ICING RESEARCH TEAM

Presently operating Icing Research Tunnel (foreground) is overshadowed by 45-ft. diameter Altitude Wind Tunnel (above).

Peggy Evanich (standing) and Steve Labbe of the Safety Technology Section discuss helicopter inlet performance program with Linda Schuller of the Computer Services Division.

Harold Schmidt (left) indicates extent of possible ice formation on an airplane wing to Nilza Ramos.

Bill Olsen (left), Safety Technology Section head Jack Reinmann, Branch Chief Roger Luidens and Joe Shaw display ice models and a pneumatic boot de-icer.

The icing research program now underway at Lewis has deep historical roots that go back 40 years when Lewis was NACA's Aircraft Engine Research Laboratory.

Then, during the early years of World War II when the world's aircraft were powered strictly by piston driven engines, icing was just about the worst thing that could happen to an airplane—next to its wings falling off.

Scientists and aeronautical engineers here worked earnestly on ice protection during the 1940s and early '50s, and through their efforts, our commerical fleets and our fighters and bombers avoided the catastrophic effects of accumulated ice.

Now, four decades later, Lewis has been called back to face the same problem again.

The reasons: (1) the general aviation sector, with 200,000 planes and some 800,000 private pilots, is either being impeded in its operations or, at times, experiencing catastrophe from ice; (2) the helicopter is taking on expanded civilian and military assignments, and despite the fact that many of its crucial missions take it into the icing phenomenon, no U.S. built helicopter is certified to fly into predicted icing conditions.

The new program is being carried out in the recently formed Safety Technology Section headed by John J. Reinmann, a mechanical engineer and physicist. It operates as part of the Low Speed Aerodynamics Branch under the leadership of Roger Luidens. The other members of the Icing Research staff include aerospace engineers Peggy Evanich, Porter Perkins, Joe Shaw, Bill Olsen, Harold Schmidt and Bernie Blaha.

In addition, about 115 Lewis staffers representing a host of different disciplines and technical skills have been involved in the project.

Working for the past three years on a $500,000 annual budget, the section will face a new start in fiscal 1982 with a $15 million, ten-year base R&T program, with more funding expected for specific aircraft applications.

Plans are also being made to rehabilitate the presently mothballed Altitude Wind Tunnel for full operation in 1987. With both 20-foot diameter and 45-foot diameter test sections, it can accommodate many full-sized general aviation aircraft and a number of full-sized helicopters for altitude testing.

When on line, the tunnel would provide a broad range of testing capabilities. Its 26-foot diameter drive fan, powered by a 30,000 HP drive motor, provides wind simulations and altitude pressurization. Its two water-spray systems and its 7350-ton cooling capacity will enable it to create icing conditions under which testing of both fixed and rotating airfoils, as well as airframe components, can be done.

"For the time being, though," says Reinmann, "our icing research tunnel, with its 6-foot by 9-foot test section, is the largest refrigerated wind tunnel in North America. Within it we can duplicate precise icing conditions, study factors that cause icing and test proposed anti-icing and de-icing systems."

The goal of the new icing program is to *increase the effectiveness of existing ice protection systems and develop advanced concepts for both anti-icing and de-icing systems for smaller aircraft and rotorcraft that will be reliable, cost-effective, energy-efficient, light in weight and easy to maintain.* This will be done through experiment and through analysis. The analytic thrust will capitalize upon modern fluid dynamic computational techniques executed by high-speed digital computers. The experimental work will be evenly balanced between substantiating the analytic predictions and establishing performance criteria for new and improved ice protection systems.

Icing occurs almost exclusively between ground level and 20,000 feet. In order to fly through an area having predicted icing conditions, an airplane must be certified to do so by the Federal Aviation Administration. Such certification is earned by having approved ice protection systems on board; and pilots flying into predicted icing conditions without certification do so illegally.

The growth of the versatile helicopter during the past 35 years has been meteoric and its use today is more widespread than that of any other type of aircraft. Civil applications include servicing off-shore oil rigs, search and rescue missions and emergency operations. Its military development includes tac-

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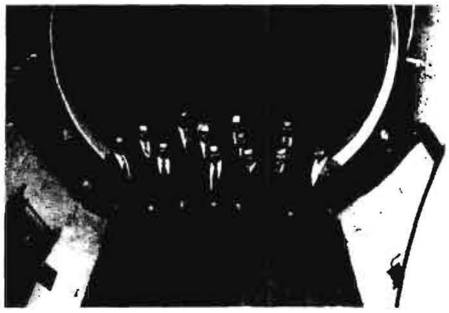

The AWT Project Office Team poses in the 20-foot diameter test section of the tunnel. Present are (from left): Bob Suhay, Howard Wine, Mike Makinen, Joe Gaby, Don Altmost, Ray Karabinus, Bernie Blaha, Bob Horansky, Charlie Giamati, Joe Yuska, Jim Winemiller and Bob Allen.

TEAM PROMOTION

Altitude Wind Tunnels

LEWIS AWARENESS

Lewis' Altitude Wind Tunnel, presently inoperative, is being promoted as a new icing research tunnel. Proposed rehabilitation completion date is 1987.

TEAM PROMOTION

TEAM PROMOTION

TEAM PROMOTION

(continued from page 3)

tical operations, logistical transport, rescue and evacuation and observation.

The helicopter is one of NATO's principal defensive weapons against enemy tanks. This is one important area that makes solving the icing problem of special significance to the military.

Helicopters rarely fly higher than 10,000 feet, so virtually all of its missions are carried out well within altitudes where icing occurs. Moreover, its limited fuel capacity restricts its range and its ability to take evasive action from an icing environment.

While all of the vital parts of a helicopter are subject to ice accretion, its rotor blades are most sensitive. Because they serve as both wings and propellers, and are in constant motion, traveling at speeds far greater than the craft is flying forward, they pick up more ice faster.

There are numerous solutions to the icing problem now under study by the Lewis team. They include existing schemes and others still on the drawing board. Included are:

The Icephobic: Aviation engineers have long sought an "icephobic," an agent that has an aversion to ice in much the same way that Teflon and silicones repel various substances.

"Without doubt," says Reinmann, "the ideal anti-icing agent is the 'icephobic,' one that could be permanently applied to critical surfaces, adding little weight, being low in cost and never needing replacement."

"The search for that miracle," continues Reinmann, "is a high-risk venture with a high pay-off potential and it is well up on the list of alternatives we are studying."

Electro-Thermal: One method that is currently in use by both planes and helicopters is electrically generated heat. In fact, the electro-thermal approach has been tested and in use for some time and is now felt to be the most developed of all ice protection ideas under consideration for helicopters.

In use, a network of wires is imbedded in the leading edges of the rotor blades. The system produces a sufficient level of heat to release ice. But to create enough heat to raise blade surface temperatures to 40°F requires the output of 25 watts of electricity per square inch of blade surface. To do that requires a generator equal to the weight of one passenger in a five-passenger helicopter, which represents a payload reduction of 20 percent. Lewis engineers are striving to advance this technology and make its use less penalizing in terms of on-board weight.

Pneumatic boots: Boots are in wide use but their effectiveness is limited. They don't always remove all the ice and they do not, of course, affect ice that has built up aft of the boots. Introduced 40 years ago, the boot has undergone a number of design improvements. But the FAA feels that boot technology can be advanced further. Thus, it is receiving careful attention here.

There are numerous other ice protection system possibilities such as mechanical vibrators, oscillators, microwaves and electromagnetic impact, all of which are included in the Lewis Icing Research program. But attacking icing is—like all problems involving natural phenomenon— a complex venture. It involves meteorology, aviation science and engineering, chemistry, metallurgy, physics and other fields of study.

The Lewis role is to spearhead this multidisciplined attack by coordinating the efforts of government agencies, private industries and universities to solve the new challenges in aircraft icing.

ENGINEERING SERVICES...

(Continued from page 6)
to complete, 80% were completed in 8 weeks or less. To further improve service, work continued toward implementing our new computer-aided design/computer-aided engineering (CAD/CAE) capability. Equipment will be installed in the 10x10 CAD area early in 1982. A technical group from EDD has been assigned responsibility for easing into extensive use of the new computer-supported design activities.

Test Rigs

Major progress was made in the design of a number of unique major test rigs. These included the Near Field Antenna Test Rig, the Transient Flow Combustion Rig, the High Pressure Turbine Corrosion Facility, the T700 Engine Test Facility and the Spinning Wave Burner.

The Altitude Wind Tunnel Project is in preliminary engineering activities for proposed modifications of the Altitude Wind Tunnel for aircraft icing research, propeller-powered propulsion research and V/STOL propulsion aeroelastic research. Major activities completed include a preliminary configuration and cost estimate, a Facilities Requirements Document and an evaluation of the existing AWT structures and systems to determine the feasibility of their rehabilitation. The study has shown the proposed usage of the existing AWT structures and systems as the nucleus of a new research facility is both technically and economically sound. A safe, versatile research tool with a long productive service life can be constructed around this nucleus. Phase B of the study effort is directed toward completion of a statement of work, advocacy development and completing contractual studies concerned with concepts that will enhance the tunnel capabilities and productivity.

Reliability and Quality Assurance

During 1981 the Reliability and Quality Assurance Office (R&QAO) developed and implemented a computerized management information system for the National Wind Program. A Joint Industry/NASA Performance Assurance Requirements Panel for the 30/20 GHz communications satellite project completed the criteria for the flight, ground and software systems and activities related to the project. This recommended series of requirements covers all the assurance disciplines in one document on quality, reliability, testing, safety, parts, materials and processes, and flight readiness. The panel's objective was to make maximum use of contractor's normal mode of operation to effect maximum cost effectiveness without compromising equipment reliability and quality. The Product Assurance Laboratory facility capabilities have been improved this year by the addition of a new scanning electron microscope. A mini-computer has been installed to help perform long-term analyses under carefully controlled conditions.

The R&QAO staff were justifiably proud of their involvement in the four successful Atlas/Centaur launches in 1981. The attention to quality and reliability by all participants in the program is certainly a major factor in its success record of 16 consecutive successful launches during the past 47 months. Members of the office also provided support and guidance in planning for future hardware procurement for the Atlas/Centaur and Shuttle/Centaur programs, especially in the electrical and electronic parts area.

Nearly completed Central Control Building.

Master Planning

1981, the second year for the Master Planning Office, was an exciting year of involvement. Major activities of the Office were focused on development and implementation of a system to integrate and synchronize planning for Lewis plant and support capabilities with research planning. The Lewis ADP and CofF plans were prepared using this approach. Facility and computing requirements were solicited throughout the Lab and were integrated and reviewed within each directorate for advocacy support and prioritization. The ADP Plan was then formulated by the Computer Services Division and others. For facility needs, Project Definition Teams were formed to fully define and document each facility's requirements. An integrated CofF Plan based on all this information was then formulated by the Master Planning Office together with the Facilities Engineering Division and others, and presented to the Lewis Facilities Review Board for final consideration. This planning process has worked very well in its first year and has produced the best long-range plans for ADP and CofF that Lewis has produced to date.

In summary, 1981 was a busy and productive year. We are proud of our accomplishments and look forward with enthusiasm to the challenges and opportunities that lie ahead.

TECHNICAL SERVICES

The year 1981 was again one of accomplishment and change for the Center in general and Technical Services in particular. Of course, the major event for the Directorate was the retirement of Jim Connors and the reassignment of this writer to pick up the reigns. In addition, as part of the required Center staffing reduction, the directorate complement was reduced approximately 5%. Fortunately, this could be accomplished without significantly reducing the capability of the Directorate to serve research. During the year, many other events took place covering both aspects of the directorate charter: research program support and institutional operations.

Noteworthy are the following:

Technician monitors 30-inch-diameter optical comparator.

Program Support

During the year, numerous major accomplishments were achieved of a programmatic nature. These included fabrication, instrumentation, installation and operation support. Notable among them are the following:

- Completion of the Uniform Engine test program in PSL-3.
- Installation of the modified MOD-O wind machine at Plum Brook Station.
- Bringing the 3000-hp helicopter transmission facility into operation.
- Completion of the mechanical aspect of the installation of the Interim Near Field Antenna test facility in the Altitude Wind Tunnel.
- Completion of the installation and checkout of the T-700 power absorption system.
- Moving of the hybrid simulation lab to the Research Analysis Center.
- Bringing of a Laser Doppler Velocimeter (LDV) system into an operational status in the 8 x 6 wind tunnel.

Warner L. Stewart
Director

Major events occuring in the area of facility and operational support to research included:

- Quickly bringing the PSL-4 back into operation after an engine failure.
- Rapid recovery from a major fire in the PSL Equipment Building.
- Excellent response from in-house personnel in bringing the No. 3 Combustion Air Compressor back into service.
- Completion of the repair of the 8 x 6 No. 2 drive motor, allowing this facility to be brought back into operation.

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NASA
National Aeronautics and Space Administration
Lewis Research Center
Volume 20 Issue 17 August 26, 1983
LewisNews

AWT renaissance to provide NASA with dual facility

Lewis' Altitude Wind Tunnel, its powerful drive fan excised long ago and its cavernous steel windpipe put to work in a variety of non-aerodynamic tasks since, is scheduled to undergo a renaissance that will result in an aeronautical research facility unique in the free world.

Lewis is developing a plan to spend an estimated $112 million over the next several years to convert the veteran tunnel - retired from active aeronautical research service more than 25 years ago - into both a modern large scale propulsion system test section and the first large scale, altitude-simulating rotorcraft icing facility.

"New aircraft propulsion systems, like the Advanced Turboprop (ATP), vectored-thrust fighters and V-STOL aircraft, will be increasingly affected by the air flow around the airframe structure," explains Bob Allen, manager of the rehabilitation project. "With the planned AWT facility, we will be able to study that interaction."

Furthermore, says Allen, no rotorcraft flying today is certified to operate in weather conditions that may produce icing. That means, for example, that the military - which depends on helicopters for many vital missions - has to fly into unknown and dangerous conditions in the winter.

The AWT rehab calls for a 20-foot diameter Advanced Propulsion Systems Test Section to be built in place of the original AWT test section. The new section will be capable of testing future medium to full-scale versions of the ATP and full and subscale models of V-STOL aircraft, vectored thrust fighters and futuristic small-scale rotorcraft that will have all-weather capability.

The special design of the test section will allow researchers to study deflected thrust and engine down wash phenomena associated with coming generations of V-STOL and vectored thrust aircraft designs. To simulate engine propulsion, researchers at the facility will make extensive use of Lewis' central high pressure air system.

This section of the tunnel will be capable of simulating actual flight test conditions with air speeds up to Mach 1, bone-chilling temperatures of minus 20 degrees Fahrenheit and altitude simulations of up to 55,000 feet.

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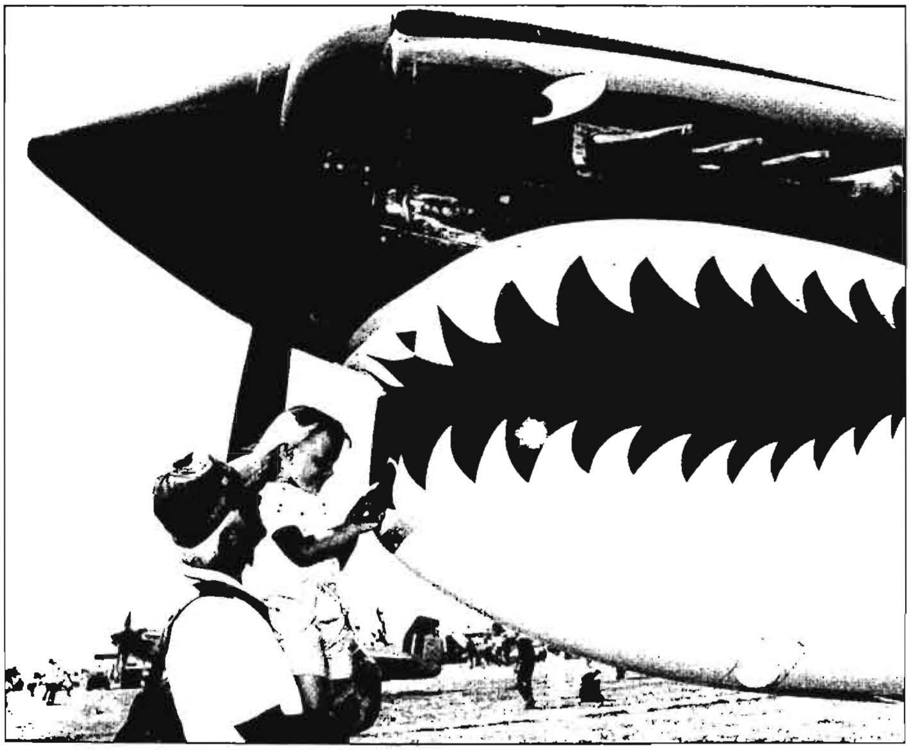

YOUNG LADY TAMES JAWS? - Lewis Photographer Don Huebler, on assignment at the recent EAA Fly-In Convention and Airshow at Oshkosh, Wisc., caught this young aviation enthusiast getting a close up look at a World War II fighter. Turn to page 5 for highlights of the airshow, which featured NASA's aviation research.

Lewis aids in Shuttle insulation probe

Beginning in September, Lewis' two supersonic wind tunnels will play an important role in determining why portions of Challenger's new blanket insulation material were damaged during its first use aboard the Shuttle.

During the five-week Lewis investigation, a one-thirtieth scale model of the shuttle orbiter - its bare metal skin covered with hundreds of pressure sensors - will undergo simulated flights in both the 10X10 and the 8X6 tunnels.

During the tests, NASA and Rockwell engineers will study closely the aerodynamic environment that surrounds Challenger's Orbital Maneuvering System (OMS) pods during simulated ascent and reentry. Those pods, which contain fuel for two small engines that provide orbital maneuvering and retro thrust, are covered with blankets of insulation material designed to replace the individually fitted silica tiles that previously covered OMS pods like a finely crafted mosaic.

Known as Advanced Flexible Reusable Surface Insulation (AFRSI) blankets, the insulation material was found to be badly abraded following STS-6, the first flight of both the AFRSI and Challenger.

According to James H. Diedrich, who along with Robert R. Smalley and Harold E. Zager is managing the investigation, the excessive wear could have been caused by acoustic pressures on lift off or by aerodynamic forces during reentry."

"There might just be a shockwave laying in that area during the flight that could have generated pressure waves strong enough to abrade the AFRSI blankets," Diedrich said.

Under the joint investigation, Lewis will provide the facilities for the tests and Rockwell will supply a major portion of the instrumentation and test crew. The Lewis portion completes a program begun recently in Ames Research Center's 11X11 wind tunnel.

Continued on page 3

NASA displays featured at Cleveland airshow

The Cleveland National Air Show, a local Labor Day tradition dating back more than half a century, will feature most of NASA's recent Oshkosh Airshow display and some Cleveland exclusives, Sept. 3, 4 and 5 at Burke Lakefront Airport.

Joining such Airshow crowd pleasers as the Air Force Thunderbirds, the Army's Golden Knights parachute team and the Eagles aerobatic team will be a static display of NASA's AD-1, an oblique wing jet aircraft that can pivot its wing to aid fuel efficiency.

NASA's displays, to be contained in several large tents, are being coordinated by a veteran group of airshow planners. Headed by Phil Stone of the External Affairs Office, the group includes Judy Olsen, Norm Prahst, Phil Meng, Joe Wikete, Charles Slauter and Howard Wine. The team was responsible for NASA's involvement in the giant Oshkosh Airshow earlier this month.

The AD-1, sent to Cleveland by Ames Research Center, will be joined by other NASA aircraft, including

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NASA
National Aeronautics and Space Administration
Lewis Research Center
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LewisNews

Season's Greetings

Bill Richardson photo

Lewis day care center clears first hurdle

Dozens of Lewis employees – most of them parents of pre-school children – attended a series of information meetings recently to hear the results of a day care center feasibility study.

Will Lewis have a day care center? The bottom line, as stated by Hal Wharton, operations manager for the Administration and Computer Services Directorate, is that Lewis will support the formation of a non-profit corporation that would operate a proposed day care facility.

"The administration is ready and willing to do whatever it legally can to foster the creation of a day care facility," Wharton said. "That means the Center is willing to spend about $30,000 to bring the Mitchell House (a private home converted by Lewis into a meeting facility) up to code standards and make it available."

Wharton added that the Center's legal arm would provide the required legal services needed to get a non-profit corporation formed.

An organizational meeting involving interested employees to consider the formation of a non-profit corporation was scheduled for Dec. 15.

Speculating on possible routes parents who would operate the corporation can take, Wharton said they can either decide to run the facility themselves or hire a contractor to handle the daily operation of the facility.

The decision to support the formation of a day care center was made after a labor and management panel informed Director Andy Stofan that there was a need for such a facility and recommended the establishment of a program here.

A similar program begun several years ago at Goddard Space Flight Center has been so successful that many working parents are on a day care waiting list, according to Wharton.

"We have determined that a day care center set up in the Mitchell House can accommodate 25 children," Wharton explained. "Based upon the turnout at the informational meetings, we may face a situation similar to Goddard's."

Wharton said day care at Lewis would probably not begin until late in 1984 at the earliest. □

New test facility investigates large space antennas

Research on large antennas for the more "talkative" communications satellites envisioned for the 1990's and beyond is now underway in a unique new facility here.

Lewis' Near-field Antenna Test Facility is involved in the precise measurement of the powerful electric fields very near the antenna, the so-called near-field. From these measurements scientists can determine the pattern and characteristics of the antenna beam as it would be produced from a satellite orbiting 22,300 miles above the earth (the so-called far-field).

"Our near-field testing facility is probably unique in terms of combination of size and high frequency capability," said Dr. Charles A. Raquet, head of Lewis' Antenna Technology Section. "We will be able to test antennas up to 20 feet in diameter at frequencies up to 60 gigahertz.

"For example, we are testing now a proof-of-concept multibeam antenna of the type we expect will be a key to substantially increasing the traffic-carrying capability of the next generation of communications satellites."

Large antenna testing is part of a broad Lewis effort to design, build, launch and conduct experiments with an advanced communications satellite operating in the higher 30/20 gigahertz range before 1990. Such a satellite will require a larger, more complex antenna than present satellites carry. But conventional far-field testing for larger antennas requires a separation of many miles between the antenna under test and a transmitting probe, making measurements of the beam very difficult if not impossible.

In the near-field environment just a few feet away from the surface of the antenna, however, precise measurements can be made of the beam pattern and used to calculate a very accurate image of the antenna's far-field pattern.

Thus near-field testing can be an important first step toward establishing or confirming design and

Continued on page 4

Making satellites more "talkative"

Continued from page 1

performance criteria for more complex antennas before having to commit to final hardware and actual flight testing.

The antennas carried by present communications satellites have wide beam widths covering, for example, the whole of the United States with two or three single beams.

"The technology Lewis is working on is to design antennas that will have many extremely narrow, non-interfering beams," explains Raquet. "This is crucial to greatly increasing the nation's and world's traffic-carrying capability per satellite because the more beams there are, the more channels of information that can be transmitted simultaneously."

Going to higher frequency bands and spacing each satellite closer together in orbit will not be sufficient to offset the coming traffic jam in space communications, Raquet maintains.

"All these reasons underly the rationale for our moving ahead, together with the communications industry, to develop narrow-beam technology or multiple-beam technology as it is sometimes called," says Raquet.

The narrow beam concept is analogous to a high power searchlight forming a highly directed and concentrated beam of light. And, like a searchlight, an antenna beam can be aimed in one fixed direction or moved (scanned) from one location to another.

Physically, the new near-field antenna facility is located in what was once part of the old Altitude Wind Tunnel. The 40-foot-tall walls of the chamber enclose the test antenna and the facility's key instrument, a scanner that makes numerous precise measurements of the antenna beam on a flat surface very near the antenna's surface. The walls of the chamber are covered by thousands of small foam pyramids that absorb stray microwave reflections like the black paint used to reduce light reflections inside a camera or darkroom.

Computers process the near-field data measurements recorded in the chamber and calculate the detailed beam pattern as it will appear far from the antenna.

In operation, the small probe or scanner makes measurements of the antenna field produced just inches in front of the antenna as it moves up and down on a 22-foot tower mounted on a carriage that moves across the chamber on rails. The system permits scanning and acquiring data over a surface area 22 feet square. Laser beams are used to check precise alignments of the two moving systems.

Motion of the probe is controlled by drive motors operated by a computer. Probe position is precisely measured by the same laser beams that check alignments of the two systems.

"By providing this very flat, very rigid base, we can move the probe to within a few thousandths of an inch over the entire 22x22-foot scan area. It is this precision that will permit us to make measurements of antennas at frequencies up to 60 gigahertz." □

Better Service

continued from page 2

productivity alterations. When the RFP task group was constituted earlier this year, it was a larger operation that included fellow contract specialists Kathy Needham and George Virosteck, along with several co-op students.

"As we developed more efficient processes and procedures, we were able to trim down the size of the staff," explained Williams, who added, "the third member of the staff is co-op student Ted Ley."

Additional productivity improvements are being studied for implementation and could benefit the entire Procurement Division by improving service to Center technical staff and minimizing red tape for all. □

More engines for mighty Atlas

Lewis has definitized a contract with Rockwell International valued at $34.4 million for four Atlas launch vehicle engine systems. The fixed-price incentive contract is for fabrication, assembly, test and delivery of the four MA-5 engine systems. The Atlas, the first operational U.S. ICBM built in the late 1950s, has served a wide variety of peaceful missions, including the Mercury manned space program and as a booster for Lewis' Centaur upperstage.

Holt heads commercial accounts

Juanita R. Holt has been named head of the Commercial Accounts Section at Lewis.

Promoted from voucher examiner in the section, Holt now manages a staff of nine examiners and collection agents responsible for handling the Center's commercial payouts estimated at over $1 million daily. The section also collects all payments due Lewis.

Holt is a 22-year NASA employee and a member of the Center's Women's Advisory Group. She has taught classes in operating office machines for the Center's high school summer youth employees the past seven years.

The new Lewis supervisor is a 10-year member of Berea's Civil Service Commission, currently serving a second term as chairman. □

A LEWIS CHRISTMAS - Santa (Greg Kelbach) greets the grand-children of Lloyd Trunk, a member of Lewis' Photographic Branch, at last Saturday's Christmas Show. In addition to seeing a live performance of "A Sesame Street Christmas" and visiting with St. Nick, the children were treated to refreshments, gifts and visits with their favorite cartoon characters.
Bill Richardson photo

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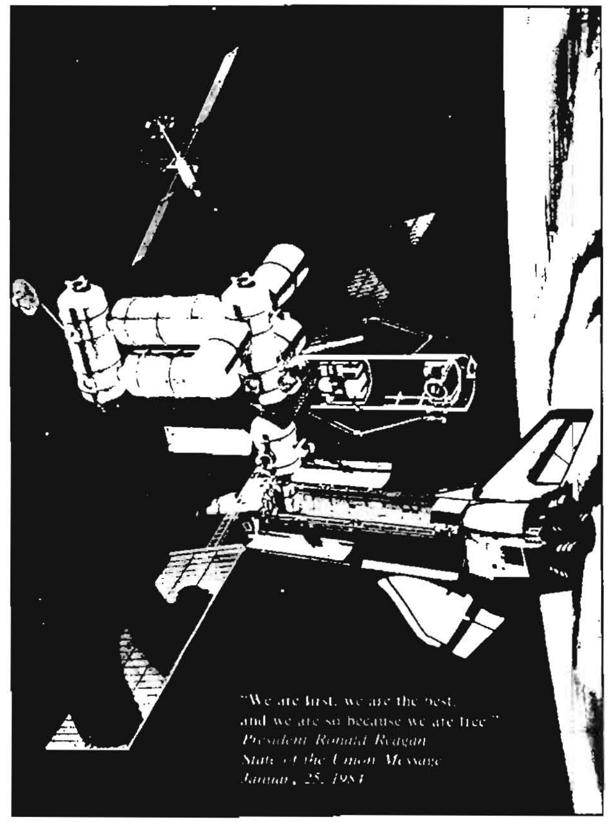
NASA
National Aeronautics and Space Administration
Lewis Research Center
Volume 21 Issue 3 February 10, 1984
LewisNews

Space station gets presidential nod



A permanent manned space station, designed to play a strong role in future U.S. space ventures, got an official go-ahead from President Ronald Reagan in his recent State of the Union message before a joint session of Congress and millions of television viewers.

During the speech Reagan called upon NASA to begin the estimated $8 billion project that will place a modularized space station manned by six to eight crewmen into low earth orbit by the early 1990's.

On the following morning, NASA Administrator James M. Beggs briefed all NASA personnel on aspects of the program via a satellite TV link.

Beggs explained the first step in the program would be Congressional approval of the FY '85 $150 million program startup request. NASA will then issue requests for proposals to a host of aerospace firms by late spring or early summer. These would provide for early design and cost estimation work with purchase of actual hardware following within several years.

Beggs projected the space station as a place in which NASA and private industry could conduct materials research and satellite repair in a zero-G environment.

Although the military has shown little early interest in NASA's space station proposals, he explained, they could be a participant later in the program. The European Space Agency, which built the Spacelab module flown recently aboard STS-9, also has expressed interest in constructing one of the station's several pressurized modules.

NASA officials say the basic space station will require five to eight Shuttle sorties to assemble, a relatively simple task for the nation's fleet of Shuttle orbiters.

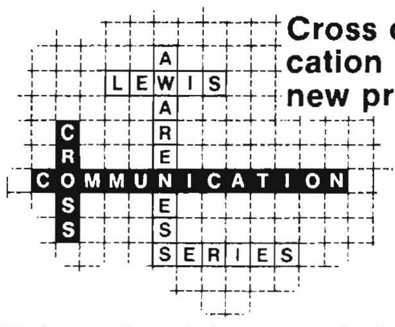
Planners of the station say it eventually might act as a launching point for any future moon exploration programs and manned flights to Mars -- all potential NASA missions in the first decades of the next century.

Lewis' role in the station program would be in the areas of power systems and secondary propulsion systems for station keeping and orbital transfer vehicles operated by station crewmembers.

Large arrays of Lewis-developed solar cells could generate the 75 kilowatts of power the station is expected to require initially. Small, highly efficient, low-thrust, reusable propulsion systems are already under study here.

The robot-like Orbital Transfer Vehicle would taxi satellites and other payloads to higher orbits or retrieve satellites for repairs at the station or back on earth. □

Cross communication is goal of new program



The Awareness Communications Activity Group will begin a "Cross Communication Series" Feb. 15 designed to exchange views between senior management and supervisors in an informal setting.

The program, set to run until summer, will be formulated around small groups of supervisors meeting informally with Director Andy Stofan at the Guerin House. One or two such meetings a month is the present schedule to accommodate all supervisors who wish to take part.

Invitations to the meetings will be sent to supervisors selected randomly across directorate lines. This concept gives the program its name.

"I really would like each supervisor to share ideas and discuss issues with me," said Stofan, "because their input vitally affects the productivity and strength of the Center."

"Some of the subjects we want to get into involve strategic planning, the budget, quality circles and productivity," said Awareness Coordinator Joyce Bergstrom.

Bergstrom said that Chuck Slauter, chief of the Fabrication Branch and a member of the Awareness Communications Activity Group, developed the name to describe the process envisioned for the get-togethers. □

Rudey heads AWT rehabilitation project

Rudey

Richard A. Rudey has been appointed Special Assistant to the Director for the Altitude Wind Tunnel (AWT) project at NASA Lewis Research Center. Previously he served as Chief of the Aerothermodynamics and Fuels Division.

Reporting directly to Lewis Director Andrew J. Stofan in the new position, Rudey will be responsible for directing all activities associated with modifying and otherwise converting the Center's Altitude Wind Tunnel into a unique national capability for research and development on future aircraft propulsion systems, as well as icing research on advanced aircraft and rotorcraft.

Dual-purpose rehabilitation of the long-dormant facility is expected to cost in excess of $100 million, with major construction currently planned to begin in early 1986, pending funding approval, and completion anticipated in 1990. The reconstituted AWT will be capable of simulating altitude flight conditions with air speeds up to Mach 1, temperatures down to minus 20° F and pressures from sea level to 55,000 feet.

Since coming to Lewis from industry in 1962, Rudey has held a variety of positions including his most recent one where he managed and directed fundamental research in combustion, heat transfer and chemical kinetics and applied research on combustors, turbines and fuel systems for advanced technology aircraft engines. Prior to that he was Chief of the Airbreathing Engine Division and, before that, Chief of the Power Generation and Storage Division. In the latter position, he managed both NASA and Department of Energy programs on advanced ground-based power generation and storage systems.

Rudey has made major contributions to several research and technology programs at Lewis, including the Global Air Sampling Program (GASP), Experimental Clean Combustor Program, Advanced Cogeneration Technology Program and Broad Specification Fuels Program.

During a one-year tour of duty at NASA Headquarters in 1979, he was Manager for Propulsion in the Office of Aeronautics and Space

Continued on page 4

Lewis awards ACTS contract to RCA Group

Continued from Page 1

satellite communications service in the United States, there must be more efficient use of the spectrum currently in use, plus employment of the next higher frequency band, the Ka-band (30/20 GHz).

ACTS is designed to explore techniques of frequency reuse to be applied to present frequencies and overcome the technical problems associated with utilization of the 30/20 GHz band.

Domestic satellites presently operate with a single, continuous radio signal focused over the contiguous United States. The ACTS system will provide similar coverage via many spot beams, both fixed and scanning.

When operational, ACTS technologies will allow two basic types of service: trunking and customer premises service (CPS).

Trunking service would accommodate the high-volume user in metropolitan areas. A typical operational system would serve 10 to 20 trunking earth-station areas, each with a dedicated fixed spot beam.

CPS users, on the other hand, employing small and inexpensive earth stations located at their plant or office, would be served by either fixed beams or scanning spot beams.

A unique capability offered by these advanced operational systems derived from ACTS technologies will be satellite switching. In conventional satellite systems, messages must be switched to their destination by means of ground-based distribution networks. With an on-board computer, message switching in the ACTS system takes place on the satellite itself, greatly simplifying ground-system design. With this approach, all terminals in the system will be interconnected through on board routing and switching systems.

All satellite activity, including scheduling and message switching, will be controlled by a master control station. The MCS will be responsible for both satellite control and overall network control.

Thus, the 30/20 GHz operational system will be comprised of four major elements: (1) the satellite; (2) trunking earth stations; (3) customer premises terminals; and (4) the master control station.

NASA has been in the forefront of experimental space communications since the early 1960s when such projects as ECHO, RELAY, TELSTAR and SYNCOM II established the feasibility of communications via a satellite in geosynchronous orbit.

In 1978, the Lewis Center was assigned as the NASA lead center responsible for further advancing satellite communications technology. At that time it began laboratory studies development and testing of component technologies which will make up the ACTS system. In the new ACTS program, these laboratory-proven technologies will be tested together within a single satellite system and evaluated in an earth/space environment.

One of the primary goals of ACTS is to make available to public and private sectors alike—corporations, universities and government agencies—the capabilities of the ACTS spacecraft and ground systems for experimentation.

Universities, companies and other research organizations that meet specified requirements for space communications research will participate in such experiments during the flight phase of the program.

Over 30 inquiries have been received regarding experimental use of the new satellite.

Lewis has project management responsibilities for the ACTS program.

The Office of Space Science and Applications, NASA Headquarters, Washington, D.C. is responsible for overall program management. □

Press conference for Cleveland media announcing RCA Group contract was conducted by Samuel Keller, left, NASA Headquarters, Deputy Associate Administrator, Office of Space Science & Applications; Charles Schmidt, vice president and general manager, RCA Astro Electronics; and Director Andy Stofan.

Lewis photo by Howard Slater

Centaur lifted from 20-year berth in wind tunnel

A Centaur Rocket that has lain dormant for 20 years at the bottom of a four-story high chamber was hoisted out in a critically delicate operation at Lewis Aug. 7.

The 32-foot long, 10-foot wide launch vehicle had to be removed to make way for a planned restoration and upgrading of the Altitude Wind Tunnel. This large facility is scheduled to be refurbished to test jet engines at high altitude Mach ranges and for all-weather flight capability, including icing and heavy rain.

Lewis officials decided to remove the launch vehicle intact so that it can be put on display at a later date.

Flown here from Kennedy Space Center, Florida, in 1964, the Centaur vehicle was used as a "guinea pig" to evaluate performance of its various systems and components.

A huge crane with a 90-ton lifting capacity and a 125-foot boom hooked onto the 3,000-lb. Centaur and lifted it upward and out of its bed. After Centaur cleared the chamber, a second crane was used to rotate it to a horizontal position for placement on a pallet.

A 10-ton lid over the chamber had to be removed first.

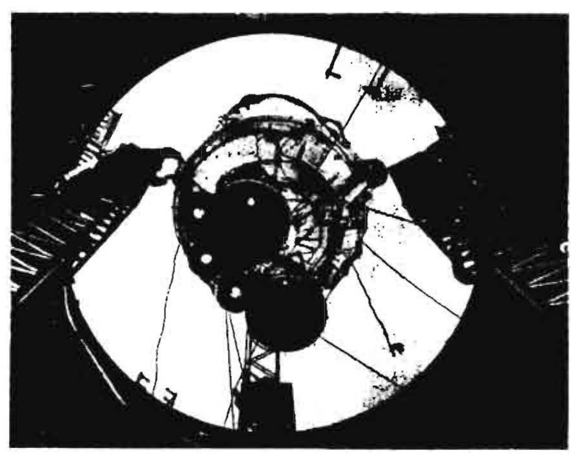
A wind factor of 20 miles an hour or more could have caused the Centaur to sway, making the crane precariously unbalanced. But winds were light and the entire operation took about three hours.

Managed by Lewis, the Centaur vehicle is used as a space booster for launching heavy payloads.

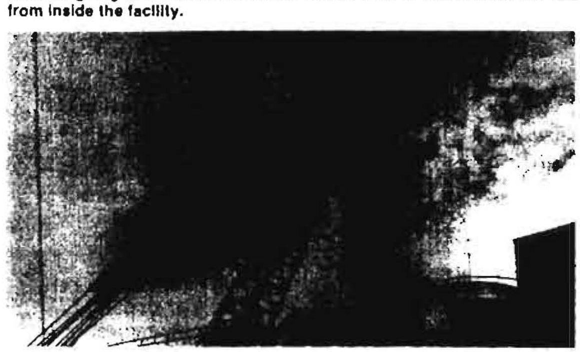
Coupled with already proven Atlas first stages, Centaur vehicles sent seven Surveyor spacecraft to probe the surface of the Moon between May 30, 1966 and Jan. 7, 1968, furnishing valuable data for the first manned landing on the Moon in July, 1969.

Centaur today is a mature, high-energy, still-viable upper stage with an overall operational reliability record of 96%.

As Centaur begins its third decade, it is being modified to fit into the Space Shuttle as a high-energy upper stage and will launch the Galileo spacecraft for further study of Jupiter and its moons as well as send the International Solar Polar spacecraft over the poles of the Sun, both launch events scheduled to take place in 1986.



Centaur going into the Altitude Wind Tunnel back in 1964 looked like this from inside the facility.



Centaur coming out of the Altitude Wind Tunnel in 1984 was a delicate lifting job for crane operators and looked like this from ground level.

Lewis photo by Don Huebler.

SOHIO gets NASA energy know-how

Continued from Page 1

"Successful technology transfer provides substantial benefits to the nation's economy and people."

The original idea for the energy storage system was conceived and the technology developed by a team under Dr. Lawrence H. Thaller, now chief of the Electrochemistry Branch, Space Power Technology Division, at Lewis.

Sohio's battery research is being conducted at the company's Research and Development Center in Warrensville Heights, Ohio. □

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SPACE FLIGHT SYSTEMS

by Lawrence J. Ross, Director

The Space Flight Systems Directorate provides the Lewis focus for the developmental and operational activities associated with the Center's space program assignments. Presently, this Directorate is responsible for development of the Advanced Communications Technology Satellite and conduct of its experimental program; development of the Centaur G and G-Prime upper stage systems for Shuttle and DOD missions; and development and operation of the Atlas/Centaur launch vehicle system in support of assigned missions.

In addition, the Space Flight Systems Directorate manages research and advanced development of communications satellite technology. The Directorate is also responsible for conducting the Center's Reliability and Quality Assurance program.

The directorate has undergone the least amount of reorganization among the research directorates. The mission of the directorate remains essentially unchanged in character, however, a significant change occurred in specific responsibility following the approval to proceed with the ACTS flight program.

The NASA headquarters direction to proceed followed by the contract signing with RCA for the flight system development has necessitated a change in organization of the Space Communications Division.

The ACTS Project Office will be separated from the Space Communications Division and will report as a separate organizational element to the Directorate Office. The ACTS Project Branch will move in its entirety to the new organization.

Dr. Richard T. Gedney will be the Acting ACTS Project Manager with William H. Hawersaat as deputy. The project office team is expected to add 13 to 15 people to a total of 51 during the next few months.

The balance of the current Space Communication Division without the project branch will continue to provide overall direction and management of the Lewis research and technology development programs in satellite communications.

Division activities include analysis of advanced satellite communications systems and markets, development of component and subsystem technologies in solid state, antennas and microwave tubes, proof-of-concept model development of selected technologies, in-house test and evaluation of transponder systems and the conduct of major flight experiments in concert with communications satellite system suppliers.

The Division also participates in, and provides technical consultation to, international meetings and conferences on the use of frequency spectrum and geostationary orbital arc.

The remaining organization within the directorate is unchanged with the Atlas/Centaur Project Office responsible for the successful delivery to specified orbit of all spacecraft launched by the Atlas/Centaur Space Transportation System. The office is also responsible for assuring that hardware/systems of the Atlas H vehicle, procured for delivery to the DOD, are flightworthy.

The Shuttle/Centaur Project Office is responsible for all aspects of the Centaur as a high energy upper stage for the Space Shutle. Activities include: definition of requirements and objectives; directing the design, development, production and operation of the Centaur upper stage; managing the interfaces between the Centaur and the orbiter and users, launch site facilities, various spacecraft, and tracking and data networks; and managing all budgetary and schedular aspects of the project.

The Reliability and Quality Assurance Office is responsible for the planning, direction, execution, and evaluation of all reliability and quality assurance and control tasks and operations associated with Center managed and directed R&D and operational programs. This involves any and all facets of hardware development - design, feasibility testing, procurement, fabrication, assembly, confidence testing, item or system acceptance, checkout, vehicle integration and flight readiness.

The Space Transportation Engineering Division is responsible for vehicle engineering activities including airborne and ground systems design, design analysis, development, fabrication, test and operations on behalf of the Atlas Centaur and Shuttle Centaur Project Offices. It provides technical direction and management of contractor and in-house efforts for the electronics, electrical, mechanical, ground equipment and structural elements of the Atlas Centaur and Shuttle Centaur launch vehicle systems and ensures launch vehicle flightworthiness and maintains and updates all supporting ground equipment and facilities.

With the advent of an increasing involvement of the Center in Space Station, the R&QA Office will expand to include support to the Space Station Systems Directorate as required. □

SPACE FLIGHT SYSTEMS DIRECTORATE — L. J. Ross 6000

- **ACTS PROJECT OFFICE** — R. T. Gedney, Act. 6100
- **SPACE COMMUNICATIONS DIVISION** — J. N. Sivo 6200
- **SPACE TRANSPORTATION ENGINEERING DIVISION** — S. V. Szabo, Jr. 6300
- **SHUTTLE/CENTAUR PROJECT OFFICE** — W. H. Robbins 6400
- **ATLAS/CENTAUR PROJECT OFFICE** — J. W. Gibb 6500
- **RELIABILITY AND QUALITY ASSURANCE OFFICE** — R. G. Rohal 6600

ENGINEERING AND TECHNICAL SERVICES

by Warner L. Stewart, Director

Because the support functions of this Directorate have not been greatly impacted by changes in the Center's programs, our charter and organization are basically unchanged. The charter continues to be that of supporting the Center in the areas of facility and experimental research activities.

In the facility support area, the Facilities Engineering, and the Facilities Operations and Maintenance Divisions will continue to fulfill their responsibilities related to the spectrum of facility activities. This spectrum includes planning, design, construction, operation and maintenance, and covers both research and institutional activities.

In the experimental research support area, the Engineering Design, Fabrication Support, and the Test Installations Divisions will continue their activities covering their spectrum of support. This spectrum includes design, fabrication, instrumentation, build-up and test support.

The AWT Engineering Office (formerly the Altitude Wind Tunnel Project Office) will continue to be located organizationally in the Directorate while providing the design support to the AWT Project Office located in the Aeronautics Directorate. This arrangement will exist until the AWT is an approved CoF project.

Since the relative emphasis between space and aeronautical activity has been changed, a corresponding change in emphasis will take place within the Directorate.

Facility consolidations will be made to reflect the reduction in experimental aero-related activities with a corresponding increase in space communication, space power, and shuttle payload support activities.

Some skill rebalancing will also be required to reflect the changing Center needs. □

ENGINEERING AND TECHNICAL SERVICES DIRECTORATE — W. L. Stewart 7000

- **FACILITIES ENGINEERING DIVISION** — D. J. Keliher 7600
- **ALTITUDE WIND TUNNEL ENGINEERING OFFICE** — R. L. Allen 7010
- **TEST INSTALLATIONS DIVISION** — R. G. Hoffman 7200
- **FACILITIES OPERATIONS AND MAINTENANCE DIVISION** — A. B. Szuhai 7300
- **FABRICATION SUPPORT DIVISION** — J. I. Bergstrom 7400
- **ENGINEERING DESIGN DIVISION** — J. A. Yuska 7500

Administration and Computer Services

Continued from Page 3

training course will be developed on exhibits and displays and a library and photographic educational seminar will be held. The workflow for processing technical research reports will be critiqued and improved. Copy machine use will be surveyed to determine the needs of each building. Lewis needs will be input to system studies of a NASA integrated library system.

Plum Brook Station facilities will be maintained and their continued use by other interested parties encouraged. The monitoring and maintenance costs for the Plum Brook Reactor Facility will be reduced.

Exchange facilities will be maintained, upgraded and expanded. The Main Cafeteria kitchen is being renovated and the small cafeteria in the Engine Research Building will be remodeled. □

AERONAUTICS

by Neal T. Saunders, Director

New, restructured, focused are all words that have been used to describe the Lewis aeropropulsion program for Fiscal year (FY) 1985 and the future. Although these adjectives are all relevant, they do not completely describe the magnitude and significance of the changes that will be evident as we move forward to implement a more vigorous, responsive and effective program in support of the overall objective to help ensure continued U.S. preeminence in aeropropulsion technology.

This new program will consolidate and strengthen the key disciplinary "building blocks" for future advances in aeropropulsion, provide a focus for discipline, component and system research and strengthen the roles and responsibilities for our major facilities and experiments. In addition, increased emphasis will be placed on program planning and mission analysis as a catalyst for the generation of new ideas and for the identification of promising program directions for the future.

The organizational structure of the Aeronautics Directorate has been changed to align with the new program structure. Extensive changes to the organizational structure were required to effectively implement the FY 1985 program and to position the directorate for future growth in new program areas. The resulting organizational structure consists of three offices and three divisions.

The Advanced Planning and Analysis Office will be responsible for assessing the performance potential of advanced and unconventional propulsion/aircraft systems. An additional responsibility will be identifying and analyzing new propulsion concepts and their integration which could enable new vehicle systems. This office will be key to the development of the new ideas, concepts, and systems which will provide the basis for future aeropropulsion program directions.

The Instrumentation and Controls Technology Office combines and focuses key elements of ongoing programs. Responsibilities of this office include both the development and applications of advanced instrumentation. Advanced sensor technology and the application of control theory will be emphasized as these technologies will enable the real time intelligence that "smart" engines of the future require to optimize engine performance and life. Although this office is located in the Aeronautics Directorate, it will be responsible for serving the needs of the entire center.

The Altitude Wind Tunnel (AWT) Project Office is responsible for program advocacy, an extensive in-house modeling program, design, and construction of this facility. The modeling activity involves both physical models and simulations.

The physical models (1/10 scale) include the drive system, high speed test section, icing systems, acoustic systems, dynamics and controls, and a model of the complete loop.

Computer simulations will be developed based on the results of the physical model tests and will be used to evaluate the dynamics and controls of the entire facility including the research test hardware.

Go-ahead for this key aeropropulsion facility is anticipated in FY 1986. The facility is expected to cost approximately $150M and to be on-line by the early 1990's.

AWT is essential for the development of future aeropropulsion systems and will provide a unique capability for NASA and the nation.

The Internal Fluid Mechanics (IFM) Division consolidates all the IFM related activities at Lewis. The responsibilities of this division include the development of computational methods, modeling, code development/verification and computational applications. Key research activities in the area of computational methods include numerics, mesh construction, and algorithm development.

The modeling area will be supported by fundamental research in the areas of fluid mechanics, combusion, kinetics, and heat transfer. Computational applications will be developed for all propulsion subsystems. Close ties will be established and maintained with all Lewis organizational elements that are potential users of this technology.

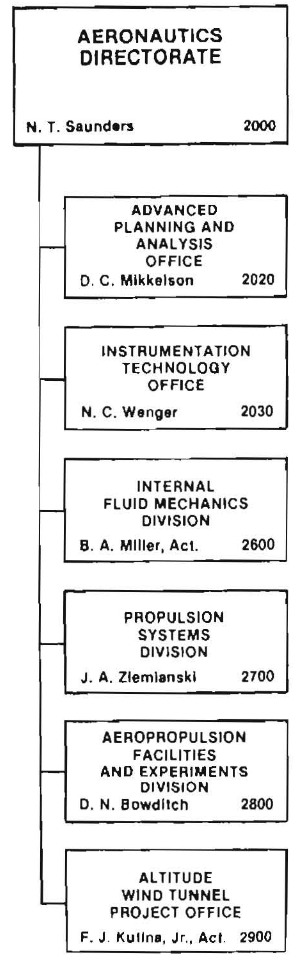
The Propulsion Systems Division is responsible for the focused interdisciplinary thrusts, propulsion focused thrusts, and vehicle focused propulsion technology. Included in this division is the management responsibility for the Advanced Turboprop Project (ATP) which is the highest priority technology project in the directorate.

Other vehicles focused propulsion technology areas include advanced rotorcraft, powered lift, supersonic aircraft, and hypersonic aircraft. In addition, the small engine technology from aeronautics and energy programs has been consolidated in this division. This brings together the small gas turbine technology (SET), the intermittent combustion engine research, and the automotive gas turbine (AGT) and diesel projects.

Component technology will be addressed as an integral part of propulsion focused or vehicle focused activities. Icing research will also be managed by this division and in addition to conducting the ongoing icing research program, substantial support will be provided to the AWT modeling effort.

The typical role for research facility operations has been expanded in the new organizational structure. The Aeropropulsion Facilities and Experiments Division will be responsible for both the management of the major Lewis aeropropulsion facilities and for the management of the experiments conducted in these facilities.

In the area of experiments management, the facility managers will be responsible for assembling a team to accomplish all aspects of the test program. □



OFFICE OF THE COMPTROLLER

by Paul G. Anderson, Comptroller

The Comptroller's Office is unchanged by the reorganization except for the minor organizational and staffing adjustments necessary to properly support the increased budget and procurement activity resulting from the approval and the Advanced Communications Technology Satellite and our new role in the Space Station. The responsibility of the Comptroller's Office remains the management of the entire financial process of the Center.

The first step in the financial process is deciding which programs and projects the Center wants to pursue and understanding what resources—money, facilities and manpower—are needed to accomplish them. This is done at Lewis through the strategic planning process which is managed by the Program Coordination Office.

For those programs that are ultimately approved and for the ongoing operation of the Center, budget requests must be submitted to the cognizant headquarters office. The Resources Analysis and Management Office and, in the case of Facilities Construction, the Program Coordination Office, manage this process. This includes receiving the headquarters budget calls, interpreting and distributing them internally, collecting the Center requirements, assuring a thorough Center review, and making the final submission.

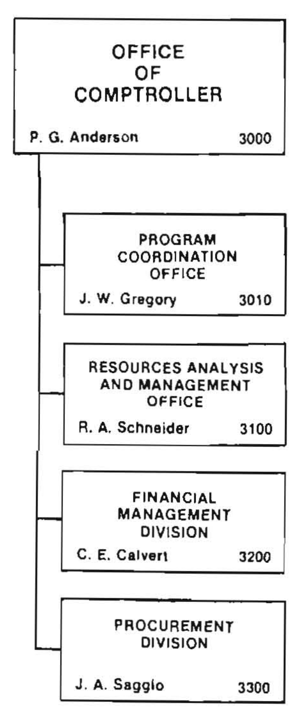
The Headquarters offices review the budget submissions and ultimately certain efforts are approved at a certain funding level and some are disapproved. The resulting funding authority is sent to the Center. The Resources Analysis and Management Office distributes those funds and monitors their expenditure to assure that the funds are utilized consistent with Center and Headquarters approvals.

The Procurement Division is responsible for placing the approved funding on contracts. Due to the multiple rules, regulations and laws that control the expenditure of government funds, this is a difficult and complex process requiring considerable effort, time, and expertise to accomplish.

The last major element in the financial process is the reporting of the status of the approved funds to a large number of internal and external elements. Internally, we send out financial reports to the various performing organizations. We also report monthly to Center management on the financial status of the Center's major projects, highlighting problems currently being experienced and projects where problems seem to be developing.

Externally, a large number of reports are made to Washington. These include reports on specific projects, procurement status, and the broad range of formal accounting reports that the Financial Management Division submits to Headquarters, the Office of Management and Budget, the Treasury, and the Congress.

In summary, the Comptroller's Office provides professional support to the Center to help assure that the Center's funds are budgeted and managed properly. □



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graphics hardware which will provide real time CRT displays of computer data when coupled with the above ESCORT III systems.

Construction of two new aeropropulsion facilities, one for turbines and one for compressors, aimed at providing technology advances in small turbine engines was initiated in ERB. An extensive test program for combustors and turbine vanes for HOST was completed in HPF.

A contract for the rehab of the Icing Research Tunnel (IRT) was awarded. This $3.6 million C of F project (which includes new drive motors, a new icing spray system, computer control and a new control room) will provide increased versatility and productivity for this heavily used facility.

Acoustic and aeroelastic tests of an advanced propeller model were completed in the 8x6 tunnel. Operation of the VLF power absorption system was successfully demonstrated during tests of the CEST convertible engine over its full power range. One of NASA's research aircraft, the DHC-6 Twin Otter, which has completed three successful icing seasons, was utilized to evaluate an electromagnetic impulse de-ice system.

Altitude Wind Tunnel Project

This past year, there was a large increase in the level of effort expended towards the modernization of the presently unused Altitude Wind Tunnel. This modification is a major C of F activity that has been proposed by NASA as an FY '86 new start. The facility will provide aerodynamic, icing and acoustic testing capability in a 20 foot octagonal test section at true pressure and temperature conditions up to 55,000 feet altitude and up to near Mach 1 speeds. An extensive study made by Sverdrup Technology, Inc. showed that no insurmountable problems exist and that a highly-productive and efficient facility can be made operational by the early 1990's.

To verify aerodynamic performance expected, an extensive analytical and experimental modeling activity was also initiated. All significant individual components, integrated groups of components and the complete loop will be experimentally evaluated. Testing of the first models of the corner-turning vanes has been started. Supporting tests for aerodynamic, acoustic and icing data have been made in the 8x6, 10x10 and IRT tunnels. □

Aerospace Technology Directorate

J. Stuart Fordyce
Acting Director

The work of the new Aerospace Technology Directorate embraces research and technology development in space power, space propulsion and in materials and structures for the space disciplines and for aeropropulsion. It is the focal point for the Center's growing program in microgravity science and space flight experiments to support our technology and space utilization objectives.

We are also continuing management responsibility for terrestrial energy programs. That our staffers maintained a high level of productivity in 1984 is attested to by the accomplishments summarized below. As a Directorate, we look forward to fruitful challenges in the year ahead.

Materials Division

Rapid solidification research has produced intermetallics with room temperature ductility. These compounds, with 3000° F melting points and density 25% less than super alloys, are normally brittle at room temperature. This new development makes possible the use of this class of lightweight materials for advanced power/propulsion systems. Controlled quenching of model superalloy single crystals produced very fine particles of the strengthening phase and improved creep behavior up to 10 times over conventionally treated material.

A heater-head alloy we identified for the Stirling engine has high strength, good oxidation resistance, low critical element and has been selected for the upgraded MOD-I engine. A wet grinding and consolidation process was developed for ceramic powders which significantly reduced the critical flaw size and population in silicon carbide thus yielding a 60% improvement in test bar strength.

PMR-15, the Lewis-developed polyimide matrix resin, is now flying on the F-18 Navy Hornet engine in a composite outer duct. This resin has 600° F use potential. A different polyimide was formulated that offers low wear rates but very high friction coefficients under ambient conditions. Potential exists for applying such a material in drive mechanisms for Space Station adjustable structures. The Division initiated the establishment of a Microgravity Materials Science Laboratory in the Materials Processing Laboratory.

Structures Division

A fully operational computer control and data acquisition system was installed in the Fatigue and High-Temperature Structures Laboratory. This is perhaps the world's most advanced laboratory for conducting high-temperature experiments on the deformation and crack initiation characteristics of advanced materials.

Two members of the Structural Dynamics Branch received IR 100 awards for a photo-optical blade displacement measuring system and for a unique rotor dynamics computer code. Aeroelastic flutter boundary analyses which include the effects of sweep on fan and turboprop blading were developed for the first time and demonstrated to be effective. Turboprop blade-to-blade mistuning was shown to be effective in minimizing the potential for flutter.

In structural analysis, codes were developed for structurally tailoring and optimizing advanced propeller blades (STAT) and for studying the hygral thermo-mechanical properties of angle-plied composite structures (ICAN).

The HOST Project held its third Annual Workshop with an attendance of about 300. HOST technology is already making its way into industrial design systems.

An advanced multi-megawatt wind turbine, the MOD-5B, is being built. It has a 320 foot rotor blade and uses blade tip control sections to maintain constant speed. Rated at 3200 kW, it will be operated by Hawaiian Electric Industries. Lewis researchers scored a significant "first" when they operated the MOD-0 wind turbine at Plum Brook with aileron control surfaces on the blades. These landmark tests proved the feasibility of aileron controls for future wind turbines.

Space Propulsion Technology Division

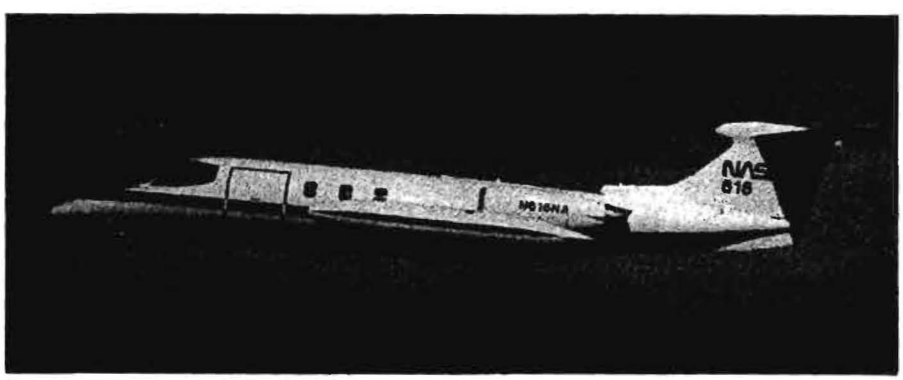
This year we continued to make progress in several major areas. We participated in the technology program for improving the performance and durability of the Space Shuttle Main Engine. Propulsion systems for orbit transfer vehicles (OTV) are being explored under contracts with three engine manufacturers who have proposed such innovations as regenerative cooling of thrust chambers using liquid oxygen and turbopumps rotating at 200,000 rpm (twice the current state of the art). An OTV Research Engine Program has been approved as a new start for FY '86.

Work on resistojets will investigate their performance with the propellants expected to be available on The Space Station. The resistojet is unique in that it is adaptable to many propellants, including biowaste. The year saw the successful conclusion of our work in one form of electromagnetic accelerators (the rail gun).

The Centaur RL 10 engine contractor is making progress in improving the RL 10 to satisfy propulsion requirements of space vehicles of the late 1980's.

After getting settled in DEB, we expect to push on in our Space Station propulsion technology efforts as well as in our long range objectives in primary and auxiliary space propulsion. Work will be expanding with storable propellants for applications in primary propulsion for

(Continued on page 4)



The Learjet can be flown to give 15 seconds of microgravity for the liquid transfer experiment.

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National Aeronautics and Space Administration
Lewis Research Center
Volume 22 Issue 3 February 8, 1985
LewisNews

Preparing for the future:
Tests help design new AWT

By Dave Anderson & John Marek
Senior Aerospace Engineers, AWT

A series of icing tests being run in cooperation with the Air Force's Arnold Engineering & Development Center (AEDC) in Tullahoma, Tenn., is helping determine the eventual design and operating procedures of Lewis' planned Altitude Wind Tunnel (AWT) rehabilitation.

Come the early '90s, when the AWT revamping is slated for completion, the facility will couple capability for advanced icing research with larger scale aerodynamics, propulsion and acoustic studies.

Icing research is still an important part of aeronautical testing, particularly today for helicopters and the more sophisticated general aviation class aircraft. Ice buildup on propulsion systems and aircraft surfaces can, as is well known, have a negative, even dramatically negative, effect on performance.

Currently, only a few wind tunnels around the world can produce icing conditions for aeronautical testing, among them the Lewis Icing Research Tunnel (IRT).

Design of the rehabbed AWT is to feature a large test section (20 feet in diameter), allowances for higher speeds (Mach 0.9 compared to IRT's present Mach 0.4) and low temperatures (-40° F).

Photo by Laura Ragnell

Rehabilitation work being done on a 50-ft. section of the AWT.

A Simulating Experience

Lewis' current icing tunnel research is focused on efforts to duplicate as accurately as possible natural icing conditions encountered in flight.

To simulate natural cloud conditions, an array of spray nozzles located upstream of the test section is used. The nozzles produce jets of water which are broken up by a flow of high-pressure atomizing air.

The size of the resulting microscopic droplets, which vary from 10 to 50 micrometers (50 micrometers is about half the thickness of a human hair), is controlled by adjusting the atomizing air pressure. The droplets' size and liquid water content are regulated so that they match the natural cloud effect encountered in flight.

But British data gathered in 1958 showed that when the atomizing air temperature was not high enough, the water droplets would turn into ice and the cloud conditions would be incorrectly simulated.

These frozen water droplets (ice crystals) would lead to the formation of ice shapes on a test model which are significantly different from those observed in natural icing clouds. In natural icing cloud conditions, the water droplets are supercooled, meaning the droplets are in liquid form even though their temperature is well below freezing. As much as -65° F supercooling is thought to be possible in icing clouds.

Crystal Clear Results

To more fully understand this process and ensure that AWT simulated icing clouds do not "freeze out" or crystallize prior to reaching the test models are the purposes of the tests going on in cooperation with the AEDC.

The AEDC single-spray nozzle tunnel is capable of producing -20° F clouds at a Mach number of 1.0. The facility also has the ability to operate with a wider range of nozzle conditions than are available now in the IRT.

In the most recent AEDC tunnel testing, a "soot slide" technique was chosen because of its simplicity to determine the degree of crystallization. In this procedure, small plexiglass slides are covered with soot from a kerosene lamp. When the slides are momentarily exposed to the spray, the drops and crystals impact the slide and leave an impression.

Upon impact, the sprayed liquid droplets form neatly shaped circles while crystals leave an irregular shape in the soot. Looking at the impressions under a microscope is very much like looking at crater impacts from meteorites.

A laser fiber optics system is used in conjunction with the soot slide technique to accurately measure particle sizes.

Testing thus far shows that crystallization could be present at some conditions under which the AWT is planned to operate. Testing also confirms that the ice shapes formed on a test model change significantly with the presence of ice crystals in the spray.

Ultimately, data obtained will indicate the allowable ranges of conditions—temperature and pressure—for the water and atomizing air. These results will help determine the design of the AWT spray bars as well as operating procedures for AWT icing experiments.

(Continued on Page 3)

25 Quality Circles now off and running!

The Quality Circle Program is expanding again!

By the end of February, ten new circles will have been added in recent months to the program. The new circles meet one hour a week to discuss issues which affect productivity and work quality.

The work groups starting new quality circles are:

- Employee/Labor Relations Branch
- Contract Support Office
- Space Experiments Office
- Engine Research Section B
- Energy and Spacecraft Section
- Materials Branch
- Research Equipment & CAE/CAD Development Section
- Army Operations Office

In the last wave of expansion which took place in July '84, a new type of circle—the functional circle—was experimented with. A functional circle brings together individuals from around the Lab who represent common areas of responsibility. These circles cut across formal organizational lines.

In July, two functional circles began operation. One of these circles is located in Test Installations and involves managers from different levels of that organization. The second group comprises administrative assistants from three research directorates. These two circles are reported to be operating very successfully.

Based on the success of these groups, two new functional circles are now being started. One involves a group of IBM personal computer users, the other division- and branch-level secretaries. Opportunities for this type of circle operation are expected to increase in the future.

The Quality Circle Program will include 25 operational circles when these new groups have completed their training. More circles are expected to be started during the summer of '85.

Members of the "AA" Quality Circle team are (seated l to r): Mary Lester, Barb DiSanto, Debbie Drdek, Jim Zelly—the facilitator; (standing l to r) Gloria O'Donnell, Karen Edwards and Debbie Drdek.

Anyone interested in organizing a circle within their work area or within a functional area of responsibility can contact Program Coordinator Debbie Griest (PAX 8641). A search is also on for individuals who might be interested in becoming circle facilitators. □

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National Aeronautics and Space Administration
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LewisNews

Director Stofan reports on '86 budget

In a recent report broadcast live from his office over Center closed-circuit television, Lewis Director Andrew J. Stofan said the proposed '86 NASA Lewis budget "is one we can work and live with."

The director reported that the total estimated Lewis budget for 1986, including both NASA and reimbursed, amounts to $830 million, as compared to $814 million for the current '85 fiscal year.

Stofan said the proposed total NASA budget of just under $7.9 billion submitted by NASA Administrator James M. Beggs to Congress on Feb. 4 was subject to federal-wide constraints because of concerns to cut costs and reduce the deficit.

In submitting the budget, Beggs said NASA should be recognized for paying its price and contributing to reducing and holding down growth on federal spending.

Although the proposed NASA budget will not, essentially, allow for any new starts, it does provide some relatively good news. The proposed NASA R&D budget for the Space Station is $230 million, compared to '85's $150 million startup funds—an increase that provides a workable budget for Phase B contracts, said Stofan. And with President Reagan's

Director Andrew Stofan

Administrator James Beggs

strong support for the program, added the director, growth is expected to continue in the years ahead.

Reporting on Lewis' proposed $830 million budget for fiscal '86, Director Stofan gave the following assessment:

Aeronautics ($100 million)—growth, but constrained

Space ($34 million)—continued, modest growth

Energy ($66 million)—phasing down as we complete our commitments to the Department of Energy

Space Science & Applications ($117 million)—healthy growth

Space Station ($30 million)—continued, planned growth in keeping with the NASA overall program

Atlas-Centaur ($325 million)—continued, on-schedule funding, with major Air Force participation.

The expected funds of $30 million for Lewis Space Station projects and $117 million for the Advanced Communications Technology Satellite (ACTS) and Materials Processing programs demonstrate a major commitment for continued growth in these areas, reported Stofan.

The Atlas/Centaur program budget at $325 million is down $64 million from '85, but the director reported that the program is healthy and the launch schedule is maintained.

Referring to the absence of fiscal '86 funding for the Altitude Wind Tunnel program (no new aeronautical facilities will be established nationwide under '86 funding), Stofan said the Administrator has indicated that aggressive efforts will be made for continued AWT program support in the '87 budget proposals. The director added that Lewis would vigorously continue its current analytical and structural modeling efforts.

The director also reported that Lewis' civil service manpower level will remain stable for the most part, with a modest 200-person attrition NASA-wide in '86.

Overall, Stofan said Lewis will continue to experience controlled modest growth based on the funds available. "We obviously didn't get everything we proposed and hoped for, but, based on what's happening in general to other agencies across the country under the President's debt reduction plan, NASA has been treated well," said Stofan.

"Let us all keep up the good work as we continue to carry out our role for NASA," said Stofan. □

Lewis' jack-of-all-trades filmmaker:
Laufman plays key role in 300-tech film legacy

When you take a look at what Art Laufman and the folks in the Center's Photographic Technology Section have accomplished over the years, an old axiom takes on new meaning: a picture is worth a thousand words.

Since 1948 when Art, a scientific photographer, first started putting together films on various aspects of Lewis' experimentation and technology, nearly 300 short-length technical films have been produced for informational and instructional purposes.

And during this 37-year period, prints of these films have gone out to thousands of requesting universities, companies and groups across the country. This year an additional six films are expected to be produced and distributed.

But the real story is the inventive and creative way in which these films are developed. And Art Laufman, who is 67 years young, is the man who provides the dedicated energy and creative genius behind Lewis' tech film legacy.

"Art is a rare breed," says co-worker Ernie Walker. "His many years of experience in working with both equipment and people to produce quality films are simply invaluable."

When you look at what Art does with what he has, his accomplishments are indeed admirable. Consider, for example, the fact that some of the equipment he uses is nearly 20 years old. Yet Laufman's jack-of-all-trades know-how can produce state-of-the-art effects, whether that means creating split screens and burn-ins or applying color enhancements and animation.

A part of the challenge is working closely with engineers and other Center staffers in developing the script

Laufman's years of photographic experience help him achieve the just-right special effects needed to produce the Center's quality tech films.

and selecting appropriate subjects to film. From the planning stages to scripting, filming, editing and the final product, it generally takes about three months.

The films, from 5 to 40 minutes long, are all 16mm with optical sound track and 24 frames-per-second projection speed. They are available from the Center on a one-week loan basis for nonprofit, noncommercial screening. And Lewis provides a 37-page "Technical Motion Picture Catalog" for selection.

In putting together a tech film, Art expresses one overriding concern: "I always strive to maintain quality no matter what the subject or despite the conditions we're challenged to film under."

Bearing testimony to the challenges of handling Center-initiated film assignments is Dave Clinton, another Lewis scientific photographer who works closely with Art.

On one occasion, Art and Dave were dangled from a basket hoisted by a crane to some 150 feet above ground. The challenge: to film the action of a gigantic wind turbine with rotating blades that measured from tip

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Deflected thrust testing of the F-100 engine with a two-dimensional nozzle was completed in PSL. Force measurements were made during thrust vectoring and the carbon/carbon nozzle liner temperatures were measured with IR cameras. Design efforts were initiated for modifying PSL-3 for testing the gaseous hydrogen fueled air-turboramjet (ATR) engine at simulated hypersonic conditions.

Altitude Wind Tunnel Project Office

This past year, activities concentrated on physical and dynamic modeling of an Altitude Wind Tunnel (AWT) design which will provide aerodynamic, icing and acoustic testing capability at true pressure and temperature conditions up to 55,000 feet altitude and up to near Mach 1 speeds. A one-tenth-scale model of the high-speed leg of the AWT was completed and operated up to a test section Mach number of 0.916 with good flow distribution and low turbulence level.

An AWT acoustic choke configuration was tested and found to effectively block noise propagation into the test section. Computer simulations of the AWT circuit and major subsystems confirm that desired tunnel response could be achieved using state-of-the-art control hardware.

Since NASA management has decided not to proceed with the AWT Rehab in the near future, the physicial modeling efforts will be phased-out and the Project Office will be disbanded during FY 1986. ▢

The nine-foot-diameter Prop-Fan developed by Hamilton Standard under a contract from Lewis is now being tested at Wright-Patterson Air Force Base.

Aerospace Technology Directorate

J. Stuart Fordyce
Director

The Aerospace Technology Directorate welcomed about 40 more young scientists and engineers to its ranks in 1985, bringing to about 30 percent the influx of new talent in the last three years.

The recent additions and the more experienced staffers have been assigned into the "flattened" organization aimed at achieving a participative climate to encourage greater individual responsibility for meeting agreed-upon goals.

A few of our many accomplishments during the past year are discussed here. We have a bright outlook for 1986 that will continue to challenge every one of our people.

Materials Division

Pursuing a broad program in advanced materials for aeronautics and space propulsion and power, the Materials Division continues to make significant contributions.

High temperature structural ceramics offer potential for new aerospace propulsion concepts. A new ceramic matrix composite of reaction bonded silicon nitride reinforced with silicon carbide fibers has been developed. This composite has both higher strength and greater toughness than conventional structural ceramics and so may help accelerate the introduction of reliable ceramics into advanced gas turbine engines. Growing from the basic Materials research efforts, the opportunity to use gravity as a process variable can have important impact on materials technologies of the future.

In support of NASA's Office of Space Science and Applications program, the Microgravity Materials Science Laboratory was opened for business. Here industry, university, and government researchers will have easy access to space flight-related hardware. Here also, sound ground-based experiments and process model development can be achieved before embarking on costly flight hardware construction and space flights.

Battelle Memorial Institute and its industrial partners in a Center for Commercial Development of Space plan to be key users of this facility. Cooperative efforts with Rocketdyne have begun on high solidification gradient single crystals and fiber-reinforced superalloys for longer-life SSME hydrogen pump blades.

In-house developed fiber-reinforced copper composites for rocket nozzles offering substantial performance/life improvements are being tested in cooperation with the Space Propulsion Technology Division. Such advanced composites were possible only because of a new arc-spray fabrication process developed at Lewis—and since licensed by both TRW and Westinghouse.

The Division's output of new technology and its focus on rapid technology dissemination are reflected by the over 160 papers and seven U.S. patents that were produced this year.

Finally, the Materials Division paved the way as the only research organization in a national and NASA-wide pilot effort with the American Productivity Center to develop improved white collar productivity and output quality. With over 30 percent of the staff participating, improved ways of doing business and measures of output quality were successfully developed.

Structures Division

The Structures Division conducts structures research in mechanics, dynamics, life prediction and advanced technology for aerospace propulsion and power systems.

In mechanics, we have developed two new computer codes for inelastic analysis of high temperature structures. These finite element (MHOST) and boundary element (BEST) codes are providing greater accuracy and reduced computer times for many examples in comparison to an existing general purpose code currently in use in industry.

In dynamics, the ASTROP aeroelastic analysis code was developed and extensively validated for turboprop configurations. This code provides the most reliable aeroelastic analysis in existence today and has been widely requested by organizations ranging from MIT to the Air Force.

Structures technology was developed for NASA projects A computer code (ICAN) was developed with an analysis which contains all the essential features required to effectively design structural

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An engineering model of the Solid Surface Combustion Experiment completely developed in-house here for a Shuttle flight scheduled for March 1986.