have access to the Langley technical library which contains half a million documents, over 40 thousands books, and 800 current journal subscriptions. In addition to the documents in the library, two computer terminals connect with the central NASA indexing systems to provide access to bibliographic data of over 800,000 citations.

VISITING MEMBERS PROGRAM

A Visiting Scientists and Engineers Program provides an opportunity for scientists and engineers from government and industry and from academic and research institutions to pursue their respective research areas as visiting members of the Institute's research staff. In addition, JIAFS each year provides Visiting Fellowship appointments to outstanding scientists and engineers for periods of one year. A complementary program of Research Associate awards provides an opportunity for a year or more of postdoctoral research.

The research opportunity offered in the Institute enables visiting research scientists and engineers to involve themselves in projects (see Research at JIAFS) that excite their interest. Visiting members working at JIAFS may obtain access, on a scheduled basis, to the extensive scientific and egineering equipment and facilities at the NASA-Langley Research Center. Furthermore, they also have the opportunity to associate with NASA-Langley scientists and engineers and faculty members from George Washington University which include visiting faculty members of other universities, and other eminent visiting members who are working on related problems. It is believed that the experience gained by the visiting members during their stay at the Institute will be highly rewarding through their contact and exchange of ideas.

Visiting members of the Institute are provided by JIAFS with office, laboratory, library, and computing facilities in addition to stipends. Stipends may be made available in full or in part to supplement funds provided by their home institutions or other sources. The stipend is determined in accordance with the salary scale of the home institution.

Visiting Scientists and Engineers are appointed to JIAFS to further their respective research interests and to pursue the current interests of the Institute. Applications are welcomed from scientists and engineers from government and industry and from academic and research institutions. Appointments are made on a yearly basis, but may be for a longer period of time, depending on the interests of the individual and the Institute.

Visiting Fellowship appointments are made by the University on the recommendation of a panel of scientists appointed by JIAFS. Invitations are extended annually to interested and qualified scientists and engineers. Awards are based on the fields of research interest and the scholarly and technical achievements of the applicant. Visiting Fellows have equivalent faculty status to that of Visiting Professor.

Research Associate appointments for postdoctoral research are made each year in support of the JIAFS research program. Applications are selected on the basis of their scholarly qualifications, their promise as research scientists, and the relevance of their research area to the general objectives of JIAFS. Each recipient, during his tenure, is assigned to a specific program and is associated with an Institute's senior scientist. Appointments are made on a yearly basis.

In addition to the formal programs for visiting members, facilities can be provided for researchers with independent financial support to come to the Institute for short term visits, including those during the summer. Applications for such visits are encouraged for research programs relevant to the work in progress at JIAFS.

For additional information and requests for application forms, see information on back cover.

ACADEMIC PROGRAM

JIAFS currently offers an academic program with areas of concentration in Acoustics, Aeronautics, Environmental Modeling, Fluid Mechanics and Thermal Sciences, Materials Science, and Structures and Dynamics leading to the degrees of Master of Science, Professional degree, and Doctor of Science. The objective of the academic program is to prepare qualified students for careers in research, develop-

ment, design, and teaching to meet the challenge of ever-increasing technical problems and the nation's needs in these fields.

The education and research opportunities offered in the program combines the academic resources of George Washington University with the professional research staff and facilities of NASA-Langley Research Center. These unique opportunities enable students to involve themselves in "real world" research projects that excite their interest, while taking their graduate academic courses, and at the same time permit them to associate with prominent visiting members who are working on related problems. The faculty and NASA scientists conduct research, and students are closely knit into the intimate association of research and instruction from the day of their arrival. It is believed that the experience of the students during their stay at the Langley Research Center will be highly rewarding and will benefit them throughout their future careers.

The courses are taught at NASA-Langley Research Center by NASA scientists and engineers and the faculty of the George Washington University's School of Engineering and Applied Science. NASA-Langley's extensive scientific and engineering facilities and equipment are utilized whenever feasible. The School of Engineering and Applied Science's Department of Civil, Mechanical, and Environmental Engineering offers the following programs of study.

The Institute also offers a full range of supporting courses in Electrical Engineering and Computer Science, Operations Research, and Engineering Administration in addition to the programs and courses listed above. Each student's program of study and research is designed to fit his particular interest. Students must consult with their advisors for the formulation of a degree program. For detailed information regarding admission procedure, degree program and course descriptions, refer to the School of Engineering and Applied Science Bulletin.

ACOUSTICS

ApSc 211: Analytical Methods in Engineering I
ApSc 212: Analytical Methods in Engineering II
ApSc 213: Analytical Methods in Engineering III
ApSc 215: Analytical Methods in Engineering V
ApSc 216: Special Topics in Engineering Analysis
EngS 203-4: Probability and Statistics of Metrology
EngS 217. Analytical Mechanics
EngS 270: Theoretical Acoustics I
EngS 271: Random Process Theory I
EngS 272: Random Process Theory II
EngS 273: Time Series Analysis
EngS 274: Environmental Acoustics
EngS 275: Theoretical Acoustics II
EngS 276: Acoustical and Mechanical Measurements
EngS 277: Physical Acoustics
EngS 278: Psychological and Physiological Acoustics
EngS 279: Human Factors in Engineering
EngS 280: Special Topics in Acoustics
EngS 284: Numerical Methods in Engineering
EngS 298: Research
EngS 299-300: Thesis Research
EngS 310: Aeroacoustics
EngS 311: Nonlinear Acoustics
EngS 312: Theory of Random Vibration
EngS 313: Structural Acoustic Interaction
EngS 314: Advanced Numerical Methods in Engineering
EngS 398: Advanced Reading and Research
EngS 399: Dissertation Research
ME 215: Theory of Vibrations
ME 216: Structural Dynamics
ME 221: Intermediate Fluid Mechanics
ME 227: Viscous Flow
ME 231: Hydrodynamics
ME 235: Compressible Flow
ME 312: Theory of Turbulence

AERONAUTICS

ApSc 211: Analytical Methods in Engineering I
ApSc 212: Analytical Methods in Engineering II
ApSc 213: Analytical Methods in Engineering III
ApSc 214: Analytical Methods in Engineering IV
ApSc 215: Analytical Methods in Engineering V
ApSc 216: Special Topics in Engineering Analysis
EE 202: Linear System Theory I
EngS 217: Analytical Mechanics
EngS 284: Numerical Methods in Engineering
ME 215: Theory of Vibrations
ME 221: Intermediate Fluid Mechanics
ME 222: Applied Fluid Dynamics
ME 223: Aeroelasticity
ME 227: Viscous Flow
ME 231: Hydrodynamics
ME 235: Compressible Flow
ME 237: Energetics of Fluid Flow I
ME 238: Energetics of Fluid Flow II
ME 248: Seminar: Aircraft Design I
ME 249: Seminar: Aircraft Design II
ME 270: Aerodynamics of Flight Vehicles
ME 271: VTOL Aircraft Technology
ME 272: Powered-Lift Technology
ME 273: Principles of Automatic Flight Control
ME 274: Principles of Flight Guidance
ME 275: Stability and Control of Vehicles
ME 277: Numerical Methods in Fluid Mechanics
ME 278: Performance, Stability, and Control of Helicopters
ME 279: Special Topics in Flight Sciences
ME 281: Nonequilibrium Thermodynamics
ME 290: Kinetic Theory of Gases
ME 295: Statistical Thermodynamics
ME 298: Research
ME 299-300: Thesis Research
ME 312: Theory of Turbulence

AERONAUTICS (Continued)

ME 315: Hypersonic Flow
ME 398: Advanced Reading and Research
ME 399: Dissertation Research

ENVIRONMENTAL MODELING

ApSc 211: Analytical Methods in Engineering I
ApSc 213: Analytical Methods in Engineering III
EngS 263: Atmospheric Physics for Engineers I
EngS 264: Atmospheric Physics for Engineers II
EngS 284: Numerical Methods in Engineering
EngS 298: Research
EngS 299-300: Thesis Research
EngS 314: Advanced Numerical Methods in Engineering
ME 221: Intermediate Fluid Mechanics
ME 227: Viscous Flow
ME 231: Hydrodynamics
ME 257: Energy Technology I
ME 265: Air-pollution Meteorology
ME 285: Reaction Kinetics
ME 288: Convective Heat and Mass Transfer
ME 289: Radiative Heat Transfer
ME 296: Special Topics in Heat and Mass Transfer
ME 312: Theory of Turbulence

FLUID MECHANICS AND THERMAL SCIENCES

ApSc 211: Analytical Methods in Engineering I
ApSc 212: Analytical Methods in Engineering II
ApSc 213: Analytical Methods in Engineering III
ApSc 214: Analytical Methods in Engineering IV
ApSc 215: Analytical Methods in Engineering V
ApSc 216: Special Topics in Engineering Analysis
EngS 218: Introduction to Continuum Mechanics
EngS 289: Special Topics in Theoretical and Applied Mechanics
ME 221: Intermediate Fluid Mechanics
ME 222: Applied Fluid Dynamics
ME 223: Aeroelasticity
ME 227: Viscous Flow
ME 231: Hydrodynamics
ME 235: Compressible Flow
ME 280: Advanced Thermodynamics
ME 281: Nonequilibrium Thermodynamics
ME 287: Heat Conduction
ME 288: Convective Heat and Mass Transfer
ME 289: Radiative Heat Transfer
ME 295: Statistical Thermodynamics
ME 297: Special Topics in Fluid Mechanics
ME 298: Research
ME 299-300: Thesis Research
ME 310: Mechanics of Non-Newtonian Fluids
ME 311: Nonsteady Flow
ME 312: Theory of Turbulence
ME 315: Hypersonic Flow
ME 317: Physical Gas Dynamics
ME 398: Advanced Reading and Research
ME 399: Dissertation Research

SOLID MECHANICS AND MATERIALS ENGINEERING (including Materials Science)

ApSc 211: Analytical Methods in Engineering I
ApSc 212: Analytical Methods in Engineering II
ApSc 213: Analytical Methods in Engineering III
ApSc 214: Analytical Methods in Engineering IV
ApSc 215: Analytical Methods in Engineering V
ApSc 216: Special Topics in Engineering Analysis
CE 252: General Structural Dynamics
CE 253: Failure and Reliability Analysis of Engineering Structures
CE 254: Special Topics in Structural Engineering
CE 261: Analysis of Plates and Shells
CE 263: Theory of Structural Stability
EngS 215: Advanced Strength of Materals

SOLID MECHANICS (Continued)

EngS 218: Introductior to Continuum Mechanics
EngS 221: Theory of Elasticity I
EngS 222: Theory of Elasticity II
EngS 229: Transformations in Materials
EngS 230: Deformation of Materials
EngS 231: Structure of Materials
EngS 234: Composite Materials
EngS 236: Experimental Techniques in Materials Science
EngS 237: Environmental Effects on Materials I
EngS 238: Environmental Effects on Materials II
EngS 240: Fracture Mechanics
EngS 241: Fatigue and Failure of Materials
EngS 242: Materials Recycling and Recovery
EngS 249: Special Topics in Materials Science
EngS 256: Introduction to the Theories of Inelastic Media
EngS 284: Numerical Methods in Engineering
EngS 285: Finite Element Methods in Engineering Mechanics
EngS 288: Advanced Finite Element Methods in Structural Mechanics
EngS 289: Special Topics in Theoretical and Applied Mechanics
EngS 298: Research
EngS 299-300: Thesis Research
EngS 398: Advanced Reading and Research
EngS 399: Dissertation Research
ME 215: Theory of Vibrations
ME 216: Structural Dynamics
ME 221: Intermediate Fluid Mechanics
ME 280: Advanced Thermodynamics
ME 281: Nonequilibrium Thermodynamics
ME 295: Statistical Thermodynamics
ME 310: Mechanics of Non-Newtonian Fluids

STRUCTURES AND DYNAMICS

ApSc 211: Analytical Methods in Engineering I
ApSc 212: Analytical Methods in Engineering II
ApSc 213: Analytical Methods in Engineering III
ApSc 214: Analytical Methods in Engineering IV
ApSc 215: Analytical Methods in Engineering V
ApSc 216: Special Topics in Engineering Analysis
CE 253: Failure and Reliability Analysis of Engineering Structures
CE 254: Special Topics in Structural Engineering
CE 261: Analysis of Plates and Shells
CE 263: Theory of Structural Stability
EE 157: Machine and Assembly Language Programming
EngS 221: Theory of Elasticity I
EngS 222: Theory of Elasticity II
EngS 234: Composite Materials
EngS 281: Advanced Programming Techniques for Engineering Mechanics Problems
EngS 282: Computer-aided Design
EngS 283: Application of Computer Graphics in Engineering
EngS 284: Numerical Methods in Engineering
EngS 285: Finite Element Methods in Engineering Mechanics
EngS 286: Analysis and Design of Thin-walled Structures
EngS 287: Automated Design of Complex Structures
EngS 288: Advanced Finite Element Methods in Structural Mechanics
EngS 289: Special Topics in Theoretical and Applied Mechanics
EngS 299-300: Thesis Research
EngS 314: Advanced Numerical Methods in Engineering
EngS 398: Advanced Reading and Research
EngS 399: Dissertation Research
ME 215: Theory of Vibrations
ME 216: Structural Dynamics
ME 223: Aeroelasticity
ME 248: Seminar: Aircraft Design I
OR 251: Linear Programming
OR 252: Nonlinear Programming

The graduate programs are open to qualified students. An appropriate Bachelor's degree is required for admission to Master's study, an appropriate Master's degree is required for admission to the Professional or Doctor of Science degrees. Courses may also be taken by non-degree students with the approval of the instructor.

MASTER OF SCIENCE DEGREE

The student's program may provide for a broad coverage in a variety of fields or may be designed to provide a concentration in particular areas. Upon admission the student is assigned an adviser. The student and adviser determine the program of study based on the individual's background and the requirements of the School.

Admission

Admission to graduate study toward a Master's degree requires an appropriate Bachelor's degree from a recognized institution and evidence of capacity for productive work in the field selected, as indicated by undergraduate grades, Graduate Record Examination scores, and similar data. The applicant must submit the following items to be considered for admission:

1. A completed Application form.
2. Official transcripts from each educational institution attended since high school graduation.

Transfer Credit

Up to 6 semester hours of satisfactory credit (with grades of A or B), which normally must have been earned in a graduate program at another accredited institution, may be accepted in transfer, when applicable, to satisfy the Master's degree requirements.

Requirements for the Degree

The minimum Master's degree program consists of 24 semester hours of approved graduate courses and a Master's thesis (equivalent of 6 semester hours). With the approval of the Department a student may elect an optional program without a thesis which consists of a minimum of 33 semester hours of approved graduate course work. All Master's degree candidates are required to pass a Master's Comprehensive Examination which may be oral, written, or both.

PROFESSIONAL DEGREE

The Professional degree program has been established to provide an educational program for those students who are interested in pursuing course work beyond the Master's degree with emphasis on applied subject material rather than on research. The student and adviser determine the program of study, based on the individual's background and the requirement of the school.

Admission

Admission to a graduate study toword the Professional degree requires an appropriate Master's degree from a recognized institution and evidence of capacity for productive work in the field selected as indicated by prior scholarship and, where appropriate, professional experience. The applicant must submit the following items to be considered for admission:

1. A completed Application form.
2. Official transcripts from each educational institution attended since high school graduation.

Transfer Credit

Up to 6 semester hours of satisfactory credit with the grade of B or better while enrolled in a graduate program beyond Master's degree requirements at another accredited institution may be accepted in transfer to satisfy the Professional degree requirements.

Requirements for the Degree

The minimum of 30 semester hours of approved graduate courses are required for the Professional degree program, of which 6 credit hours may be in an approved technical or design project.

DOCTOR OF SCIENCE DEGREE

The doctoral program is designed

to prepare the student for a career of creative scholarship by providing a broad balanced background of knowledge and guidance in the performance of research. It requires study of interrelated fields of learning as well as original research in the field of central interest. The doctoral program for each student is determined, on an individual basis, by the student and his adviser. Work for the doctoral degree must be done in residence on campus except when special permission is granted by the Chairman of the Department for a student to be admitted for study to the program at the GWU—NASA-Langley Graduate Program at Hampton, Virginia.

Admission

A satisfactory Master's degree from an accredited institution is required, together with acceptable personal qualities and a capacity for creative scholarship. The applicant must submit the following items to be considered for admission:

1. A completed Application form.
2. Official transcripts from each educational institution attended since high school graduation.
3. Two letters of recommendation; one of these, if possible, should be from the student's Master's adviser.

Transfer Credit

Up to 6 semester hours of credit earned in approved courses completed with the grade of B or better while enrolled in a doctoral program at another accredited institution may be accepted in transfer to satisfy doctoral requirements of this School.

Requirements for the Degree

The program of study for the degree is divided into two stages. The first—made up of a study of interrelated fields of learning which supports the general area of research conventration—culminates in the qualifying examination. The second—composed of research investigation of a particular subject in a special field and the presentation of such research findings in a written dissertation—culminates in the final examination. The general requirements for the Doctor of Science degree are (1) a minimum of 30 semester hours of course work beyond the Master's degree in preparation for the qualifying examination; (2) a reading knowledge of one foreign language, preferably Russian; (3) the satisfactory completion of the qualifying examination; (4) a dissertation, equivalent to a minimum of 24 semester hours; and (5) the satisfactory passing of the final oral examination.

GRADUATE RESEARCH SCHOLAR ASSISTANTSHIP PROGRAM

A number of Research Scholar Assistantships are available for both Fall and Spring semesters to qualified students seeking an outstanding opportunity for graduate study and research leading to the degrees of Master of Science and Doctor of Science. Successful applicants will be awarded Research Scholar Assistantships with stipends of $8,000 a year for a Master of Science degree, and $9,000 a year for the Doctor of Science degree, and will be enrolled in the JIAFS academic program.

The current program offers the curriculum in the areas of Acoustics, Aeronautics, Environmental Modeling, Materials Science, and Structures and Dynamics. The objective of the program is to prepare well qualified students for careers in these fields to meet the challenge of ever-increasing technical problems of the nation's needs, and to conduct research of relevance to NASA, the students and the university. The education and research opportunities offered in the program combine the academic resources of The George Washington University and the professional research resources and facilities of NASA-Langley Research Center. These opportunities also enable students to involve themselves in projects of "real world" research problems that excite their interest and permit them to associate with faculty from George Washington University, scientists and engineers from NASA-Langley Research Center, and promi-

nent visiting members who are working on related problems. Most of the graduated Research Scholar Assistants have already had their research findings appear in NASA publications; others have published papers in scientific journals.

It is well known that most universities now recognize the necessity for engineers to have practical experience as well as strong academic backgrounds. Many schools have again begun to reemphasize the more applied aspects of engineering. This program adopts a more practical approach to graduate education by offering the student a comprehensive range of graduate academic programs and the opportunity to conduct "real world" research in a large research organization with modern facilities and extensive research laboratories and equipment.

Currently, university funds available for construction of new facilities, new faculty appointments for research and graduate education are extremely limited. It appears that these joint education and research programs, as developed in the JIAFS, do indeed offer a viable option for graduate study in the future. Furthermore, this specific program has been-instrumental in increasing the number of rigorously trained and educated engineers who are capable of making meaningful contributions to the solutions of problems in many technical areas concerned.

Graduate students admitted to this program take courses during the academic year and conduct research one-half time during the academic year and full-time during the summer. Normally it takes two years for a student to complete the Master of Science degree program. Three years of study beyond the M.S. degree generally are required for the D.Sc. degree. The student takes courses in the academic program in JIAFS and conducts research in the NASA facilities in conjunction with the GWU faculty and NASA researchers.

For additional information and requests for application forms for this program, see information on back cover.

Figure 20—CDC Star-100 Computer

JIAFS MEMBERS

FACULTY

ARMSTRONG, ERNEST S., Aerospace Technologist, and Assistant Professorial Lecturer in Engineering. B.S 1959, M.S. 1961, Clemson University; Ph.D. 1967, North Carolina State University at Raleigh. Research Areas: linear systems theory, optimal control, numerical analysis.

BARKSTROM, BRUCE R., Associate Research Professor of Applied Science. B.S. 1966, University of Illinois; M.S. 1971, Ph.D. 1972, Northwestern University. Research Areas: radiative transfer methods-direct and inverse; energy balance of the atmosphere.

BARNWELL, RICHARD W., Aerospace Technologist, and Associate Professorial Lecturer in Engineering. B.S. 1961, M.S. 1962, Auburn University; Ph.D. 1966, Virginia Polytechnic Institute and State University. Research Areas: low-speed airfoil testing, transonic aerodynamics, supersonic blunt-body aerodynamics, computational fluid mechanics.

BATTE, WILLIAM C., Self-employed, and Professorial Lecturer in Engineering. E.E. 1950, I.E. 1950, Virginia Polytechnic Institute and State University; Ph.D. 1965, Case Institute of Technology. Research Areas: digital systems engineering; electronics and electrical engineering and computer sciences.

BEACH, H. LEE, JR., Group Leader, High Speed Aerodynamics Division, and Assistant Professorial Lecturer in Engineering. B.S. 1966, M.S. 1968, Ph.D. 1970, North Carolina State University. Research Areas: propulsion, thermodynamics, heat transfer.

BECKWITH, IVAN E., Head, Gas Dynamic Section, and Associate Professorial Lecturer in Engineering. B.S. 1948, State University of Iowa. Research Areas: supersonic fluid-mechanics and quiet tunnel development.

BOWLES, ROLAND L., Head, Simulation Programming and Analysis Section, and Assistant Professorial Lecturer in Engineering. B.S. 1959, Randolph Macon College; M.S. 1961, Ph.D. 1974, University of Virginia. Research Areas: simulation technology; aeronautical flight simulation; sample data design techniques; math modeling of physical systems; numerical analysis.

BRICE, RICHARD S., Associate Research Professor of Applied Science. B.S. 1959, East Texas State University; M.S. 1968, North Texas State University; Ph.D. 1973, University of Texas at Austin. Research Areas: design, performance measurement and evaluation of computer operating and data management systems; simulation.

BUCKLEY, JOHN D., Technical Assistant, Fabrication Division and Associate Professorial Lecturer in Engineering. B.S. 1950, St. Lawrence University; B.S. 1959, M.S. 1961, Clemson University; Ph.D. 1968, Iowa State University. Research Areas: physical and thermal properties of materials, metals, ceramics, polymers design and fabrication of composite materials.

CAMPBELL, JOHN P., Research Professor of Engineering. B.S. 1939, Auburn University. Research Areas: aerodynamic performance, stability and control of low-speed aircraft.

CARD, MICHAEL F., Aerospace Engineer and Assistant Professorial Lecturer in Engineering. B.S.A.E. 1958, Massachusetts Institute of Technology; M.S. 1964, Ph.D. 1970, Virginia Polytechnic Institute and State University. Research Areas: composite materials; theory of plates and shells; stability of plates and shells; non-linear mechanics.

CARTER, JAMES E., Aerospace Technologist and Assistant Professorial Lecturer in Engineering. B.S. 1966, Virginia Polytechnic Institute and State University; E.A.A. and M.S. 1968, Massachusetts Institute of Technology; Ph.D. 1972, Virginia Polytechnic Institute and State University. Research Areas: aerodynamics; numerical analysis; separated flows.

COE, PAUL L., JR., Aerospace Engineer and Associate Professorial Lecturer in Engineering. B.S. 1966, Hofstra University; M.S. 1967, Ph.D. 1972, New York University. Research Areas: low-speed stability and control; performance of aircraft.

JIAFS MEMBERS—FACULTY

CROSWELL, WILLIAM F., Assistant Head, Electromagnetics Research Branch and Professorial Lecturer in Engineering. B.S. 1952, Virginia Military Institute; M.S. 1954, Air Force Institute of Technology. Research Areas: antennas; electromagnetic theory, plasma-antenna interaction; control theory-feedback, stability, compensation, and design.

DONELY, PHILIP, Retired Chief Engineer, NASA-Langley Research Center and Professorial Lecturer in Engineering. B.S. 1931, Massachusetts Institute of Technology. Research Areas: structural and fracture mechanics; aircraft operations; meteorology and the airplane; general design.

DUBERG, JOHN E., Associate Director, NASA-Langley Research Center and Adjunct Professor of Engineering. B.S. 1938, Manhattan College; M.S. 1940, Virginia Polytechnic Institute and State University; Ph.D. 1948, University of Illinois at Urbana-Champaign. Research Areas: aerospace engineering; structural mechanics; statics and dynamics.

ERICKSON, WAYNE D., Senior Scientist and Professorial Lecturer in Engineering. B.S. 1954, M.S. 1955, Michigan State University; S.M. 1958, ScD 1962, Massachusetts Institute of Technology. Research Areas: thermodynamics; combustion; chemical physics; energy technology.

ESTERLING, DONALD M., Associate Professor of Engineering and Applied Science. B.S. 1964, University of Notre Dame; M.A. 1966, Ph.D. 1968, Brandeis University. Research Areas: application of the constructs and methodology of solid-state-physics to problems in materials science engineering, particularly plasticity and fracture.

FARASSAT, FEREIDOUN, Associate Research Professor of Engineering. B.E. 1967, American University of Beirut, Lebanon; M.S. 1970, Syracuse University; Ph.D. 1973, Cornell University. Research Areas: aeroacoustics.

FOUDRAIT, EDWIN C., Staff Scientist and Associate Professorial Lecturer in Engineering. B.S. 1950, University of Illinois; M.S. 1965, Ph.D. 1966, Ohio State University. Research Areas: flight dynamics; control of spinning satellite vehicles; parameter identification; systems and control; control system software.

FRALICH, ROBERT W., Aerospace Technologist and Associate Professorial Lecturer in Engineering. B.Ae.E. 1947, University of Cincinnati; M.Ae.E. 1952, University of Virginia; Ph.D. 1963, Virginia Polytechnic Institute and State University. Research Areas: mathematical programming and advanced structural design procedures; improved finite element and finite difference methods.

FULTON, ROBERT E., Head, IPAD Development Section and Professorial Lecturer in Engineering. B.S. 1953, Auburn University; M.S. 1958, Ph.D. 1960, University of Illinois at Urbana-Champaign. Research Areas: computer-aided design; application of computers to structural mechanics problems; advanced numerical methods.

GATSKI, THOMAS B., Aerospace Technologist and Assistant Professorial Lecturer in Engineering. B.S. 1970, M.S. 1972, Ph.D. 1976, Pennsylvania State University. Research Areas: turbulence; applied mathematics; hydrodynamic stability; acoustics.

GRISWOLD, TRUMAN L., Retired Chief, Scientific and Technical Liaison Office, Air Force Systems Command, and Assistant Professorial Lecturer in Engineering. A.E. 1949, University of Cincinnati; MEA 1964, The George Washington University. Research Areas: engineering administration; administration of research and development; administration of engineering contracts; program management; personnel administration.

GROSE, WILLIAM L., Aerospace Engineer and Assistant Professorial Lecturer in Engineering. B.S. 1961, Virginia Polytechnic Institute and State University; M.S. 1966, College of William and Mary; Ph.D. 1969, Virginia Polytechnic Institute and State University. Research Areas: atmospheric chemistry; circulation of the atmosphere.

HAIGLER, GEORGE W., Aerospace Technologist and Assistant Professorial Lecturer in Engineering. B.S. 1950, Newberry College; M.S. 1952, University of South Carolina. Research Areas: analytical geometry; calculus; numerical techniques; algorithmic methods.

JIAFS MEMBERS—FACULTY

HARDIN, JAY C., Head, Surface Interaction Noise Section and Associate Professorial Lecturer in Engineering. B.S. 1964, M.S. 1965, Ph.D. 1969, Purdue University. Research Areas: stochastic processes; acoustics; fluid mechanics.

HEARTH, DONALD P., Director, Langley Research Center and Professorial Lecturer in Engineering. B.S. 1951, Northeastern University. Research Areas: management; research and development, and technology administration.

HOGGE, JOHN E., Assistant Head, Computer Applications Branch and Assistant Professorial Lecturer in Engineering. B.S. 1960, Randolph-Macon College; M.S. 1968, College of William and Mary. Research Areas: mathematical and computational techniques for digital computer applications to flight mechanics research with particular emphasis on approximation and estimation techniques.

HOHL, FRANK, Aerospace Engineer and Assistant Professorial Lecturer in Engineering. B.E.E. 1961, University of Florida; M.E.E. 1963, New York University; M.S. 1965; Ph.D. 1967, College of William and Mary. Research Areas: basic electrical engineering and electronics; applied mathematics; plasma physics; stellar dynamics.

JACHIMOWSKI, CASIMIR J., Research Chemist and Associate Professorial Lecturer in Engineering. B.S. 1960, DePaul University; Ph.D. 1964, Michigan State University. Research Areas: combustion chemistry; reaction kinetics; thermodynamics.

JONES, W. LINWOOD, JR., Aerospace Technologist and Assistant Professorial Lecturer in Engineering. B.S.E.E. 1962, Virginia Polytechnic Institute and State University; M.E.E. 1965, University of Virginia; Ph.D. 1971, Virginia Polytechnic Institute and State University. Research Areas: communications; controls and systems.

KIRBY, CECIL E., Head, Facilities Systems Section and Assistant Professorial Lecturer in Engineering. B.S.E.E. 1955, Clemson University; M.S.M.E. 1963, Ph.D. 1968, University of South Carolina. Research Areas: solar energy systems (residential); non-current—combustion and rocket propulsion systems.

KLEIN, VLADISLAV, Associate Research Professor. Mech.Eng. 1954, Techn. University, Czechoslovakia; Candidate of Techn. Sci. 1962, Military Academy, Czechoslovakia; Ph.D. 1974, Cranfield Institute of Technology, England. Research Areas: flight dynamics; flight test data analysis; system identification.

KRUSZEWSKI, EDWIN T., Assistant Head, Structures and Associate Professorial Lecturer in Engineering. B.S. 1942, Carnegie Institute of Technology; M.S. 1956, Ph.D. 1968, Virginia Polytechnic Institute and State University. Research Areas: applied mathematics; mechanics of solids; dynamics.

LAMAR, JOHN E., Aeronautical Research Scientist and Assistant Professorial Lecturer in Engineering. B.S. 1962, M.S. 1963, University of Alabama; Ph.D. 1972, Virginia Polytechnic Institute and State University. Research Areas: wing design; vortex lift, aeroelasticity.

LEYBOLD, HERBERT A., Head, Fracture Mechanics Section and Associate Professorial Lecturer in Engineering. B.C.E. 1955, Polytechnic Institute of Brooklyn; M.S.M.E. 1963, Virginia Polytechnic Institute and State University; Ph.D. 1969, North Carolina State University. Research Areas: fatigue and fracture of metals and composites.

LIEBOWITZ, HAROLD, Dean, School of Engineering and Applied Science, The George Washington University and Professor of Engineering and Applied Science. B.Ae.E. 1944, M.Ae.E. 1946, D.Ae.E. 1948, Polytechnic Institute of Brooklyn. Research Areas: aeronautics; solid mechanics; fluid mechanics; fracture mechanics.

LIU, CHEN-HUEI, Aerospace Technologist and Assistant Professorial Lecturer in Engineering. B.S. 1963, Cheng Kung University; M.S. 1968, Ph.D. 1971, New York University. Research Areas: fluid mechanics, aeroacoustics; computing; sound propagation.

LOENDORF, DAVID D., Aerospace Engineer, US Army at NASA-Langley Research Center and Assistant Professorial Lecturer in Engineering. B.S. 1969, M.E. 1971, Old Dominion University; M.E. 1974, University of Michigan. Research Areas: computer graphics.

JIAFS MEMBERS—FACULTY

LOFTIN, LAURENCE K., JR., Distinguished Research Associate, NASA-Langley Research Center and Professorial Lecturer in Engineering. B.M.E. 1943, University of Virginia. Research Areas: aerodynamics; aircraft design.

MALLEY, GEORGE T., Retired Chief Counsel, NASA-Langley Research Center and Professorial Lecturer in Engineering. B.A. 1936, University of Rochester; J.D. 1948, Cornell University. Research Areas: engineering law and management; administrative law; government contracts; admiralty law.

McNULTY, JAMES F., Head, Aeronautical Systems Engineering Branch and Assistant Professorial Lecturer in Engineering. B.E. 1944, Union College; M.S. 1954, University of Virginia; Ph.D. 1974, Union College. Research Areas: engineering administration; management of research and development.

MIKULAS, MARTIN M., JR., Principal Scientist (Concepts) and Assistant Professorial Lecturer in Engineering. B.S. 1961, M.S. 1964, Ph.D. 1970, Virginia Polytechnic Institute and State University. Research Areas: analysis and design of fibrous composite structures; structural dynamics.

MILLER, DOUGLAS R., Visiting Associate Professor of Operations Research. B.S. 1966, Carnegie Institute of Technology; M.A. 1969, Ph.D. 1971, Cornell University. Research Areas: applied stochastic processes (especially applications to nonparametric statistics, reliability theory, and sequential decision problems), probability theory of nonlinear polymers, topological measure theory.

MONTGOMERY, RAYMOND C., Aerospace Technologist and Assistant Professorial Lecturer in Engineering. B.S. 1963, M.S. 1964, University of Alabama; Ph.D. 1969, Virginia Polytechnic Institute and State University. Research Areas: stability and control of airplanes and helicopters; optimization; flight path and orbit determination; digital control systems.

MORIN, MAURICE K., Assistant Chief, Analysis and Computation Division and Assistant Professorial Lecturer in Engineering. B.A. 1955, Boston University. Research Areas: computer sciences (operational systems software).

MYERS, MICHAEL K., Professor of Engineering and Applied Science. B.A. 1962, Willamette University; B.S. 1962, M.S. 1963, Ph.D. 1966, Columbia University. Research Areas: duct acoustics; atmospheric sound propagation.

NOOR, AHMED K., Professor of Engineering and Applied Science. B.S. 1958, Cairo University; M.S. 1961, Ph.D. 1963, University of Illinois at Urbana-Champaign. Research Areas: solution techniques for structural members; improved finite element methods for non-linear and dynamic problems; shell structures.

OLSTAD, WALTER B., Chief, Space Systems Division and Professional Lecturer in Engineering. B.S. 1954, Brown University; M.S. 1958, Virginia Polytechnic Institute and State University; Ph.D. 1966, Harvard University. Research Areas: high temperature gas dynamics and heat transfer.

PARK, JAE H., Research Assistant Professor, College of William and Mary and Assistant Professorial Lecturer in Engineering. B.S. 1961, Seoul National University; M.S. 1967, Wilkes College; Ph.D. 1972, University of Colorado. Research Areas: atmospheric physics (atmospheric modeling, pollution remote sensing).

PARK, STEPHEN K., Aerospace Technologist/Mathematician and Assistant Professorial Lecturer in Engineering. B.S. 1964, Shippensburg State College; M.S. 1967, Ph.D. 1969, North Carolina State University. Research Areas: applied mathematics; optimization techniques; digital image processing; multispectral data analysis.

PAULS, SIDNEY F., Assistant Division Chief, Business Data Systems and Assistant Professorial Lecturer in Engineering. B.A. 1958, College of William and Mary; M.S.A. 1970, The George Washington University. Research Areas: engineering economics; engineering administration; management of computer organizations; systems analysis.

JIAFS MEMBERS—FACULTY

QUEIJO, MANUEL J., Head, Aerospace Dynamics Branch and Professorial Lecturer in Engineering. B.S. 1944, Worcester Polytechnic Institute; M.S. 1954, University of Virginia; Ph.D. 1963, Virginia Polytechnic Institute and State University. Research Areas: parameter identification from flight data (aero derivatives); simulation technology; ground effects on aircraft.

REICHLE, HENRY G., JR., Aerospace Technologist and Assistant Professorial Lecturer in Engineering. B.S.E. 1959, M.S.E. 1965, M.S. 1967, Ph.D. 1969, University of Michigan. Research Areas: atmospheric physics.

ROBERTSON, JAMES B., Aerospace Technologist and Assistant Professorial Lecturer in Engineering. B.S. 1958, The Citadel; B.S. 1961, M.S. 1962, Clemson University; Ph.D. 1966, Virginia Polytechnic Institute and State University. Research Areas: infrared detectors; liquid crystals.

RUNYAN ,HARRY, L., JR., Associate Research Professor of Engineering. B.S. 1939, Rutgers University; M.S. 1950, University of Virginia; Ph.D. 1974, Loughborough University of Technology. Research Areas: unsteady fluid dynamics; rotor dynamics and aeroelasticity.

RUSSELL, JAMES M., III, Research Scientist and Assistant Professorial Lecturer in Engineering. B.E.E. 1962, Virginia Polytechnic Institute and State University; M.E.E. 1966, University of Virginia; Ph.D. 1970, University of Michigan. Research Areas: atmospheric sciences; remote sensing of atmospheric properties.

SCHEIMAN, JAMES, Aerospace Engineering and Assistant Professorial Lecturer in Engineering. B.M.E. 1951, Ohio State University; M.S. 1969, Ph.D. 1972, Virginia Polytechnic Institute and State University. Research Areas: helicopter acoustics; helicopter aerodynamics; helicopter dynamics.

SCHEISS, JAMES R., Aerospace Technologist and Assistant Professorial Lecturer in Engineering. B.S. 1965, Purdue University; M.S. 1968, College of William and Mary. Research Areas: lumped and distributed parameter estimation theory; curve fitting.

SHAUGHNESSY, JOHN D., Aerospace Technologist and Associate Professorial Lecturer in Engineering. B.S. 1964, M.S. 1967, Ph.D. 1974, Virginia Polytechnic Institute and State University. Research Areas: helicopter handling qualities; stability and control.

SHOOSMITH, JOHN N., Head, Computer Mathematics and Programming Branch and Assistant Professorial Lecturer in Engineering. B.Sc. 1956, Queens University, Ontario, Canada; M.S. 1967, College of William and Mary; Ph.D. 1973, University of Virginia. Research Areas: numerical solution of two-point, boundary-value problems; boundary value problems in partial differential equations.

SMITH, G. LOUIS, Aerospace Technologist and Assistant Professorial Lecturer in Engineering. B.S. 1960, M.S. 1963, Ph.D. 1968, Virginia Polytechnic Institute and State University. Research Areas: earth radiation budget; statistical data reduction techniques.

SOBIESKI, JAROSLAW, Senior Research Scientist and Associate Professorial Lecturer in Engineering. B.S. 1955, M.S. 1957, Dr. Eng. 1964, Technical University of Warsaw. Research Areas: computer-aided structural analysis and design of aircraft and aerospace structures; advanced optimization techniques.

STEIN, BLAND, Assistant Head, Materials Research Branch and Assistant Professorial Lecturer in Engineering. B.S. 1956, City College of New York; M.S. 1964, Virginia Polytechnic Institute and State University. Research Areas: high temperature mechanical behavior of alloys and composites as affected by their operating environments.

STEIN, MANUEL, Senior Aerospace Engineer and Associate Professorial Lecturer in Engineering. B.S. 1943, University of Pittsburgh; M.Ae.E. 1951, University of Virginia; Ph.D. 1958, Virginia Polytechnic Institute and State University. Research Areas: static and dynamic analysis of plate and shell structures; numerical solutions of solid mechanics and flutter problems.

STERMER, ROBERT L., JR., Aerospace Technologist and Associate Professorial Lecturer in Engineering. B.E.E. 1960, M.E.E. 1965, University of Virginia; Ph.D. 1971, Duke University. Research Areas: magnetic domain (bubble) memories.

JIAFS MEMBERS—FACULTY

STRAETER, TERRY A., Aerospace Technologist and Assistant Professorial Lecturer in Engineering. A.B. 1964, William Jewell College; M.A. 1966, College of William and Mary; Ph.D. 1971, North Carolina State University. Research Areas: optimization techniques; reliable software; computational optimal control.

SWIFT, CALVIN T., Aerospace Technologist/Microwave Physicist and Assistant Professorial Lecturer in Engineering. B.S. 1959, Massachusetts Institute of Technology; M.S. 1965, Virginia Polytechnic Institute and State University; Ph.D. 1969, College of William and Mary. Research Areas: microwave remote sensing of the ocean and atmosphere.

TABAK, DANIEL, National Research Council Senior Research Associate, NASA-Langley Research Center and Professorial Lecturer in Engineering. B.Sc. 1959, M.Sc. 1953, Technion, Haifa, Israel; Ph.D. 1967, University of Illinois at Urbana. Research Areas: optimization methods; control systems; digital systems; computer organization; microprocessors; computer control; differential games; reliability analysis.

TENNEY, DARREL R., Research Engineer and Associate Professorial Lecturer in Engineering. B.S. 1964, West Virginia Wesleyan College; Ph.D. 1969, Virginia Polytechnic Institute and State University. Research Areas: metal-matrix composites: analytical and experimental characterization of interfacial reactions and their effect on mechanical properties of composites, high temperature fatigue and creep, fracture and toughness characteristics of commercially available metal-matrix composites.

TUCKER, JERRY H., Electrical Engineer and Assistant Professorial Lecturer in Engineering. B.S.E.E. 1964, Mississippi State University; M.E.E.E. 1970, University of Virginia; Ph.D. 1974, Virginia Polytechnic Institute and State University. Research Areas: Boolean calculus and its applications; switching theory; microprocessors; minicomputers.

UNNAM, JALAIAH, Post-doctoral Research Associate, GWU and Assistant Professorial Lecturer in Engineering. B.Tech. 1970, Indiana Institute of Technology; M.S. 1972, Ph.D. 1975, Virginia Polytechnic Institute and State University. Research Areas: solid state diffusion; X-ray diffraction; composite materials; numerical analysis and computer programming; electron microprobe; scanning electron microscope; quantitative metallography; mechanical testing.

WALBERG, GERALD D., Head, Aerothermodynamics Branch and Assistant Professorial Lecturer in Engineering. B.S. 1956, M.S. 1963, Virginia Polytechnic Institute and State University; Ph.D. 1974, North Carolina State University. Research Areas: hypersonic aerothermodynamics; radiative and convective aerodynamic heating; outer planet entry vehicles.

WALSH, THOMAS M., Head, Radar Systems Section and Associate Professorial Lecturer in Engineering. B.S.E.E. 1953, Ohio State University; M.S.E. 1962, University of Akron; Ph.D. 1974, Ohio State University. Research Areas: microwave landing systems; aircraft guidance and flight control systems; imaging radars; terminal area air traffic control system studies.

WHITESIDES, JOHN L., JR., Associate Professor of Engineering and Applied Science. B.S. 1965, Ph.D. 1968, University of Texas at Austin. Research Areas: analytical methods in fluid mechanics; acoustics.

YATES, E. CARSON, JR., Aerospace Engineer and Associate Professorial Lecturer in Engineering. B.S. 1948, M.S. 1949, North Carolina State University; M.S. 1953, University of Virginia; Ph.D. 1959, Virginia Polytechnic Institute and State University. Research Areas: steady and unsteady aerodynamics; aeroelasticity and structural dynamics.

YU, JAMES CHUN-YING, Aerospace Engineer and Associate Professorial Lecturer in Engineering. B.S. 1962, National Taiwan University; M.S. 1968, Ph.D. 1971, Syracuse University. Research Areas: duct acoustics; flow-surface interaction noise; jet noise.

YUAN, S. W. Professor of Engineering and Applied Science; B.S. University of Michigan; Ae.E., Stanford University; M.S., Ph.D., California Institute of Technology. Research Areas: fluid mechanics, heat and mass transfer; aerodynamics; rotary-wing aerodynamics; hypervelocity impact; solar energy.

VISITING SCIENTISTS AND ENGINEERS (Current)

AGRAWAL, PRADEEP K., Visiting Scientist. B.Sc. 1968, Agra University, India; B. Tech. 1968, Indian Institute of Technology, India; M.Sc. 1969, Ph.D. 1972, Ohio State University. Research Areas: electrophysics; microstrip antennas.

BAALS, DONALD D., Consultant. B.S.M.E. 1938, M.S. 1939, Purdue University. Research Areas: wind-tunnel design and development.

BHAT, RAMA B., Visiting Scientist. B.E. 1966, University of Mysore, India; M. Tech. 1968, Ph.D. 1973, Indian Institute of Technology, India. Research Areas: structural dynamics.

BREWER, DANA A., Post-doctoral Research Associate. B.S. 1972, Pennsylvania State University; Ph.D. 1977, Virginia Polytechnic Institute and State University. Research Areas: development of chemical kinetic model to be used with severe storms computer program.

CHO, YOUNG-CHUNG, Visiting Scientist. B.S. 1963, Seoul National University, Korea; Ph.D. 1972, Massachusetts Institute of Technology. Research Areas: sound propagation in and radiation from ducts.

JOSHI, MAHENDRA C., Post-doctoral Research Associate. B.Sc. 1967, University of Madras, India; DMIT 1970, Madras Institute of Technology, India; M.Tech. 1972, Indian Institute of Technology, India; Ph.D. 1976, University of Tennessee Space Institute. Research Areas: noise generation from flow-surface interaction.

KURZEJA, ROBERT J., Post-doctoral Research Associate. A.B. 1967, University of Chicago; Ph.D. 1976, Florida State University. Research Areas: development of models to study the transport of chemicals in the stratosphere.

LIU, NAN-SUEY, Post-doctoral Research Associate. B.S. 1970, M.S. 1972, National Taiwan University, Taiwan; Dr. Ing. 1977, RWTH Aachen, Germany. Research Areas: numerical study of the effects of flow on sound propagation.

NATARAJAN, MURALI, Post-doctoral Research Associate. B.Tech. 1968; M.Tech. 1971, Indian Institute of Technology, India; Ph.D. 1976, State University of New York at Stony Brook Research Areas: study of response of stratospheric chemical structures to variations in the solar ultraviolet radiation.

RAJU, IVATURY S., Post-doctoral Research Associate. B.E. 1965, College of Engineering, Kakinada; M.E. 1967, Ph.D. 1973, Indian Institute of Science, India. Research Areas: numerical development of a 3-D stress analysis of composite blades with holes.

SWAROOP, ANAND, Post-doctoral Research Associate. B.Sc. 1967; M.Sc. 1969, Lucknow University, India; Ph.D. 1975, Indian Institute of Technology, India. Research Areas: development of reliable interatomic potentials for both simple and transition metals to be used in defect simulation.

CHATTERJEE, SARAN JNAN, Visiting Scientist. B.Sc.(Hons.) 1941, M.Sc. 1943, Calcutta University; Dip.Mc. 1946, Marconi College, United Kingdom; Ph.D. 1954, Calcutta University. Research Areas: electromagnetics.

PFENNINGER, WERNER, Senior Research Scientist. Diploma Mech. Engr, 1936; Ph.D. 1946, ETH, Zurich Institute of Aerodynamics, Switzerland. Research Areas: laminar flow control.

VILLE, JEAN-MICHEL, Post-doctoral Research Associate. Maitrise 1972, AEA 1973, DEA 1975, Thesis 1977, Universite Des Sciences, Lille, France. Research Areas: duct acoustics.

VISITING SCIENTISTS AND ENGINEERS (1970-1978)

BLOOM, ALVIN M., Assistant Research Professor of Engineering. B.S. 1962, M.S. 1964, Ph.D. 1967, University of Texas. Research Areas: aerodynamics; heat transfer.

BOLLARD, JOHN J. R., Consultant. M.S. 1950, Canterbury College, New Zealand; Ph.D. 1954, Purdue University. Research Areas: structural mechanics.

CALLEGARI, ANDREW J., Visiting Scientist. B.S. 1961, Columbia College; B.S. 1962, New York City College; M.S., 1963, Columbia Engineering School; Ph.D. 1966, Columbia University. Research Areas: nonlinear waves; perturbation theory.

CHEN, TSING-CHANG, Post-doctoral Research Associate. B.S. 1965, National Taiwan Normal University; M.S. 1968, National Central University Chung-Li, Taiwan; M.A. 1972, Johns Hopkins University; Ph.D. 1975, University of Michigan. Research Areas: dynamic meteorology.

CLARKSON, BRIAN L., Adjunct Professor of Engineering and Applied Science. B.S. 1951, Ph.D. 1953, University of Leeds, England. Research Areas: acoustics; structural dynamics.

DAVIES, PETER A. O. L., Senior Visiting Research Scientist. B.Eng. 1947, University of Sydney, Australia; Ph.D. 1951, University of Cambridge, U.K. Research Areas: fluid dynamics; structure of turbulence.

DEMPSEY, THOMAS K., Post-doctoral Research Associate. B.A. 1966, State University of New York; M.A. 1961, Ph.D. 1971, University of Louisville. Research Areas: psychology; pattern recognition.

FARASSAT, FEREIDOUN, Assistant Research Professor of Engineering. B.E. 1967, American University of Beirut, Lebanon; M.S. 1970, Syracuse University; Ph.D. 1973, Cornell University. Research Areas: aeroacoustics.

GARRICK, I. E., Adjunct Professor. B.S. 1934, Chicago University. Research Areas: aeroelasticity, acoustics.

GRIFFIN, MICHAEL J., Visiting Assistant Professor of Engineering. B.Sc. 1968, University of Southampton, England; Ph.D. 1972, Institute of Sound & Vibration Research, England. Research Areas: human response to vibration and noise.

JAFRI, JAWED A., Post-doctoral Research Associate. M.Sc. 1968, Karachi University, Pakistan; M.Phil. 1969, Islamabad University, Pakistan; Ph.D. 1975, State University of New York at Stony Brook. Research Areas: molecular quantum mechanics.

KAMEL, HUSSEIN A., Visiting Professor. B.S. 1955, Cairo University; Ph.D. 1964, DIC 1966, Imperial College of Science and Technology. Research Areas: aircraft structures; continuum mechanics; numerical analysis; computer programming.

KAPLAN, MICHAEL LEWIS, Visiting Scientist. B.A. 1967, M.S. 1968, Rutgers University; Ph.D. 1972, State University of New York. Research Areas: atmospheric sciences; severe storms.

KAZA, KRISHNA RAO, Post-doctoral Research Associate. B.S. 1963, Andhra University, India; M.S. 1965, Indian Institute of Science, India; Ph.D. 1974, Stanford University. Research Areas: aeroelasticity and rotor dynamics.

KLEIN, LAWRENCE A., Research Scientist. B.E.E. 1963, City College of New York; M.S. 1966, University of Rochester; Ph.D. 1973, New York University. Research Areas: plasma physics; electrophysics; remote sensing.

KLEIN, VLADISLAV, Visiting Scientist. Diploma in Engineering 1954, C.Sc. 1962, Military Academy, Brno, Czechoslovakia; Ph.D. 1974, Cranfield Institute of Technology. Research Areas: flight dynamics; flight test data analysis.

KLEINSTEIN, GERALD G., Visiting Scientist. B.M.E. 1958, Polytechnic Institute of Brooklyn; M.Sc. 1959, Columbia University; Ph.D. 1963, Polytechnic Institute of Brooklyn. Research Areas: fluid mechanics; aeroacoustics.

VISITING SCIENTISTS AND ENGINEERS (1970-1978)

KOOPMANN, GARY H., Visiting Associate Research Professor of Engineering. B.S. in M.E. 1962, University of Nebraska; M.S.E. 1967, Ph.D. 1969, Catholic University of America. Research Areas: physical acoustics.

KUHN, GEORGE F., Visiting Assistant Research Professor. B.Sc. 1964, State University of New York at Buffalo; M.S.E. 1968, Ph.D. 1971, The Catholic University of America. Research Areas: experimental acoustics.

MUNGAR, PARMANAND, Associate Research Professor of Engineering. B.Sc. 1962, London University, England; A.W.P. 1963, Woolwich-Polytechnic, London, England; Ph.D. 1966, London University, England. Research Areas: aeroacoustics; sound propagation.

PAN, YUAN-SIANG, Visiting Staff Scientist. B.S. 1957, Tainan, Taiwan, China; Ph.D. 1964, Brown University. Research Areas: fluid mechanics.

PETYT, MAURICE, Visiting Associate Research Professor. B.Sc. 1956, M.S. 1958, University of Hull, England; Ph.D. 1967, Southampton University, England. Research Areas: structural dynamics.

RAMANATHAN, VEERABHADRAN, Visiting Scientist. B.E. 1965, Annamalou University, Madras, India; M.S. 1970, Indian Institute of Science, India; Ph.D. 1975, State University of New York at Stony Brook. Research Areas: infrared radiative transfer; atmospheric energy balance; general circulation.

REISSNER, ERIC, Consultant. Dipl Ing. and Dr. Ing., Technische Hochschule, Berlin; Ph.D., Massachusetts Institute of Technology. Research Areas: mechanics; applied mathematics; aeroelasticity; variational method and solution of elasticity problems.

RICE, CHRISTOPHER G., Visiting Research Scientist. B.S. 1959, Southampton University; M.S. 1961, London University. Research Areas: psychoacoustics; operational acoustics.

RUPF, JOHN A., JR., Research Engineer. B.S.E.E. 1961, University of Kansas; M.S.E.E. 1964, Massachusetts Institute of Technology; Ph.D. 1969, Purdue University. Research Areas: speech communication.

SIDWELL, KENNETH W., Visiting Scientist. B.S. 1953, M.S. 1955, Michigan State University; Ph.D. 1965, Purdue University. Research Areas: atmospheric turbulence.

SOVA, JAN A., Visiting Scientist. Diploma in Engineering 1966, Charles University, Czechoslovakia, Ph.D. 1972, Southampton University, England. Research Areas: fracture toughness of composite materials.

SUCCI, GEORGE P., Post-doctoral Research Associate. B.S. 1973; Ph.D. 1977, Massachusetts Institute of Technology. Research Areas: aeroacoustics.

TAM, CHRISTOPHER K. W., Visiting Scientist. D.Eng. 1962, McGill University, Canada; M.Sc. 1963, Ph.D. 1966, California Institute of Technology. Research Areas: aeroacoustics.

UNNAM, JALAIAH, Post-doctoral Research Associate. B.Tech. 1970, Indian Institute of Technology; M.S. 1972; Ph.D. 1975, Virginia Polytechnic Institute and State University. Research Areas: composite materials; diffusion; x-ray diffraction.

WRIGHT, SELWYN E., Assistant Research Professor. Ph.D. 1969, Southampton University, England. Research Areas: rotor noise.

GRADUATE RESEARCH SCHOLAR ASSISTANTS

Acoustics Program

Adams, Arnold E. (Tech. Inst. of Great Britain)
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Prescott, Jonathan R. (Bowdoin Coll.)
Ramakrishnan, Ramani (Madras Inst.)
Smith, Charles D. (GWU)
Strenkert, Arthur L. (U.S. Merchant Marine Academy)
Sullivan, Patrick J. (William & Mary)
Thorpe, Wilson A. (Embry-Riddle U.)

Aeronautics Program

Burnheimer, Ronald C. (U. of Michigan)
Callan, William M. (U. of Colorado)
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Forsyth, David R. (GWU)
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Jen, Hsianmin F. (Cheng King U. & U. of Miss.)
Jones, Henry E. (U. of Texas at Arlington)
Kardas, Gerald E. (MIT)
Kroll, William B. (Purdue U.)
Kulla, Donna G. (American U.)
Murphy, Patrick C. (Univ. of Va. & Stevens Inst. of Technology)
Pelaccio, Dennis G. (Univ. of Michigan)
Satran, Dale R. (Wichita State Univ.)
Shaw, Linda G. (MIT)
Shubert, Gary L. (Michigan State Univ.)
Sliwa, Steven M. (Princeton Univ.)
Streett, Craig L. (Ohio State Univ.)
Viney, James E. (U. of Maryland)
Williams, David H. (U. of Colorado)
Yetter, Jeffrey A. (Embry-Riddle Univ.)

Environmental Modeling Program

Arduini, Robert F. (Coll. of William & Mary)
Augustsson, Tommy R. (U. of Florida)
Bobowiec, Paul W. (Boston Univ.)
Larsen, Jack C. (Ohio State Univ.)
Myrick, David L. (Old Dominion Univ.)
Scotti, Stephen J. (Michigan State Univ.)
Stephenson, Denise M. (Spelman College)
Wong, Yih-Ren (Georgia Inst. of Technology)

Materials Science Program

Bilodeau, Douglas J. (Indiana Univ.)
Ence, Brian M. (Brigham Young Univ.)
House, Larry J. (Florida St. Univ. & Murray State Univ.)
Howard, Darryl A. (Hunter College)
Navrotski, Gary K. (Case Western Reserve Univ.)
Nguyen, Xuan-Dinh (Lehigh Univ.)
Phelps, Henry R. (Ohio State Univ.)
Stout, Frank H. (East Tennessee State Univ. & Clemson Univ.)
Svarney, Thomas E. (Clarkson College of Tech.)

Structures and Dynamics Program

Berger, Paul E. (U. of Kansas)
Camin, Robert A. (Virginia Polytechnic Institute & State Univ.)
Farley, Gary L. (Virginia Polytechnic Institute & State Univ.)
Green, William H. (Georgia Inst. of Technology)
Knight, Norman F. (Virginia Polytechnic Institute & State Univ.)
Lowder, Harold E., Jr. (Purdue Univ.)
Mathers, Michael D. (MIT & U. of California)
Nemeth Michael P. (North Carolina State Univ.)
Peebles, James H. (U. of Illinois)
Rehak, Daniel R. (Carnegie-Mellon)

RESEARCH PUBLICATIONS AND PRESENTATIONS

ACOUSTICS PROGRAM

No.	Title	Author
A-101	"Discrete Radiation from Rotating Periodic Sources" Published: Journal of Sound & Vib., Vol. 17, No. 4, 1971, pp. 437-498.	S. E. Wright
A-102	"Discrete Rotor Noise" Presented: American Helicopter Soc., Durham, NC, Sept. 29-30, 1971. 1971 Conference on Noise Control, Purdue Univ., W. Lafayette, IN, July 14-16, 1971.	S. E. Wright
A-103	"A Unique Program of Research and Education in Noise Acoustics" Presented: 81st Meeting of the Acoustical Soc. of Am., Washington, D.C., April 20-23, 1971.	S. E. Wright
A-104	"Estimates of the Response of Box Type Structures to Acoustic Loading" Presented: AGARD Symposium on Acoustic Fatigue, Toulouse, France, Sept. 26-27, 1972.	B. L. Clarkson
A-105	"Computer Based Analysis of the Response of Box Type Structures to Random Pressures" Presented: National Symposium on Computerized Structural Analysis and Design, The George Washington University, Washington, D.C., March 27-29, 1972.	B. L. Clarkson I. Ashie
A-106	"Flow Resistance of Perforated Plates in Tangential Flow" Published: NASA TM X-2361, October 1971.	M. Budoff W. Zorumski
A-107	"Reduction of Noise from Supersonic Jet Flows" Published: AIAA Jour., Vol. 9, No. 12, Dec. 1971, pp. 2346-2453.	D. S. Dosanjh J. C. Yu A. N. Abdelhamid
A-108	"Far Noise Field of a Subsonic Air Jet" Presented: 84th Meeting of Acoustical Society of America, Miami Beach, FL, November 28-December 1, 1972.	J. C. Yu
A-109	"Noise Field of a Supersonic Mach 1.5 Cold Model Jet" Published: Journal of Acoustical Soc. of Am., Vol. 51, No. 5, Part 1, May 1972, pp. 1400-1410.	J. C. Yu
A-110	"Reply by Authors to Comments on 'Reduction of Noise from Supersonic Jet Flows' " Published: AIAA Journal, Vol. 11, No. 3, March 1973, pp. 415-416.	D. S. Dosanjh J. C. Yu
A-111	"Experimental Investigation of Radiated Acoustic Power of an Externally Blown Flap" Presented: 85th ASA Meeting, Boston, Mass., April 1973.	N. N. Reddy J. C. Yu
A-112	"Acoustic Wave Propagation in an Axisymmetric Swirling Jet" Presented: AIAA Aeroacoustics Specialist Meeting, Seattle, Wash., Oct. 1973, Paper No. 73-1004. Published: AIAA Progress Series in Astronautics and Aeronautics, Vol. 37, *Jet and Combustion Noise*, Duct Acoustics, 1974.	J. C. Yu P. Mungur

ACOUSTICS PROGRAM

No.	Title	Author
A-113	"Sound Interaction with a Helical Flow Contained in an Annular Duct with Radial Gradients of Flow, Density, and Temperature" Presented: AIAA Aeroacoustics Specialist Meeting, Seattle, Wash., October 1973, Paper No. 73-1010. Published: AIAA Progress Series in Astronautics and Aeronautics, Vol. 37, *Jet and Combustion Noise,* Duct Acoustics, 1974.	A. Kapur P. Mungur
A-114	"On the Influence of Temperature Gradients in Jet Flows on the Radiation of Sound" Presented: 86th ASA Meeting, Los Angeles, CA, November 1973.	J. L. Whitesides P. Mungur
A-115	"Far Noise Field of a Two-Dimensional Subsonic Jet" Presented: AIAA 12th Aerospace Sciences Meeting, Washington, D.C., Jan. 1974, AIAA Paper No. 74-44.	C. Kouts J. C. Yu
A-116	"On the Accuracy of Whitham's Method" Published: AIAA Journal, Vol. 12, No. 2, pp. 203-207, February 1974.	M. K. Myers G. I. Zahalak
A-117	"The Acoustic Far-field of Rigid Bodies in Arbitrary Motion" Published: Journal of Sound and Vib., Vol. 32(3), 1974.	F. Farassat
A-118	"Theoretical Evaluation of Sound Fields in Circular or Annular Ducts with Rigid or Non-Rigid Radial Splitters" Presented: 87th ASA Meeting, New York, New York, April 1974.	P. Mungur A. Kapur
A-119	"Investigation of Acoustic Radiation from Supersonic Turbulent Jets by Double-Pulse Holographic Interferometry" Presented: 87th ASA Meeting, New York, New York, April 1974.	A. Ozkul
A-120	"Cross-Correlation Methods for Studying Near- and Far-field Noise Characteristics of Several Flow-Surface Interaction Problems" Presented: 87th ASA Meeting, New York, New York, April 1974.	Y. S. Pan
A-121	"Human Perception of Apparent Direction and Movement of Aircraft Noise" Presented: 87th ASA Meeting, New York, New York, April 1974.	W. J. Gunn H. A. Scholl T. K. Dempsey F. Gibson N. Whitted
A-122	"Helicopter Rotor Rotational Noise Prediction Based on Measured High-Frequency Blade Loads" Published: NASA TN D-7624, Dec. 1974	R. N. Hosier R. Ramakrishnan
A-123	"The Prediction of Rotor Rotational Noise Using Measured Fluctuating Blade Loads" Presented: 30th Annual National Forum of the American Helicopter Society, Wash., D.C., May 1974.	R. N. Hosier R. Ramakrishnan R. J. Pegg

ACOUSTICS PROGRAM

No.	Title	Author
A-124	"Noise and Flow Characteristics of an Externally Blown Flap" Published: Proceedings of the 2nd Interagency Symposium on University Research in Transportation Noise, Vol. I, pp. 219-237, Raleigh, NC, June 1974.	J. C. Yu N. N. Reddy J. L. Whitesides
A-125	"A Study of Impinging Jet-Noise Characteristics of Cross-Correlation Techniques" Published: Proceedings of 2nd Interagency Symposium on University Research in Transportation Noise, Vol. I, pp. 204-218, Raleigh, NC, June 1974.	Y. S. Pan
A-126	"Some Theoretical Studies on Noise Propagation, Attenuation and Radiation in Turbo-Fan Engine Environments" Published: Proceedings of 2nd Interagency Symposium on University Research in Transportation Noise, Vol. II, pp. 888-901, Raleigh, NC, June 1974.	P. Mungur J. C. Yu J. L. Whitesides W. R. Arnold
A-127	"Some Research on Helicopter Noise-Thickness and Rotational Noise" Published: Proceedings of 2nd Interagency Symposium on University Research in Transportation Noise, Vol. I, pp. 363-370, Raleigh, NC, June 1974.	F. Farassat
A-128	"A Computer Program to Predict Rotor Rotational Noise" Published: NASA TM X-3281, Feb. 1976.	R. Ramakrishnan D. Randall R. Hosier
A-129	"A Method for Studying Near- and Far-Field Noise Characteristics of Impinging Jets" Presented: AIAA 7th Fluid and Plasma Dynamics Conference, June 17-19, 1974, Palo Alto, CA (AIAA Paper No. 74-569).	Y. S. Pan J. S. Preisser
A-130	"A Theoretical Evaluation of the Acoustic Response of a Free Turbulent Jet and Some Aspects of Relative Amplification and Frequency Selection" Presented: 8th International Congress on Acoustics, London, 1974, Paper No. 153. Published: Proceedings of the 8th ICA, Vol. II, p. 530, 1974.	P. Mungur J. C. Yu J. L. Whitesides
A-131	"Noise and Flow Characteristics of a Subsonic Jet Impinging on a Finite Rigid Plate" Presented: 8th International Congress on Acoustics, London, July 1974. Published: Proceedings of the 8th ICA, Vol. II, p. 547, 1974.	J. C. Yu N. N. Reddy
A-132	"Thickness Noise of Rotating Machinery at Low and High Speeds" Presented: 8th International Congress on Acoustics, London, July 1974. Published: Proceedings of the 8th ICA, Vol. I, p. 20, 1974.	F. Farassat
A-133	"The Effect of Jet Temperature Gradients on the Directivity of Sound Radiation" Presented: 8th International Congress on Acoustics, London, July 1974, paper No. 161. Published: Proceedings of the 8th ICA, Vol. II, p. 486, 1974.	J. L. Whitesides P. Mungur

ACOUSTICS PROGRAM

No.	Title	Author
A-134	"A Theoretical Formulation of the Influence of a Boundary Layer Growth in an Inlet Flow Duct with Temperature Gradients on Sound Distribution" Presented: 8th International Congress on Acoustics, London, July 1974, Paper No. 633. Published: Proceedings of the 8th ICA, Vol. II, p. 489, 1974.	A. Kapur P. Mungur
A-135	"Acoustic Radiation Analysis in Jet Flow Environment" Published: J. Sound Vib., 1974(36)1, pp. 21-52.	P. Mungur H. E. Plumblee P. E. Doak
A-136	"Methodological Considerations in the study of Human Discomfort to Vibration" Presented: International Conf. on High-Speed Ground Transportation, Tempe, AZ, Jan. 7-10, 1975. Published: Jour. of High Speed Ground Transportation, Jan. 1976.	T. K. Dempsey J. Leatherwood
A-137	"A Model and Predictive Scale of Discomfort" Published: NASA TM X-72623, Dec. 1974.	T. K. Dempsey
A-138	"Notes on the Acoustic Field of Rigid Bodies" Published: J. of Sound and Vib., Vol. 38(2), 1975, pp. 267-270.	F. Farassat
A-139	"Noise Radiation from an Externally Blown Flap" Published: NASA TN D-7908, 1975.	N. N. Reddy J. C. Yu
A-140	"Thickness Noise of Helicopter Rotors at High Tip Speeds" Presented: AIAA 2nd Aeroacoustics Conference, March 1975, Hampton, VA, AIAA Paper No. 75-453.	F. Farassat R. J. Pegg D. A. Hilton
A-141	"Influence of Grazing Flow on Duct Wall Normal Impedances" Presented: AIAA 2nd Aeroacoustics Conference, March 1975, Hampton, VA, AIAA Paper No. 75-494.	P. Mungur J. L. Whitesides
A-142	"Sound Propagation in Curved Ducts" Presented: AIAA 2nd Aeroacoustics Conference, March 1975, Hampton, VA, AIAA Paper No. 75-497.	M. K. Myers P. Mungur
A-143	"Noise Radiation from Turbulent Flows Over Compliant Surfaces" Presented: AIAA 2nd Aeroacoustics Conference, March 1975, Hampton, VA, AIAA Paper No. 75-507.	Y. S. Pan
A-144	"Trailing Edge Noise" Presented: AIAA 2nd Aeroacoustics Conference, March 1975, Hampton, VA, AIAA Paper No. 75-489.	C. K. W. Tam J. C. Yu
A-145	"Acoustic Wave Propagation in a Lined Duct with Non-Uniform Admittance" Presented: AIAA 2nd Aeroacoustics Conference, March 1975, Hampton, VA, AIAA Paper No. 75-515.	J. C. Yu C. D. Smith P. Mungur
A-146	"Remarks on the Theory of Aerodynamic Noise" Presented: 89th ASA Meeting, Austin, TX, Apr. 8-11, 1975 (Paper No. T3).	Y. S. Pan

ACOUSTICS PROGRAM

No.	Title	Author
A-147	"Sparse Matrix Techniques Applied to Modal Analysis of Multi-Section Duct Liners" Presented: AIAA 2nd Aeroacoustics Conference, March 1975, Hampton, VA, AIAA Paper No. 75-714.	W. R. Arnold
A-148	"Duct Acoustics and Acoustic Finite Element" Presented: AIAA 2nd Aeroacoustics Conference, March 1975, Hampton, VA, AIAA Paper No. 75-498.	A. Kapur P. Mungur
A-149	"Far Noise Field of a Two-Dimensional Subsonic Jet" Published: AIAA Journal, Vol. 13, No. 8, Aug. 1975, pp. 1031-1035.	C. A. Kouts J. C. Yu
A-150	"Cross-correlation Methods for Studying Near- and Far-field Noise Characteristics of Flow-Surface Interactions" Published: Jour. of the Acoustical Society of America, Vol. 58, No. 3, September 1975, pp. 586-594.	Y. S. Pan
A-151	"Perturbation Solution of the Navier-Stokes Equations and its Relation to the Lighthill-Curle Solution of Aerodynamic Sound" Published: Jour. of the Acoustical Society of America, Vol. 58, No. 4, Oct. 1975, pp. 794-799.	Y. S. Pan
A-152	"Sound Propagation in Curved Ducts" Presented: Third Interagency Symposium on University Research in Transportation Noise, US Dept. of Transportation, Salt Lake City, UT, Nov. 12-14, 1975. Published: Proceedings of the Symposium.	M. K. Myers P. Mungur
A-153	"A Treatment of the Noise from Non-Compact Source Distribution Due to Surface Pressure" Presented: Third Interagency Symposium on University Research in Transportation Noise, US Dept. of Transportation, Salt Lake City, UT, Nov. 12-14, 1975. Published: Proceedings of the Symposium.	F. Farassat
A-154	"Theory of Noise Generation from Moving Bodies with an Application to Helicopter Rotors" Published: NASA TR R-451, Dec. 1975.	F. Farassat
A-155	"A Computer Program for the Determination of the Acoustic Pressure Signature of Helicopter Rotors Due to Blade Thickness" Published: NASA TM X-3323, Jan. 1976.	G. H. Mall F. Farassat
A-156	"A New Formula for the Determination of the Acoustic Pressure Signature of Helicopter Rotors" Presented: Review of Research Theme "Helicopter and V/STOL Aircraft Research", Oct. 7-8, 1975, Moffett Field, CA.	F. Farassat T. J. Brown
A-157	"Acoustic Wave Propagation in a Lined Duct With Non-Uniform Admittance" Presented: Third Interagency Symposium on University Research in Transportation Noise, U.S. Dept. of Transportation, Salt Lake City, UT, Nov. 1975. Published: Proceedings of the Symposium.	J. C. Yu C. D. Smith P. Mungur

ACOUSTICS PROGRAM

No.	Title	Author
A-158	"A New Capability for Predicting Helicopter Rotor Noise in Hover and in Flight" Presented: 1976 Army Science Conference, West Point, NY, June 22-25, 1976.	T. J. Brown F. Farassat
A-159	"Noise from Turbulent Jet Flow Over Wing/Flap Surfaces" Presented: AIAA 3rd Aeroacoustics Conference, July 1976, Palo Alto, CA, AIAA Paper 76-522.	N. N. Reddy J. C. Yu
A-160	"Development of a Noncompact Source Theory with Applications to Helicopter Rotors" Presented: AIAA 3rd Aeroacoustics Conference, July 1976, Palo Alto, CA, AIAA Paper 76-563.	F. Farassat T. J. Brown
A-161	"Frequency Modulation at a Moving Material Interface and a Conservation Law for Wave Number" Published: Jour. of Sound and Vibration, Vol. 48, No. 22, Sept. 1976.	G. G. Kleinstein M. D. Gunzburger
A-162	"On the Mathematical Conditions for the Existence of Periodic Fluctuations in Nonuniform Media" Published: Jour. of Sound and Vibration, Vol. 48, No. 3, Oct. 1976.	M. D. Gunzburger G. G. Kleinstein
A-163	"Effects of High Subsonic Flow on Sound Propagation in a Variable-Area Duct" Presented: 13th Annual Meeting of the Society of Engineering Science, Hampton, VA, Nov. 1-3, 1976. Published: Proceedings of the Meeting.	A. J. Callegari M. K. Myers
A-164	"Stability of Neutral Equations with Constant Time Delays" Presented: 13th Annual Meeting of the Society of Engineering Science, Hampton, VA, Nov. 1-3, 1976. Published: Proceedings of the Meeting.	L. K. Barker J. L. Whitesides
A-165	"Influence of Grazing Flow on Duct Wall Normal Impedances" Published: *Progress in Astronautics and Aeronautics*, Vol. 44, p. 289, 1976.	P. Mungur J. L. Whitesides
A-166	"Sound Propagation in Curved Ducts" Published: *Progress in Astronautics and Aeronautics*, Vol. 44, p. 347, 1976.	M. K. Myers P. Mungur
A-167	"Trailing Edge Noise" Published: *Progress in Astronautics and Aeronautics*, Vol. 45, p. 259, 1976.	C. K. W. Tam J. C. Yu
A-168	"Acoustic Wave Propagation in a Lined Duct with Non-Uniform Admittance" Published: *Progress in Astronautics and Aeronautics*, Vol. 44, p. 397, 1976.	J. C. Yu C. D. Smith P. Mungur
A-169	"Application of the Wave Number Jump Condition to the Normal and Oblique Interaction of a Plane Acoustic Wave and a Plane Shock" Published: Journal of Sound & Vib., Vol. 53, Nr. 3, pp. 417-433,1977.	G. G. Kleinstein M. D. Gunzburger
A-170	"Noise Radiation from Turbulent Flows Over Compliant Surfaces" Published: *Progress in Astronautics and Aeronautics*, Vol. 45, p. 315, 1976.	Y. S. Pan

ACOUSTICS PROGRAM

No.	Title	Author
A-171	"The Acoustic Modes of a Two-Dimensional Rectangular Cavity" Published: Journal of Sound & Vib., Vol. 49, Nr. 3, pp. 353-364, 1976.	C. K. W. Tam
A-172	"Some Measured and Calculated Effects of Forward Velocity on Propeller Noise" Presented: AMSE Gas Turbine Conference and Products Show, Philadelphia, PA, March 27- 31, 1977. Published: ASME Paper #77-GT-70.	R. J. Pegg B. Magliozzi F. Farassat
A-173	"Effects of Geometry and Jet Velocity on Noise Associated with an Upper-Surface Blowing Model" Published: NASA TN D-3836, March 1977.	L. R. Clark J. C. Yu
A-174	"On the Singular Behavior of Linear Acoustic Theory in Near-Sonic Duct Flows" Published: Journal of Sound & Vib., Vol. 51, Nr. 4, April 1977.	M. K. Myers A. J. Callegari
A-175	"Noise Effects on Passenger Communication in Light Aircraft" Presented: Society of Automotive Engineers Business Aircraft Meeting, Wichita, KS, March 29-April 1, 1977. Published: SAE Paper 770446.	J. A. Rupf
A-176	"Discontinuities in Aerodynamics and Aeroacoustics: The Concepts and Applications of Generalized Derivatives" Published: Journal of Sound and Vibration, Vol. 55, No. 2, pp. 165-193. November 1977.	F. Farassat
A-177	'A New Capability for Predicting Helicopter Rotor and Propeller Noise Including the Effect of Forward Motion" Published: NASA TM X-74037, June 1977.	F. Farassat T. J. Brown
A-178	"Interior Noise Reduction in Large Civil Helicopter" Published: NASA TN D-8477, July 1977.	J. T. Howlett S. A. Clevenson J. A. Rupf W. J. Snyder
A-179	"Development of Cumulative Noise Measure for the Prediction of General Annoyance in an Average Population" Published: Journal of Sound and Vibration, Vol. 52, No. 3, pp. 345-364.	C. G. Rice
A-180	"An Experimental Investigation of Trailing Edge Noise Mechanism" Published: AIAA 4th Aeroacoustics Conference 77-1291, Oct. 3-5, 1977.	J. C. Yu
A-181	"Nonlinear Effects on Sound in Nearly Sonic Duct Flows" Published: AIAA 4th Aeroacoustics Conference 77-1296, Oct. 3-5, 1977.	A. J. Callegari M. K. Myers
A-182	"The Parabolic Approximation for Sound Propagation in a Stratified Moving Medium" Published: AIAA 4th Aeroacoustics Conference 77-1310, Oct. 3-5, 1977.	M. K. Myers G. L. McAninch

ACOUSTICS PROGRAM

No.	Title	Author
A-183	"Noise Transmission Through Plates Into an Enclosure" Published: NASA TP 1173, May 1978.	W. B. McDonald R. Valcaitis M. K. Myers
A-184	"The Effect of the Length of a Lined Duct on Its Average Transmission Loss in a Frequency Band" Presented: 95th Meeting Acoustical Society of America, Providence, RI, May 16-19, 1978.	Y. C. Cho
A-185	"Bounds on Thickness and Loading Noise of Rotating Blades and the Favorable Effect of Blade Sweep on Noise Reduction" Presented: Int'l. Specialist Symposium, Helicopter Acoustics, Langley Research Center, May 22-24, 1978. Published: Proceedings of Symposium.	F. Farassat P. A. Nystrom T. J. Brown
A-186	"Theoretical Study of Sound Radiation From an Inlet Duct" Presented: 94th Mtg. of Acoustical Society of America, Miami Beach, FL, December 12-16, 1977.	Y. C. Cho D. L. Lansing
A-187	"Directivity Study of the Radiated Sound from Ducts by Using the Uncertainty Principle" Presented: 94th Meeting of Acoustical Society of America, Miami Beach, FL, December 12-16, 1977.	Y. C. Cho
A-188	"Nonlinear Theory of Sound Transmission in a High Subsonic Flow" Presented: 8th US National Congress of Applied Mechanics, June 26-30, 1978.	M. K. Myers A. J. Callegari
A-189	"Transmission of Sound Through High Subsonic Flows in Non-Uniform Ducts" Published: AIAA Paper No. 78-115. Presented: AIAA 11th Fluid and Plasma Dynamics Conference, July 10-12, 1978.	M. K. Myers A. J. Callegari
A-190	"Parabolic Approximation for Sound Propagation in the Atmosphere" Published: AIAA Journal, Aug. 1978.	M. K. Myers G. L. McAninch

ACOUSTICS DISSERTATIONS AND THESES

1. "Response of a Box Type Structure to Acoustic Loading," I. A. Ashie, MS Thesis, February 1973.
2. "Measurement of Acoustic Impedance of Typical Duct Lining Materials Subjected to Tangential Air Flow," M. A. Budoff, MS Thesis, March 1973.
3. "On the Design of Pressure Gradient Condenser Microphone," E. A. Gonzaga, MS Thesis, January 1973.
4. "On the Aerodynamic Noise Generation by Axial-Flow Compressors," R. G. Holm, MS Thesis, September 1972.
5. "An Experimental Investigation on the Noise Field Characteristics of a High Aspect Ratio, Cold, Subsonic, Model Slot Jet," C. A. Kouts, MS Thesis, September 1973.
6. "On Discrete Noise Radiation from Helicopters," R. Ramakrishnan, MS Thesis, September 1973.
7. "Investigation of Acoustic Radiation from Supersonic Turbulent Jets by Double-Pulse Holographic Interferometry," A. Ozkul, MS Thesis, June 1974.
8. "Acoustic Propagation Through a Wall-Jet Flow with Compliant Plates," R. Ramakrishnan, DSc Dissertation, May 1977.

9. "Scattering of an Acoustic Dipole by an Infinite Cylinder with Application to the Prediction of Airframe Noise," B. M. Brooks, MS Thesis, June 1977.
10. "An Experimental Investigation of Acoustic Radiation From a Source Inside a Large Turbulent Free Jet," A. Ozkul, Professional Engineer, June 1977.
11. "Noise Transmission Through Elastic Plates Into a Rectangular Enclosure," W. B. McDonald, MS Thesis, August 1977.

AERONAUTICS PROGRAM

No.	Title	Author
FS-101	"Vortex Pollution—Wing Tip Vortices" Published: J. of the Aero. Soc. of India, Vol. 23, No. 2, May 1971.	S. W. Yuan
FS-102	"Suspension-Line Wave Motion During the Lines-First Parachute Unfurling Process" Published: AIAA Journal, Vol. 12, No. 1, January 1974.	L. R. Poole J. L. Whitesides
FS-103	"A Vortex Entrainment Model Applied to Slender Delta Wings" Published: AIAA Journal, Vol. 12, No. 1, January 1974.	P. L. Coe, Jr.
FS-104	"Free-Flight Investigation of the Stability and Control Characteristics of a STOL Model with an Externally Blown Jet Flap" Published: NASA TN D-7411, April 1974.	L. P. Parlett S. J. Emerling A. E. Phelps, III
FS-105	"Wind-Tunnel Free-Flight Investigation of a Spin-Resistant Fighter Configuration" Published: NASA TN D-7716, June 1974.	S. B. Grafton J. R. Chambers P. L. Coe, Jr.
FS-106	"Experimental Investigation of Wing-Tip Vortex Abatement" Published: Proceedings of the 9th Int'l. Congress of Aeronautical Sciences, August 1974, Haifa, Israel.	S. W. Yuan A. M. Bloom
FS-107	"A Wind Tunnel Investigation of the Wake Near the Trailing Edge of a Deflected Externally Blown Flap" Published: NASA TM X-3079, October 1974.	W. G. Johnson G. E. Kardas
FS-108	"Effect of Upper Surface Blowing on Static Longitudinal Stability of a Swept Wing" Published: Journal of Aircraft, Vol. 11, No. 9, September 1974.	P. L. Coe, Jr. D. G. Kulla
FS-109	"Roll-up of Aircraft Trailing Vortices Using Artificial Viscosity" Published: Jour. of Aircraft, Vol. 11, No. 11, Nov. 1974, pp. 714-716.	A. M. Bloom H. Jen
FS-110	"A Wind Tunnel Investigation of the Wake Near the Trailing Edge of a Distributed Upper-Surface-Blown Flap" Published: NASA TMX-72637, 1975.	D. R. Forsyth L. P. Yip A. M. Bloom
FS-111	"Summary of Information on Low-Speed Lateral-Directional Derivatives Due to Rate of Change of Sideslip β" Published: NASA TN D-7972, Sep. 1975.	P. L. Coe, Jr. A. B. Graham J. R. Chambers

AERONAUTICS PROGRAM

No.	Title	Author
FS-112	"Flow Visualization of Leading-Edge Vortex Enhancement by Spanwise Blowing" Published: NASA TMX-72702, Sep. 1975.	G. E. Erickson J. F. Campbell
FS-113	"Analytical Method for Determining the Stability of Linear Retarded Systems with Two Delays" Published: NASA TR R-446, Nov. 1975.	L. K. Barker J. L. Whitesides
FS-114	"Low-Speed Wind-Tunnel Investigation of a Four-Engine Upper Surface Blown Model Having a Swept Wing and Rectangular and D-Shaped Exhaust Nozzles" Published: NASA TN D-8061, Dec. 1975.	W. C. Sleeman, Jr. W. C. Hohlweg
FS-115	"Flow Visualization of Vortices Locked by Spanwise Blowing Over Wings Featuring a Unique Leading- and Trailing-Edge Flap System" Published: NASA TM X-72788, Dec. 1975.	G. E. Erickson J. F. Campbell
FS-116	"Overview of Powered-Lift Technology" Presented: NASA Conference on Powered-Lift Aerodynamics and Acoustics, Hampton, VA, May 24-26, 1976. Published: Proceedings of the Meeting, NASA SP-406, 1976.	J. P. Campbell
FS-117	"Pressure Distributions on a 1- by 3-Meter Semispan Wing at Sweep Angles from 0° to 40° in Subsonic Flow" Published: NASA TN D-8307, 1976.	L. P. Yip G. L. Shubert
FS-118	"Stability Analysis for Linear Systems with Time Delays" Published: Jour. of Sound and Vibration, Vol. 51(1), pp. 7-21, 1977.	L. K. Barker J. L. Whitesides
FS-119	"Augmentation of Maneuver Performance by Spanwise Blowing" Published: NASA TM X-73998, January 1977.	G. E. Erickson J. F. Campbell
FS-120	"Recent Research on Powered-Lift STOL Ground Effects" Presented: AIAA/NASA Ames V/STOL Conference, Palo Alto, CA, June 6-8, 1977. Published: Proceedings of Meeting.	J. P. Campbell J. L. Hassell, Jr. J. L. Thomas
FS-121	"Advances in Engineering Science" Published: NASA CP-2001, Volumes I-IV, November 1976.	
FS-122	"Workshop on High Reynolds Number Research" Published: NASA CP-2009, May 1977.	D. D. Baals, Ed.
FS-123	"Determination of Longitudinal Aerodynamic Derivatives from Steady State Measurement of an Aircraft" Presented: AIAA 4th Atmospheric Flight Mechanics Conference, Hollywood, FL, August 8-10, 1977. Published: Proceedings of Meeting.	V. Klein
FS-124	"Design Considerations of the National Transonic Facility"	D. D. Baals

AERONAUTICS PROGRAM

No.	Title	Author
FS-125	"Compatibility Check of Measured Aircraft Responses Using Kinematic Equations and Extended Kalman Filter" Published: NASA TN D-8514, August 1977.	V. Klein J. R. Scheiss
FS-126	"Improvement of Maneuver Aerodynamics by Spanwise Blowing" Published: NASA TP 1065, December 1977.	G. E. Erickson J. F. Campbell
FS-127	"A Parametric Experimental Study of the Interference Effects and the Boundary-Condition Coefficient of Slotted Wind-Tunnel Walls" Presented: AIAA 10th Aerodynamic Testing Conference, April 19-21, 1978, San Diego, CA.	J. L. Everhart R. W. Barnwell
FS-128	"Ground Effects on Lift for Turbofan Powered-Lift STOL Aircraft" Published: Journal of Aircraft, Vol. 15, No. 2, February 1978, pp. 78-84.	J. P. Campbell J. L. Hassell, Jr.
FS-129	"Aircraft Parameter Estimation in Frequency Domain" Presented: AIAA 5th Atmospheric Flight Mechanics Conference, Palo Alto, CA, August 7-9, 1978. Published: Proceedings of the Meeting.	V. Klein
FS-130	"Wind Tunnel Tests of A Two Bladed Rotor With Tip Blowing To Reduce Rotor Noise" Published (NASA TP), 1978.	S. W. Yuan A. M. Bloom H. L. Runyan

AERONAUTICS DISSERTATIONS AND THESES

1. "Verification of a Theory on the Jet Flap and Its Application to an Externally-Blown Flap High Lift System," G. E. Kardas, June 1973.
2. An Analytical and Experimental Investigation of the Feasibility of Estimating Aerodynamic Coefficients from Model Free-Flight Tests," L. G. Shaw, September, 1973.
3. "Lateral-Directional Stability of a Jet-Transport Model Utilizing an Externally Blown Flap System," S. J. Emerling, September 1973.
4. "Analytical Calculations of Spin/Recovery Characteristics of a Modern Fighter Aircraft," C. W. Carroll, September 1973.
5. "Analysis of a Distributed Upper-Surface Blown Wing-Body Combination," D. R. Forsyth, December 1974.
6. "Two-Dimensional Analysis of a Wall Jet Flow Exhausted from a Discrete Upper-Surface-Blown Engine Over a Wing and Radius Flap Combination," W. C. Hohlweg, February 1976.
7. "A Closure Model for Calculating the Development of Turbulent Boundary Layers," H. F. Jen, February 1976, D.Sc. Dissertation.
8. "Prediction of the Flat Spin Characteristics of a Fighter Airplane," A. B. Graham, June 1976.
9. "An Analytical Investigation of the Stall, Departure, and Spin Entry Characteristics of a Current Fighter Airplane Using Conventional and Rotary Aerodynamic Models," W. B. Kroll, September 1976.
10. "A Computational Method for the Prediction of the Three-Dimensional Viscous Flow Pressure Distribution Over Finite Wings Using Strip Analysis," G. L. Shubert, September 1976.

11. "The Use of Rotation-Balance Aerodynamic Data in Theoretical Spin Studies," D. H. Williams, September 1976.
12. "Augmentation of Maneuver Performance by Spanwise Blowing," G. E. Erickson, December 1976.
13. "A Computational Method for the Design of Transonic Airfoils Using Numerical Optimization," D. E. Edwards, August 1977.

ENVIRONMENTAL MODELING PROGRAM

No.	Title	Author
EM-101	"On the Use of a Finite Difference Method for Solving Anisotropic Scattering Problems" Presented: Meeting of Division of Planetary Sciences of the American Astronomical Society, Columbia, MD, Feb. 17-21, 1975. Published: Bulletin, American Astronomical Society, Vol. 7, No. 2, Part II, 1975, pp. 389-390.	B. R. Barkstrom
EM-102	"A Finite Difference Method for Solving Anisotropic Scattering Problems" Presented: 10th Thermophysics Conference of the AIAA, Denver, CO, May 27-29, 1975. Published: AIAA Paper 75-701 and 1975 Thermophysics Vol. of the AIAA Progress in Astronautics and Aeronautics Series.	B. R. Barkstrom
EM-103	"Atmospheric Chlorofluorocarbons and Ozone Reductions: Effects on the Global Surface Temperature" Presented: Fall Annual Meeting, Am. Geophysical Union, Dec. 31, 1975, San Francisco, CA.	V. Ramanathan R. Boughner
EM-104	"The Stratosphere: Scattering Effects, A Coupled 1-D Model, and Thermal Balance Effects" Presented: 4th CIAP Conference, Boston, MA, Feb. 1975.	L. B. Callis V. Ramanathan R. E. Boughner B. R. Barkstrom
EM-105	"A Finite Difference Method of Solving Anisotropic Scattering Problems" Published: J. Quant. Spectr. and Radiat. Transfer, Vol. 16, pp. 725-739, 1976	B. R. Barkstrom
EM-106	"Application of the Diffusion Approximation to the Transfer of Visual Radiation in Clouds of Finite Size" Accepted for Publication: J. Atmos. Sci.	R. F. Arduini B. R. Barkstrom
EM-107	"A Radiative-Convective Model Study of the CO_2-Climate Problem" Published: J. Atmos. Sci., Vol. 34, No. 3.	T. Augustsson V. Ramanathan
EM-108	"On the Kinetic Energy of the Divergent and Non-divergent Flow in the Atmosphere" Accepted for Publication: Tellus, 1976.	T. C. Chen A. C. W. Nielsen
EM-109	"An Equivalent Potential Vorticity Theory Applied to the Analysis and Prediction of Severe Storm Dynamics" Presented: AMS Sixth Conference on Weather Analysis and Forecasting, May 1976, Albany, NY.	D. Paine M. L. Kaplan

ENVIRONMENTAL MODELING PROGRAM

No.	Title	Author
EM-110	"A Numerical Study of the Radiative-Dynamic Interaction in the Stratosphere by a Time-Dependent Zonal Mean Circulation Model" Presented: Joint DMG/AMS International Conference on Simulation of Large-Scale Atmospheric Processes, Hamburg, Germany, Aug. 30-Sep. 4, 1976.	R. E. Turner K. V. Haggard T. C. Chen
EM-111	"The Observed Divergence of the Horizontal Velocity Field and Pressure Gradient Force at the Mesoscale: Its Implications for the Parameterization of Three-Dimensional Momentum Transport in Synoptic Scale Numerical Models" Presented: Joint AMS/DMG International Conference on Simulation of Large-Scale Atmospheric Processes, Aug. 30-Sep. 4, 1976.	M. L. Kaplan D. Paine
EM-112	"The Effect of Finite Horizontal Size of Clouds Upon the Visual Albedo of the Earth" Presented: Symposium on Radiation in the Atmosphere, Garmisch-Partenkirchen, W. Germany, Aug. 19-28, 1976.	B. R. Barkstrom R. F. Arduini
EM-113	"Effects of Realistic Angular Reflection Laws for the Earth's Surface Upon Calculations of the Earth-Atmosphere Albedo" Presented: Symposium on Radiation in the Atmosphere, Garmisch-Partenkirchen, W. Germany, Aug. 19-28, 1976.	J. C. Larsen B. R. Barkstrom
EM-114	"The Diffusion Approximation—An Application to Radiative Transfer in Clouds" Presented: 13th Annual Meeting of the Society of Engineering Science, Hampton, VA, Nov. 1-3, 1976. Published: Proceedings of the Meeting.	R. F. Arduini B. R. Barkstrom
EM-115	"On the Absorption of Solar Radiation in a Layer of Oil Beneath a Layer of Snow" Presented: 13th Annual Meeting of the Society of Engineering Science, Hampton, VA, Nov. 1-3, 1976. Published: Proceedings of the Meeting.	J. C. Larsen B. R. Barkstrom
EM-116	"The Influence of the Diabatic Heating in the Troposphere on the Stratosphere" Presented: 13th Annual Meeting of the Society of Engineering Science, Hampton, VA, Nov. 1-3, 1976. Published: Proceedings of the Meeting.	R. E. Turner K. V. Haggard T. C. Chen
EM-117	"The Numerical Prediction of Tornadic Windstorms" Presented: 13th Annual Meeting of the Society of Engineering Science, Hampton, VA, Nov. 1-3, 1976. Published: Proceedings of the Meeting.	D. Paine M. L. Kaplan
EM-118	"Comparisons Among Second-Order, Fourth-Order and Pseudospectral Advection Techniques in a Mesoscale Numerical Model" Presented: 3rd Conference on Numerical Weather Prediction of the A.M.S., April 26-28, 1977, Omaha, NE.	M. L. Kaplan R. E. Turner Y. R. Wong

ENVIRONMENTAL MODELING PROGRAM

No.	Title	Author
EM-119	"An Improved Model for the Dielectric Constant of Sea Water at Microwave Frequencies" Published: IEEE Transactions on Antennas and Propagation, Vol. AP-25, No. 1, pp. 104, 1977.	L. A. Klein C. T. Swift
EM-120	"Equations for Precise Calculations of Dielectric Constant of Sea Water at Microwave Frequencies" Presented: 1975 Annual Meeting of the URSI, University of Colorado, October 1975.	L. A. Klein C. T. Swift
EM-121	"Effects of Foam Coverage on Interpretation of Radiometric Temperature Measurements of Ocean Water" Presented: 1976 Annual Meeting of URSI, University of Massachusetts, October 1976.	L. A. Klein
EM-122	"An Analysis Technique for Microstrip Antennas" Presented: 1976 IEEE AP-S International Symposium, University of Massachusetts, October 1976. Published: IEEE Transactions on Antennas and Propagation, Vol. AP-25, No. 6, November 1977.	P. K. Agrawal M. C. Bailey
EM-123	"A Multiscale Numerical Study Into the Cascade of Kinetic Energy Leading to Severe Local Storms" Submitted: Monthly Weather Review, January 1977.	M. L. Kaplan D. A. Paine
EM-124	"Radiometric Signature of Ocean Foam at Microwave Frequencies" Presented: 1977 Annual Meeting of URSI, Palo Alto, CA, June 1977.	L. A. Klein
EM-125	"A Technique to Calculate the Radiation Patterns of Large Spherical Reflector Antennas" Presented: 1977 IEEE AP-S International Symposium, Stanford University, June 1977.	P. K. Agrawal W. F. Croswell J. F. Kauffman
EM-126	"A Preliminary Study of the Effect of Angular Reflecting Characteristics of Earth and Ocean Surfaces Upon Calculation of the Albedo of the Earth's Atmospheric System" Accepted for Publication: J. of Geophysical Research.	B. R. Barkstrom J. R. Larsen
EM-127	"Passive Remote Sensing in the Presence of Multiple Scattering—A Numerical Inversion Method" Submitted for Presentation: Joint IAGA/IAMAP Assembly, Seattle, WA, Aug. 22-Sep. 3, 1977. Published:	B. R. Barkstrom
EM-128	"An Approximation to the Visual Radiative Effects of Finite-Sized Clouds in Atmospheric Albedo Calculations" Submitted: Joint IAGA/IAMAP Assembly, Seattle, WA, Aug. 22-Sep. 3, 1977.	R. F. Arduini B. R. Barkstrom
EM-129	"One-Dimension Steady-State Calculation of Physico-Chemical Effects Produced Antropogenic and Natural Chlorine Compounds in the Stratosphere" Submitted: Joint IAGA/IAMAP Assembly, Seattle, WA, Aug. 22-Sep. 3, 1977.	J. E. Nealey T. R. Augustsson

ENVIRONMENTAL MODELING PROGRAM

No.	Title	Author
EM-130	"A Hybrid Technique for Wire Antennas in a Cavity" Published: IEEE Transaction on Antennas and Propagation, Vol. AP-26, No. 3, May 1978.	P. K. Agrawal
EM-131	"The Multiple Nesting of Mesoscale, Submesoscale, and Nonhydrostatic Microscale Numerical Models and a Case of Mesocyclogenesis and Severe Storm Development" Presented: Third Conference on Numerical Weather Prediction of the A.M.S., April 26-28, 1977, Omaha, NE.	M. Kaplan A. Gooden
EM-132	"A Multi-Scale Numerical Model of Tornado-Producing Local Storms on CDC's STAR 100 Computer" Presented: First International Conference on Mathematical Modeling, Aug. 29-Sept. 1, 1977, St. Louis, MO.	M. Kaplan A. Gooden
EM-133	"A Numerical Simulation of Seasonal Stratospheric Climate: Part I. Zonal Temperatures and Winds" Published: Journal of Atmospheric Sciences, Vol. 35, pp. 600-614, April 1978.	V. Ramanathan W. L. Grose
EM-134	"A Numerical Simulation of Seasonal Stratospheric Climate: Part II. Energetics" Published: Journal of Atmospheric Sciences, Vol. 35, pp. 615-633, April 1978.	T. C. Chen V. Ramanathan
EM-135	"A 3-D Circulation Model Study of the Radiative-Dynamic Coupling Within the Stratosphere" In Press: Contributions to Atmospheric Physics (German Journal).	V. Ramanathan W. L. Grose
EM-136	"A Multiscale Numerical Study Into the Cascade of Kinetic Energy Leading to Severe Local Storms" Presented: 10th Conference on Severe Local Storms, Omaha, NB, October 1977.	D. A. Paine M. L. Kaplan
EM-137	"A Multiscale Synoptic-Dynamical Model of Tornado Genesis" Presented: 10th Conference on Severe Local Storms, Omaha, NB, October 1977.	M. L. Kaplan D. A. Paine
EM-138	"A Two-Dimensional Chemical Transport Model of the Troposphere and Stratosphere" (Abstract) Published: Transactions, American Geophysical Union, Vol. 58, No. 12, December 1977, p. 1148.	R. J. Kurzeja
EM-139	"Optimization of the Design Parameters for a Wide-Band Radiometer System" Published: NASA TM 78662, January 1978. Presented: IEEE AP-S International Symposium, University of Maryland, May 1978.	P. K. Agrawal
EM-140	"Some Aspects of the Interaction of Radiation with the Thermal and Mass Budgets of Cloud Droplets" Presented: 4th Joint Conference on Sensing Environmental Pollutants, New Orleans, LA, Nov. 6-11, 1977.	B. R. Barkstrom D. M. Stephenson

ENVIRONMENTAL MODELING PROGRAM

No.	Title	Author
EM-141	"An Algorithm for Optimizing the Information Content of Radiation Field Measurements in the Presence of Multiple Scattering" Presented: 3rd Conference on Atmospheric Radiation, Davis, CA, June 1978.	B. R. Barkstrom D. M. Stephenson
EM-142	"Some Comments on Radiative Flux Divergence, Heating Rates, and Cloud Droplet Population Dynamics" Presented: 3rd Conference on Atmospheric Radiation, Davis, CA, June 1978.	B. R. Barkstrom
EM-143	"Some Effects of 8 to 12 μm Radiant Energy Transfer Upon the Mass and Heat Budgets of Cloud Droplets" Published: Journal of the Atmospheric Sciences, Vol. 35, No. 4, pp. 665-673, April 1978.	B. R. Barkstrom
EM-144	"A Computer Program to Calculate Radiation Properties of Reflector Antennas" Published: NASA TM 78721, May 1978.	P. K. Agrawal
EM-145	"On Nonlinear Cascades of Atmospheric Energy and Enstrophy in a Two-Dimensional Spectral Index" Accepted for Publication: Tellus, 1978.	T. C. Chen A. Wiin-Nielsen
EM-146	"Calculated Span Characteristics of a Large Spherical Reflector Antenna" Submitted: IEEE Transactions on Antennas and Propagation, May 1978.	P. K. Agrawal J. F. Kauffman W. F. Croswell
EM-147	"Effects of Solar Cycle UV Radiance Variations on Stratospheric Structure" Presented: Fall Meeting, American Geophysical Union, Dec. 1977, San Francisco, CA.	J. E. Nealy L. B. Callis M. Natarajan

ENVIRONMENTAL MODELING THESES

1. "Iteration of the Linearized Radiative Transfer Equation as a Means of Retrieving an Absorbing Gas Profile in the Earth's Atmosphere," David L. Myrick, September 1976.
2. "Application of the Diffusion Approximation to the Transfer of Visual Radiation in Clouds of Finite Size," Robert Arduini, August 1977.
3. "Methane and Stratospheric Water Vapor: A Possible Link?," Tommy Augustsson, August 1977.
4. "Calculating Unknown Atmospheric Processes with the Dynamic Relaxation Technique," Jack Larsen, August 1977.
5. "A Comparison of Finite Difference Spectral, and Pseudospectral Method with Exact Solution of One-Dimensional Advection," Yih-Ren Wong, August 1977.

MATERIALS SCIENCE PROGRAM

No.	Title	Author
MS-101	"Lattice Theory of Three-Dimensional Cracks" Published: J. of Applied Physics, *47*, 496 (1976).	D. M. Esterling
MS-102	"Anharmonic Effects Associated with $<110>$ Screw Dislocations in Aluminum" Published: Proc. of 1976 International Conference on Computer Simulation for Materials Applications, Gaithersburg, MD, p. 858, April 20, 1976. Presented: Proceedings of Conference.	D. M. Esterling J. A. Moriarty

MATERIALS SCIENCE PROGRAM

No.	Title	Author
MS-103	"Computer Simulation of Screw Dislocation in Aluminum" Presented: 13th Annual Meeting of the Society of Engineering Science, Hampton, VA, November 1-3, 1976. Published: Proceedings of the Meeting.	D. M. Esterling
MS-104	"Applications of Solid State Physics in Materials Engineering" Published: Bulletin of American Physical Society, Vol. 22, p. 494, 1976. Presented: 1976 Meeting of Southeastern Section of American Physical Society, November 11-13, 1976.	D. M. Esterling
MS-105	"Numerical Analyses for Treating Diffusion in Single-, Two-, and Three-Phase Binary Alloy Systems" Published: NASA TM 78636, March 1978.	D. R. Tenney J. Unnam
MS-106	"Prediction of Moisture and Temperature Changes in Composites During Atmospheric Exposure" Presented: 5th ASTM Symposium on Composite Materials: Testing and Design, New Orleans, LA, March 20-22, 1978. Published: NASA TM 78711, April 1978.	S. S. Tompkins D. R. Tenney J. Unnam
MS-107	"Modified Lattice Statics Approach to Dislocation Calculations—I. Formalism" Accepted for Publication: Journal of Applied Physics.	D. M. Esterling
MS-108	"Modified Lattice Statics Approach to Dislocation Calculations—II. Applications" Accepted for Publication: Journal of Applied Physics.	D. M. Esterling J. A. Moriarty
MS-109	"Equilibrium and Kinetic Aspects of Brittle Fracture" Accepted for Publication: Int'l. Journal of Fracture.	D. M. Esterling

STRUCTURES AND DYNAMICS PROGRAM

No.	Title	Author
SD-101	"Dynamic Analysis of Frame and Plate Structures with Geometric and Material Nonlinearities" Published: Technical Report No. 3988, Structures Department, Naval Ship Research and Development Center, Carderock, Maryland, June, 1973.	T. G. Toridis
SD-102	"Improved Mixed Finite-Difference Scheme for Thermoelastic Stress Analysis of Noncircular Cylindrical Shell Roofs" Published: Proceedings of the IASS Conference on Shell Structures and Climatic Conditions, Calgary, Canada, July 3-6, 1972, pp. 335-345.	A. K. Noor
SD-103	"Plastic Dynamic Analysis of Frame Structures" Published: Final Technical Report NSF Research Grant GK-16142, George Washington University, August, 1973.	T. G. Toridis K. Khozeimeh
SD-104	"Mixed Finite-Difference Scheme for Free Vibration Analysis of Non-Circular Cylinders" Published: NASA TN D-7107, February, 1973.	A. K. Noor W. B. Stephens

STRUCTURES AND DYNAMICS PROGRAM

No.	Title	Author
SD-105	"Noncircular Cylinder Vibration by Multilocal Method" Published: J. of the Eng. Mech. Div., ASCE, Vol. 99, No. EM 2, pp. 389-407, Proc. Paper 9677, April, 1973.	A. K. Noor
SD-106	"Nonlinear Analysis of Space Trusses" Presented: Annual Meeting of the Structural Div., ASCE, April, 1973. Published: J. of Structural Div., ASCE, Vol. 100, No. ST3, pp. 533-546, Proc. Paper 10419, March, 1974.	A. K. Noor
SD-107	"Use of Symbolic Manipulation in the Development of Two-Dimensional Finite Elements" Presented: 1973 SIAM National Meeting, Hampton, VA, June 18-21, 1973.	C. M. Andersen A. K. Noor
SD-108	"Free Vibrations of Multilayered Composite Plates" Published: AIAA Journal, Vo. 11, No. 7, pp. 1038-1039, July, 1973.	A. K. Noor
SD-109	"On Improved Finite-Difference Discretization Procedures" Published: Variational Methods in Engineering, Edited by Brebbia and Tottenham, Southampton University Press, 1973, pp. 12/1 to 12/50.	A. K. Noor W. C. Schnobrich
SD-110	"Mixed Finite-Difference Scheme for a Class of Linear and Nonlinear Structural Mechanics Problems" Published: Developments in Mechanics, Vol. 7, Proceedings of the 13th Midwestern Mechanics Conference, Pittsburgh, PA, August, 1973, pp. 657-674.	A. K. Noor
SD-111	"Mixed Method for the Nonlinear Analysis of Pin Jointed Trusses" Published: Proceedings of the Fourth Australasian Mechanics Conference, Brisbane, Australia, August 20-22, 1973, pp. 217-224.	A. K. Noor
SD-112	"Mixed Finite-Difference Scheme for Analysis of Simply Supported Thick Plates" Published: Int'l. J. of Computers and Structures, Vol. 3, No. 5, September, 1973, pp. 967-982.	A. K. Noor
SD-113	"An Improved Numerical Process for the Solution of Solid Mechanics Problems" Published: Int'l. J. of Computers and Structures, Vol. 3, No. 6, November, 1973, pp. 1397-1437.	A. K. Noor W. B. Stephens R. E. Fulton
SD-114	"Comparison of Finite-Difference Schemes for Analysis of Shells of Revolution" Published: NASA TN D-7337, December, 1973.	A. K. Noor W. B. Stephens
SD-115	"Approximate Techniques of Structural Reanalysis" Published: Int'l. J. of Computers and Structures, Vol. 4, No. 4, 1974, pp. 801-812.	A. K. Noor H. E. Lowder
SD-116	"Three-dimensional Solutions of Laminated Cylinders" Published: Int'l. J. of Computer Methods in Applied Mechanics and Engineering, Vol. 3, No. 3, May 1974, pp. 319-334.	A. K. Noor P. L. Rarig

STRUCTURES AND DYNAMICS PROGRAM

No.	Title	Author
SD-117	"Use of Group-Theoretic Methods in the Development of Nonlinear Shell Finite Elements" Published: Proceedings of the Int'l. Conference on Symmetry, Similarity and Group-Theoretic Methods in Mechanics, Calgary, Canada, 1974, pp. 533-558.	C. M. Andersen A. K. Noor
SD-118	"Impact of CDC-STAR-100 Computer on Finite Element Systems" Presented: Sixth ASCE Conference on Electronic Computation, Atlanta, GA, August, 1974. Published: Proceedings of the Sixth Conference on Electronic Computation, Atlanta, GA, August, 1974, pp. 166-202. Published: J. of the Structural Div., Vol. 101, No. ST4, April 1975, pp. 731-750.	A. K. Noor R. E. Fulton
SD-119	"Nonlinear Finite Element Analysis of Laminated Composite Shells" Published: Proceedings of the Int'l. Conference on Computational Methods in Nonlinear Mechanics, Austin, TX, September 1974, pp. 999-1009.	A. K. Noor M. D. Mathers
SD-120	"Multiple Configuration Analysis Via Mixed Method" Published: J. of the Structural Div., ASCE, Vol. 100, No. ST9, September 1974, pp. 1991-1997.	A. K. Noor
SD-121	"Stability of Multilayered Composite Plates" Published: Int'l. J. of Fibre Science Technology, Vol. 8, April 1975, pp. 81-89.	A. K. Noor
SD-122	"Structural Reanalysis via a Mixed Method" Published: Int'l. J. of Computers and Structures, Vol. 5, No. 1, April 1975, pp. 9-12.	A. K. Noor H. E. Lowder
SD-123	"Shear-Flexible Finite Element Models of Laminated Composite Plates and Shells" Published: NASA TN D-8044, December 1975.	A. K. Noor M. D. Mathers
SD-124	"Hypermatrix Scheme for Finite Element System on CDC STAR-100 Computer" Presented: Second Langley Conference on Scientific Computing, Virginia Beach, VA, October 21-22, 1974. Published: Int'l. J. of Computers and Structures, Vol. 5, No. 5/6, December 1975, pp. 287-296.	A. K. Noor S. J. Voigt
SD-125	"Mixed Isoparametric Elements for Saint-Venant Torsion" Published: Developments in Mechanics, Vol. 8, Proceedings of the 14th Midwestern Mechanics Conference, Univ. of Oklahoma, March 1975, pp. 171-192.	A. K. Noor P. L. Rarig
SD-126	"Mixed Isoparametric Elements for Saint-Venant Torsion" (Extended Version of SD-125) Published: Int'l. J. of Computer Methods in Applied Mechanics and Engineering, Vol. 6, 1975, pp. 195-218.	A. K. Noor C. M. Andersen
SD-127	"Approximate Reanalysis Techniques with Substructuring" Published: J. of the Structural Div., ASCE, Vol. 101, No. ST8, August 1975, pp. 1687-1698.	A. K. Noor H. E. Lowder

STRUCTURES AND DYNAMICS PROGRAM

No.	Title	Author
SD-128	"Mixed Isoparametric Laminated Composite Plate and Shell Elements" Published: Proceedings of the World Congress on Finite Element Methods in Structural Mechanics, Bournemouth, Dorset, England, October 12-17, 1975.	A. K. Noor C. M. Andersen
SD-129	"A Computerized Symbolic Integration Technique for Development of Triangular and Quadrilateral Composite Shallow-Shell Finite Elements" Published: NASA TN D-8067, December 1975.	C. M. Andersen A. K. Noor
SD-130	"A Study of Feedback Coupled Allocation Policies in the Multi-Processor Computer Environment" Presented: Second Annual Sigmetrics Symposium on Measurement and Evaluation, Montreal, Canada, September 30 - October 2, 1974.	R. S. Brice J. C. Browne
SD-131	"Anisotropy and Shear Deformation in Laminated Composite Plates" Published: AIAA Journal, Vol. 14, No. 2, February 1976, pp. 282-285.	A. K. Noor M. D. Mathers
SD-132	'Finite Element Analysis of Anisotropic Plates" Published: Int'l. J. for Numerical Methods in Engineering, Vol. 11, 1977, pp. 289-307.	A. K. Noor M. D. Mathers
SD-133	"Symmetry Considerations for Anisotropic Shells" Published: Int'l. J. of Computer Methods in Applied Mechanics and Engineering, Vol. 9, 1976, pp. 317-335.	A. K. Noor R. A. Camin
SD-134	"Performance of a Data Base Manager in a Virtual Memory System" Presented: SIGMOD Int'l. Conference on Management of Data, June 1976. Published: Journal of Transactions on Data Base Systems, December 1976.	S. W. Sherman R. S. Brice
SD-135	"I/O Buffer Performance in a Virtual Memory System" Published: Proceedings of Symposium on Simulation of Computer Systems, Boulder, CO, August 1976.	S. W. Sherman R. S. Brice
SD-136	"Symmetries in Laminated Composite Plates" Published: Developments in Theoretical and Applied Mechanics, Vol. 8, Proceedings of the Eighth Southeastern Mechanics Conference, VPI&SU, Blacksburg, VA, April 1976, pp. 225-246.	A. K. Noor
SD-137	"Nonlinear Shell Analysis Via Mixed Isoparametric Elements" Presented: Second National Symposium on Computerized Structural Analysis and Design, GWU, Washington, DC, March 1976. Published: Int'l. J. of Computers and Structures, Vol. 7, No. 5, October 1977, pp. 615-626.	A. K. Noor S. J. Hartley
SD-138	"Substructuring Techniques—Status and Projections" Presented: Second National Symposium on Computerized Structural Analysis and Design, GWU, Washington, DC, March 1976. Published: Int'l. J. of Computers and Structures, Vol. 8, No. 5, May 1978, pp. 621-632.	A. K. Noor H. A. Kamel R. E. Fulton

STRUCTURES AND DYNAMICS PROGRAM

No.	Title	Author
SD-139	"Exploiting Symmetries for Efficient Post-Buckling Analysis of Composite Plates" Published: Proceedings of the 17th AIAA/ASME/SAE Structures, Structural Dynamics and Materials Conference, Valley Forge, PA, May 1976, pp. 39-55.	A. K. Noor M. D. Mathers M. S. Anderson
SD-140	"Mixed Isoparametric Finite Element Models of Laminated Composite Shells" (Extended Version of SD-128) Published: Int'l. J. of Computer Methods in Applied Mechanics and Engineering, Vol. 11, 1977, pp. 255-280.	A. K. Noor C. M. Andersen
SD-141	"Free Vibrations of Laminated Composite Elliptic Plates" Presented: 13th Annual Meeting of the Society of Engineering Science, Hampton, VA, November 1-3, 1976. Published: NASA CP-2001, Advances in Engineering Sciences, Vol. 2, November 1976, pp. 425-438.	C. M. Andersen A. K. Noor
SD-142	"Effect of Shear Deformation and Anisotropy on the Nonlinear Response of Composite Plates" Published: Chapter 4 in Developments in Composite Materials, edited by G. Holister, Applied Science Publishers, Ltd., 1977, pp. 55-65.	A. K. Noor S. J. Hartley
SD-143	"A Method for the Analysis of Nonlinearities in Aircraft Dynamic Response to Atmospheric Turbulence" Published: NASA TN D-8265, 1976.	K. W. Sidwell
SD-144	"Empirical Comparison of Partitioned and Non-Partitioned Buffer Management in Virtual Memory Systems" Published: Proceedings of EUROCOMP, London, England, September 1976.	R. S. Brice S. W. Sherman
SD-145	"Atmospheric Turbulence Power Spectral Measurements to Long Wavelengths for Several Meteorological Conditions" Presented: Aircraft Safety and Operating Problems Conference, Langley Research Center, Hampton, VA, October 1976. Published: NASA SP-416, 1976, pp. 271-286.	R. H. Rhyne H. N. Murrow K. W. Sidwell
SD-146	"Continuum Models for Static and Dynamic Analysis of Repetitive Lattices" Published: Proceedings of the 18th AIAA/ASME/SAE Structures, Structural Dynamics and Materials Conference, San Diego, CA, March 1977, pp. 299-310.	A. K. Noor W. H. Greene M. S. Anderson
SD-147	"Nonlinear Finite Element Analysis of Curved Beams" Published: Int'l. J. of Computer Methods in Applied Mechanics and Engineering, Vol. 12, pp. 289-307, 1977.	A. K. Noor W. H. Greene S. J. Hartley

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No.	Title	Author
SD-148	"Thermoelastic Stress Analysis of Double-Layered Grids" Presented: Second Annual ASCE Engineering Mechanics Specialty Conference, North Carolina State University, Raleigh, NC, May 23-25, 1977. Published: Advances in Civil Engineering Through Engineering Mechanics, Proceedings of the Second Annual Engineering Mechanics Division Specialty Conference, North Carolina State University, May 1977, pp. 463-466.	A. K. Noor
SD-149	"An Extension to the Performance of a Database Manager in a Virtual Memory System" Published: J. of Transactions on Database Systems, June 5, 1977.	R. S. Brice S. W. Sherman
SD-150	"Symbolic Manipulation Techniques for Vibration Analysis of Laminated Elliptic Plates" Presented: The 1977 MACSYMA User's Conference, University of California, Berkeley, CA, July 27-29, 1977. Published: NASA CP-2012, pp. 161-175.	C. M. Andersen A. K. Noor
SD-151	"A Mathematical Study of a Random Process Proposed as an Atmospheric Turbulence Model" Published: NASA CR-145200, May 1977.	K. W. Sidwell
SD-152	"Evaluation of Element Stiffness Matrices on CDC STAR-100 Computer" Published: Int'l. J. of Computers and Structures, Vol. 9, No. 2, 1979.	A. K. Noor S. J. Hartley
SD-153	"Thermal Stress Analysis of Double-Layered Grids" (Extended Version of SD-148) Published: Journal of the Structural Div., ASCE, February 1978, Vol. 104, ST2, pp. 251-262.	A. K. Noor
SD-154	"Nonlinear Curvature Expressions for Combined Flapwise Bending, Chordwise Bending, Torsion and Extension of Twisted Rotor Blades" Published: NASA TM X-73997, December 1976.	R. G. Kvaternik K. R. V. Kaza
SD-155	"Nonlinear Fla-Lag-Axial Equations of a Rotating Beam" Published: AIAA Journal, Vol. 15, June 1977, pp. 871-874.	K. R. V. Kaza R. G. Kvaternik
SD-156	"Nonlinear Aeroelastic Equations for Combined Flapwise Bending, Torsion and Extension of Twisted Nonuniform Rotor Blades in Forward Flight" Published: NASA TM X-74059, August 1977.	K. R. V. Kaza R. G. Kvaternik
SD-157	"Analysis of the Response of Linear Dynamic Systems to Product Random Processes" Published: Journal of Sound and Vibration, Vol. 55, No. 1, 1977, pp. 55-64.	K. W. Sidwell
SD-158	"Feedback Coupled Resource Allocation Policies in the Multiprocessing Environment" Published: The Communications of the ACM, 1978.	R. S. Brice S. W. Sherman

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No.	Title	Author
SD-159	"Continuum Models for Beam-Like and Plate-Like Lattice Structures" Published: Proceedings of the 19th AIAA/ASME Structures, Structural Dynamics and Materials Conference, Bethesda, MD, April 3-5, 1978, pp. 228-241.	A. K. Noor M. S. Anderson W. H. Greene
SD-160	"Development of Continuum Theories for Lattice Grids" Presented: Eighth US Nat'l. Congress of Applied Mechanics, June 26-30, 1978, The University of California, Los Angeles, CA.	A. K. Noor
SD-161	"Dynamic Finite Element Analysis on CDC STAR-100 Computer" Presented: Symposium on Future Trends in Computerized Structural Analysis and Synthesis, Washington, DC, October 30 - November 1, 1978. Published: Proceedings of the Symposium and Int'l. J. of Computers and Structures, Vol. 10, No. 1/2, 1979.	A. K. Noor J. Lambiotte
SD-162	"Computerized Symbolic Manipulation in Structural Mechanics—Progress and Potential" Presented: Symposium on Future Trends in Computerized Structural Analysis and Synthesis, Washington, DC, October 30 - November 1, 1978. Published: Proceedings of the Symposium and Int'l. J. of Computers and Structures, Vol. 10, No. 1/2, 1979.	A. K. Noor C. M. Andersen
SD-163	"Finite Element Analysis in a Minicomputer/Mainframe Environment" Presented: Symposium on Future Trends in Computerized Structural Analysis and Synthesis, Washington, DC, October 30 - November 1, 1978. Published: Research in Computerized Structural Analysis and Synthesis, NASA CP-2059, October 1978.	O. O. Storaasli R. C. Murphy
SD-164	"Analysis of Dynamic System Response to Product Random Processes" Published: NASA TM-78667, 1978.	K. Sidwell
SD-165	"A Qualitative Assessment of a Random Process Proposed as an Atmospheric Turbulence Model" Published: NASA CR-145247, September 1977.	K. Sidwell
SD-166	"Nonlinear Dynamic Analysis of Space Trusses" Published: Computer Methods in Applied Mechanics and Engineering.	A. K. Noor J. M. Peters
SD-167	"Trends in Computerized Structural and Synthesis," Proceedings of the Symposium on Future Trends in Computerized Structural Analysis and Synthesis, Washington, DC, October 30 - November 1, 1978. Published: Pergamon Press, 1978.	A. K. Noor H. G. McComb, Jr. (Editors)
SD-168	"Analysis of Beam-Like Lattice Trusses" Published: Computer Methods in Applied Mechanics and Engineering.	A. K. Noor C. M. Andersen

STRUCTURES AND DYNAMICS DISSERTATIONS AND THESES

1. "Approximate Techniques of Structural Reanalysis," H. E. Lowder, M.S. Thesis, Oct. 1974.
2. "Investigation of the Effects of Structural Dynamics on Design for Fatigue Life," P. E. Berger, M.S. Thesis, June 1975.
3. "Nonlinear Finite Element Analysis of Composite Cylindrical Shells," R. A. Camin, M.S. Thesis, October 1975.
4. "Finite Element Analysis of Laminated Composite Plates and Shells," M. D. Mathers, D.Sc. Dissertation, February 1976.
5. "Interactive Structural Optimization with Strength and Flutter Constraints," by G. L. Farley, M.S. Thesis, April 1976.
6. "Continuum Models for Static and Dynamic Analysis of Repetitive Trusses," W. H. Greene, M.S. Thesis, October 1977.
7. "Optimal Control of a Helicopter Rotor in Hover," J. H. Peebles, M.S. Thesis, November 1977.

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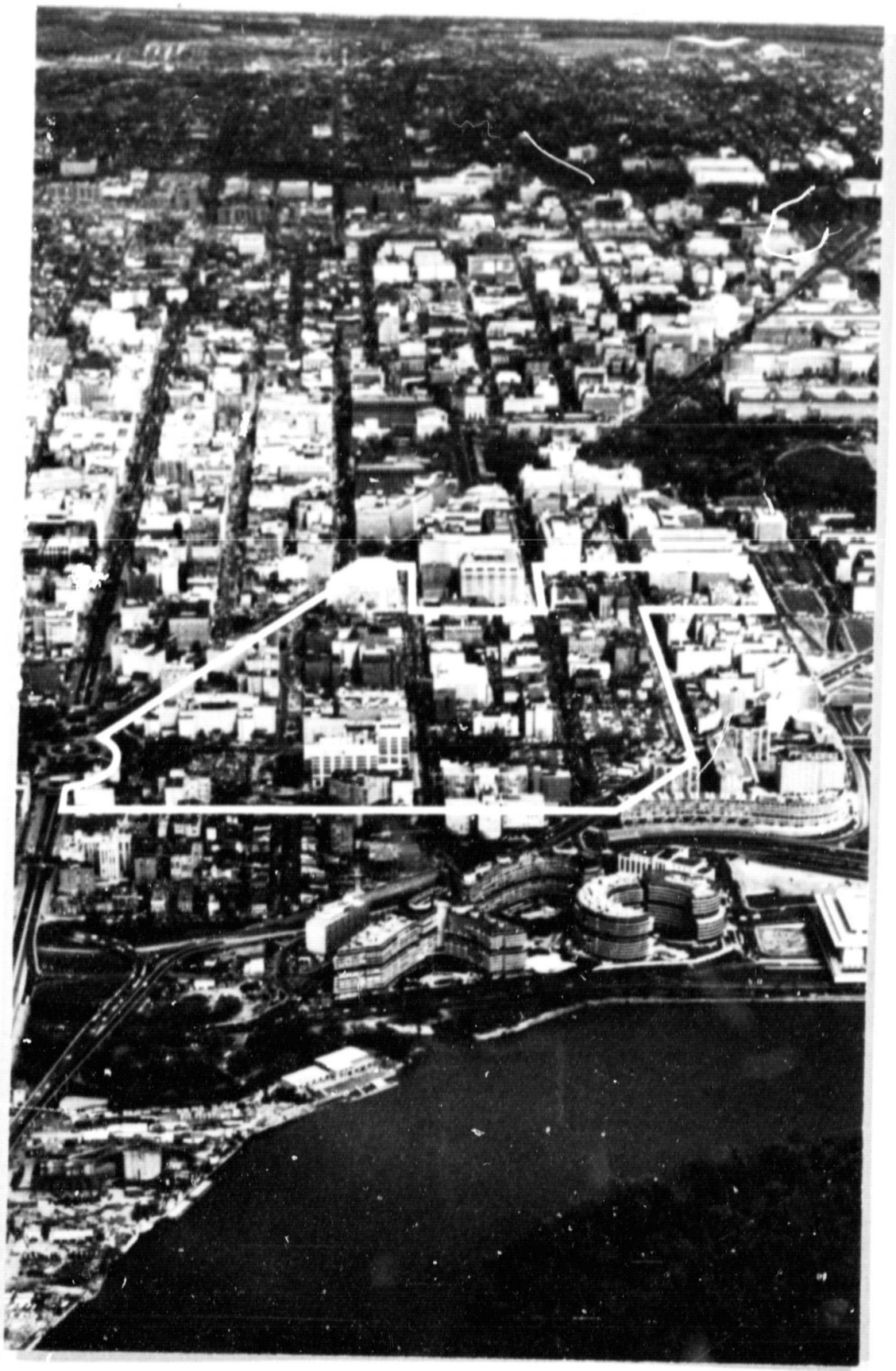

ADDITIONAL INFORMATION

Inquiries and requests for application forms for:

1. Master's Professional, or Doctor's degree Program;
2. Graduate Research Scholar Assistantship Program;
3. Visiting Scientists and Engineers, or Research Associates Program;

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S. W. Yuan
Professor, Department of
Civil, Mechanical, and
Environmental Engineering
School of Engineering and
Applied Science
George Washington University
Washington, D.C. 20052
Telephone: (202) 676-6665

John L. Whitesides
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JOINT INSTITUTE FOR ADVANCEMENT OF FLIGHT SCIENCES

RESEARCH PROGRAM IN AERONAUTICS

NASA COOPERATIVE AGREEMENT NCC1-44

Annual Report

August 1, 1980 - July 31, 1981

School of Engineering and Applied Science
The George Washington University
Washington, D. C. 20052

The program objectives are fully defined in the original proposal entitled "Research Program in Aeronautics in the JIAFS at the NASA-Langley Research Center" dated February 1980.

Specific developments and individual research in the Aeronautics Program during the period August 1, 1980 - July 31, 1981 are described herein.

The George Washington University has maintained a graduate research and education program at NASA-Langley Research Center for 13 years which has been formalized as the Joint Institute for Advancement of Flight Sciences (JIAFS). In JIAFS, GWU faculty, visiting scientists and Graduate Research Scholar Assistants (GRSA) work with NASA researchers on state-of-the-art research problems. The GRSA are recruited nationwide and those that are selected pursue their research projects and academic studies in The George Washington University graduate program at NASA. A typical recruiting flyer for the GRSA and a brochure describing the JIAFS are attached in the appendix.

During this reporting period, four GRSA were appointed under this particular grant. One of these changed his mind at the end of the summer, and thus, there were three GRSA in the program during this period.

The current program consists of Dean Harold Liebowitz, Principal Investigator; Professor J. L. Whitesides, Technical Director; three Graduate Research Scholar Assistants and secretarial assistance. Professor Whitesides has been responsible for the selection of GRSA and coordination, with Professor J. P. Campbell, of the activities, both research and academic, of the GRSA.

Each of the Research Assistants is given an overview of the current activities in JIAFS upon his arrival in the area. A suitable research project is chosen based on agreement between NASA researchers, GWU faculty and the GRSA. The Research Assistants then conduct their research while taking

their academic program through The George Washington University graduate program at NASA-Langley Research Center. Graduate Research Scholar Assistants currently in the program and their activities to date are given below.

Edward H. Dotson (B.S. in Physics, June 1980, Georgia Southern College, GPA 3.95) joined the program in August 1980 and is conducting his research in the NTF Aerodynamics Branch. His thesis research deals with the development of a computer model for flow in which homogeneous nucleation (condensation) can occur. This computer model will be compared with existing models and will be checked with experimental data from the Langley 0.3 Meter Transonic Cryogenic Tunnel. The primary purpose in developing the computer model is to provide a method of predicting the minimum operating temperature for cryogenic wind tunnels such as the National Transonic Facility.

Mr. Dotson has successfully completed the following courses leading toward his MS degree:

ApSc 213	Analytical Methods in Engineering III	A
ME 221	Intermediate Fluid Mechanics	A
ME 272	Powered-Lift Technology	B
ME 222	Applied Fluid Dynamics	A
ME 249	Seminar: Aircraft Design II	A
ME 279	Special Topics in Flight Sciences (Wind Tunnel Research Techniques)	A

Glynn R. Bartlett (B.S. in Mech. Eng., December 1980, Texas Tech University, GPA 3.72) joined the program in January 1981 and was assigned to the Propulsion Aerodynamics Branch. His thesis research involves the prop-fan concept. He will conduct integration problems of prop-fans over the subsonic speed range. He will also develop computer codes dealing with these problems and will correlate them with the experimental results.

Mr. Bartlett has successfully completed the following courses leading toward his MS degree:

ME 222	Applied Fluid Dynamics	B
ME 249	Seminar: Aircraft Design II	A
ME 279	Special Topics in Flight Sciences (Wind Tunnel Research Techniques)	A

Clifford J. Obara (B.S.M.E., December 1980, Florida Institute of Technology, GPA 3.271) joined the program in January 1981 and is conducting flight research in the Low-Speed Aerodynamics Division. His thesis research deals with the problems of identifying boundary layer transition on aircraft wings in flight. In his flight research project, a three-foot span glove having an advanced general aviation airfoil will be fitted on the wing of a NASA aircraft. The location of boundary layer transition on this glove will be determined by a number of techniques including chemical sublimation, static pressure ports, total pressure probes, hot-film sensors, and microphones.

Mr. Obara has successfully completed the following courses leading toward his MS degree:

ME 222	Applied Fluid Dynamics	C
ME 249	Seminar: Aircraft Design II	B
ME 279	Special Topics in Flight Sciences (Wind Tunnel Research Techniques)	B

Since it normally takes 2 years to complete the GRSA's research project and the academic course work, each of the three research assistants listed above will be in the program during the next year.

APPENDIX