The Fan-compressor Flutter Team

They work with the Air Force to solve excess vibration problems in aircraft turbine engines

The flutter program

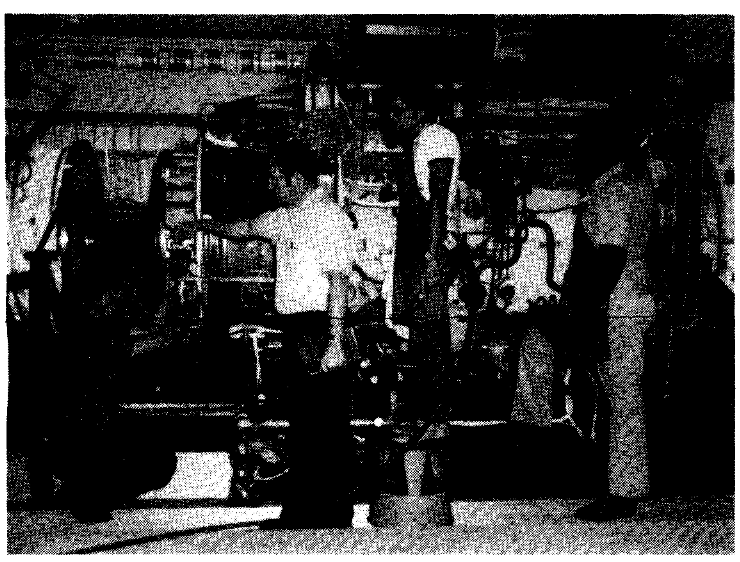
The Center is conducting two major programs to assure that fan and compressor blading of aircraft engines of the future will be flutter free.

The idea is to map, understand and remove from the operating region destructive, self-excited blade vibrations.

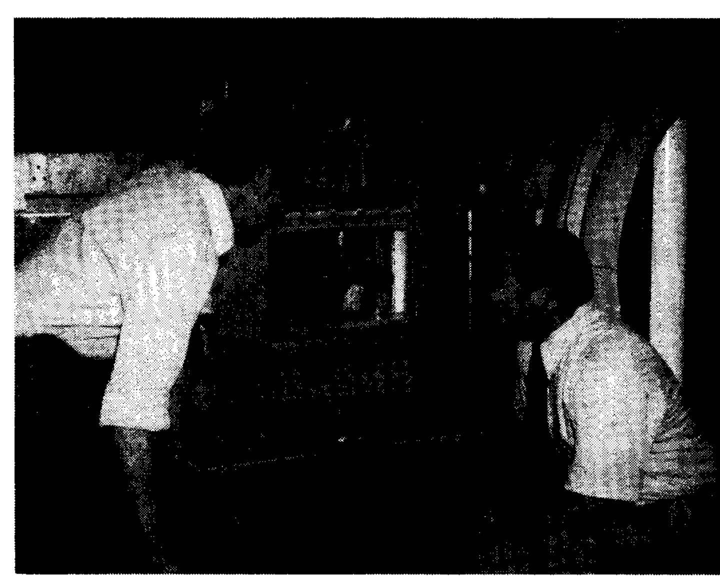
Both programs are jointly planned and coordinated with the Air Force Aero Propulsion Laboratory (AFAPL) at Wright Patterson AF Base, Dayton, Ohio.

One Program, full scale engine research (FSER), involves a substantial effort in mapping and observing flutter in advanced engines. In this activity, the Air Force provides late model advanced engines which Lewis insturments test beyond the usual operating range so blade flutter can be observed. Some of the activities leading to testing of the F-100 and the J-85-21 engines are highlighted on the following pages.

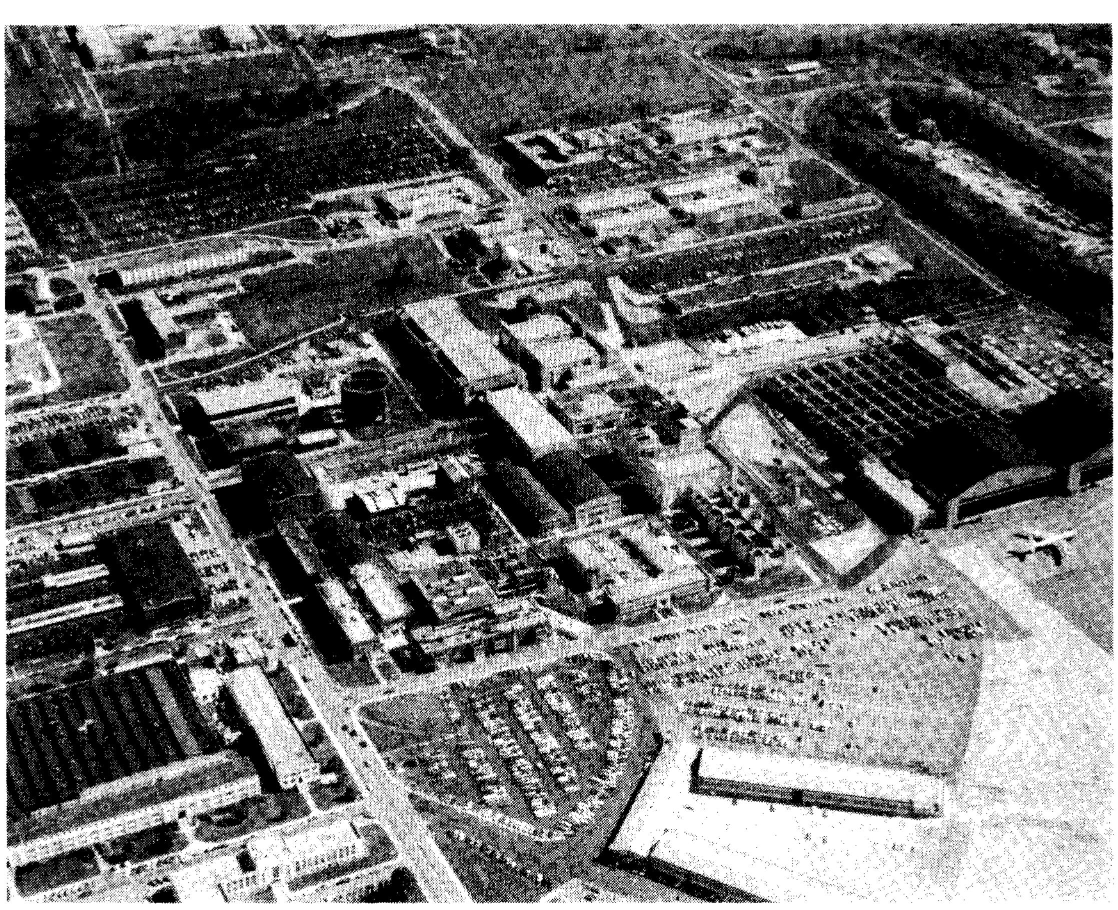
LEWIS RESEARCH CENTER



Conducting full scale engine testing in PSL.



Researchers monitor blade flutter test



AIR FORCE PROPULSION LABORATORY, LOCATED AT WRIGHT-PATTERSON AFB, DAYTON, OHIO

Aeroelasticity of turbines

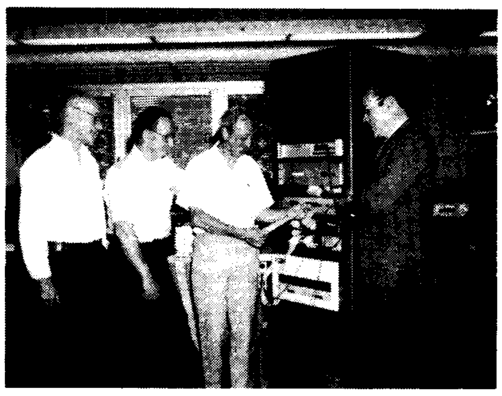
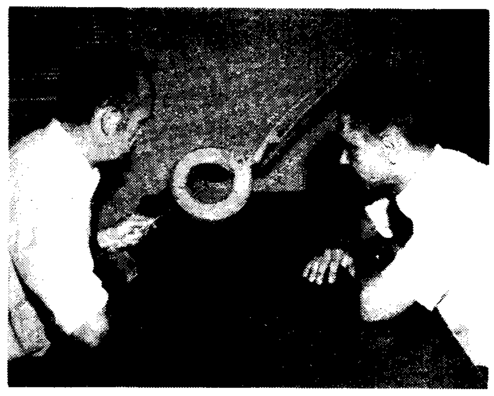
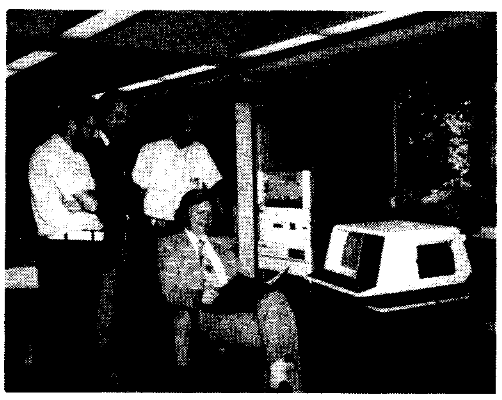
In addition to full scale engine research, the other joint program with the Air Force is aeroelasticity of turbine engines. This includes a collection of projects which provides improved criteria and overall analytical approaches for gan and compressor blading design.

Work is being done on analytical models and computer codes. Research to verify experiments pertaining to unsteady aerodynamics and vibration characteristics is also being conducted.

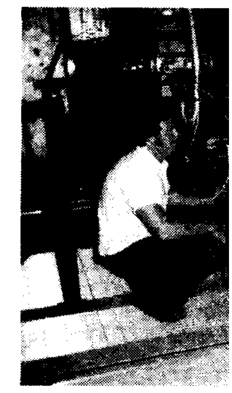
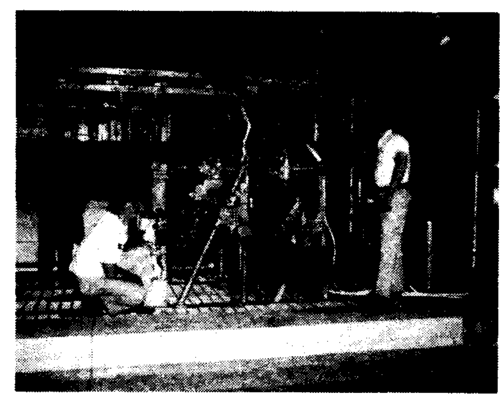
•These efforts are being accomplished by Lewis in-house and contract programs, with specific design approaches to reduce tendency of blades to flutter.

Flutter - a major part of the ful

Detailed measurements of airflow
and structural motion

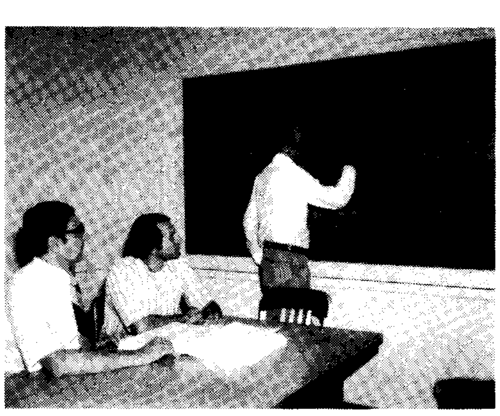

Realistic testing over a wide
of flight conditions

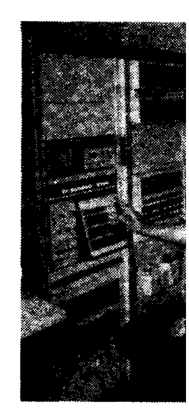
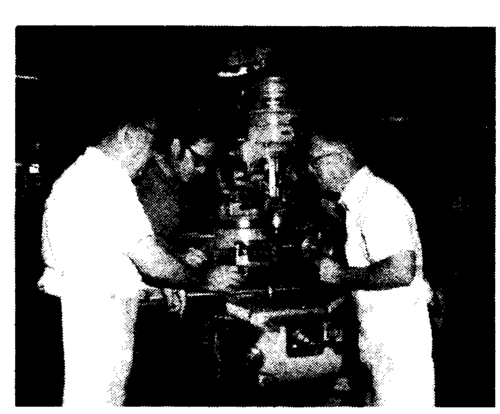

Flutter - a major part of the aeroelasti

Developing analytical methods
and computer codes





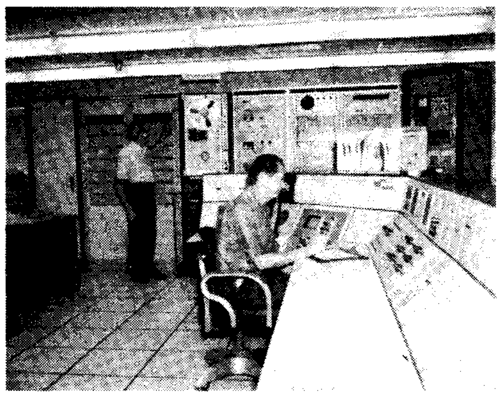

Verifying predictions by expe

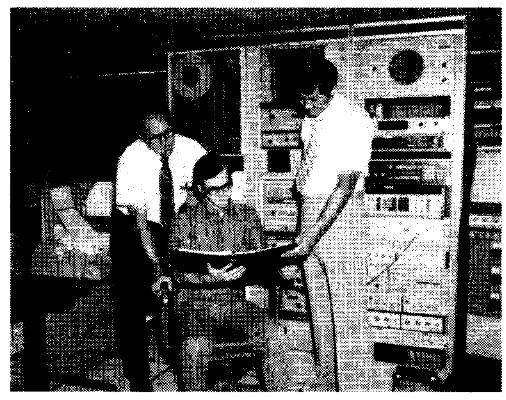





l scale engine research program

range

Data gathering and analysis





LEWIS AWARENESS

city of turbine engine (ATE) program

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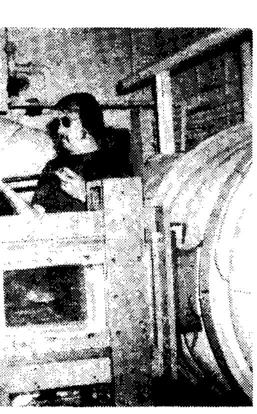
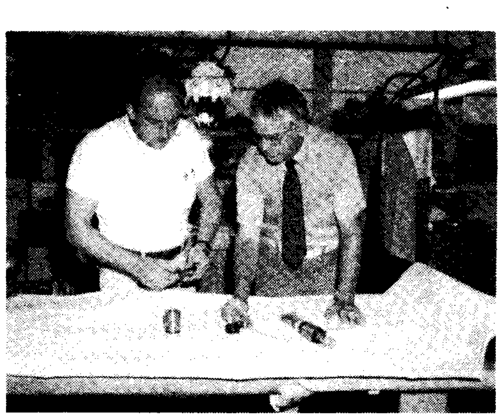
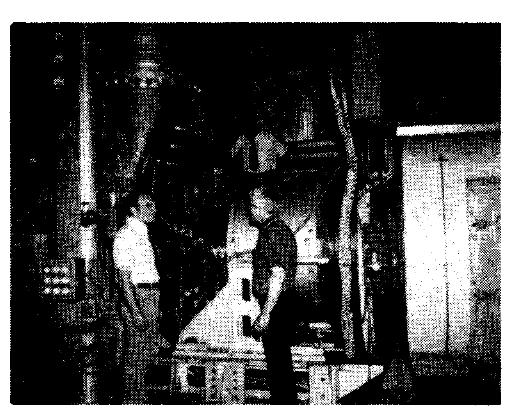
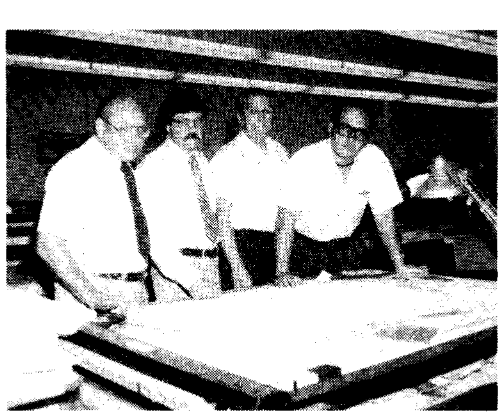
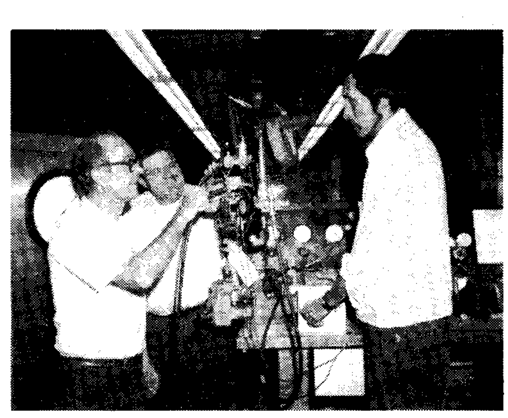


Measuring response of flexible structures to aerodynamic loads





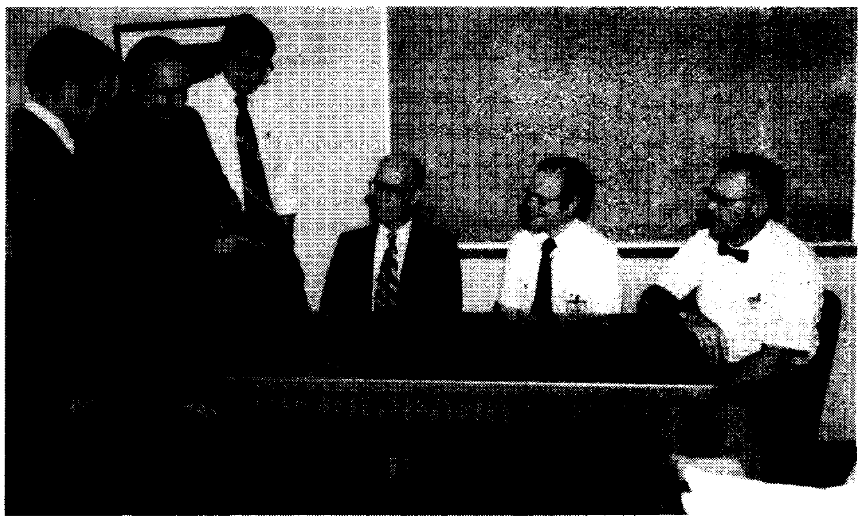




LEWIS AWARENESS

Advanced engines must be designed to be flutter free...

FULL SCALE ENGINE RESEARCH (FSER) + AEROELASTICITY OF TURBINE ENGINES (ATS) = REPORTS + COMPUTER CODES = FLUTTER FREE ENGINES



Full scale engine research program

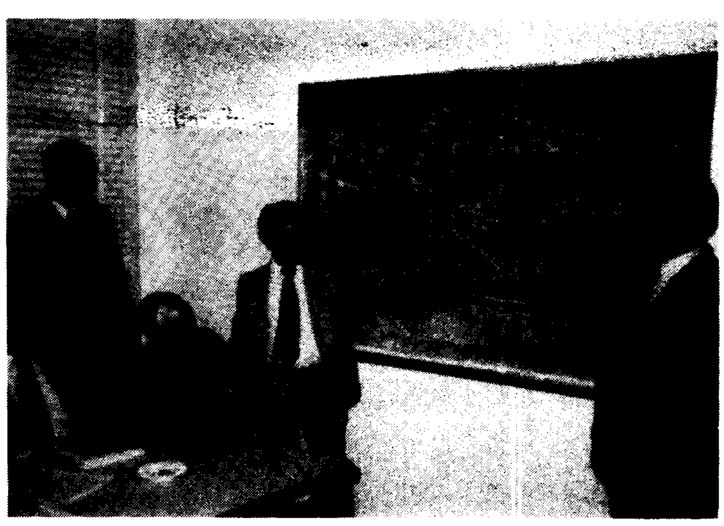
The full scale engine research program is coordinated by personnel of the Engine Research Branch, Airbreathing Engine Division.

Assembling instrumentation, operating the engine and facilities and reducing, analyzing and reporting data on the overall program involve a large number of Lewis organizations and people. Space permits only a few of the people involved to be pictured on these pages.

Full scale engine research also covers a number of technology areas, one of which is fan and compressor blade flutter. The wide capabilities of Lewis facilities permit engines to be operated at conditions beyond the normal range, including conditions producing blade flutter.

The goal of flutter testing in the engine research program is to gain more understanding of flutter phenomena through aerodynamic and structural measurements in real engine environments. From understanding, engine designers can avoid potentially destructive flutter.

The test program on the recently completed YF-100 engine was quite successful in this regard. New optical devices measured vibrations of each blade in the fluttering stage. Pressure probes of advanced design yielded detailed data on high frequency aerodynamics associated with the vibrating blades. Results of the YF-100 engine program have been published and are currently being used by Lewis and contractor personnel for predicting flutter.



AF aero propulsion program

Personnel of the Air Force Aero Propulsion Laboratory make frequent trips to Lewis to plan and to coordinate joint activities of the full-scale engine research and engine aeroelasticity programs.

The effort insures that the programs are planned and conducted to make best use of both the Air Force and Lewis capabilities. Air Force personnel arrange for advanced design engines to be tested in Lewis facilities and manage Air Force contracts relating to fan and compressor blade flutter.

Other Air Force information is obtained from development engines and the AF's Office of Scientific Research.

Air Force personnel and their NASA counterparts brief AF and NASA officials on their efforts.

Aeroelasticity of turbine engine program

The aeroelasticity of turbine engine is a NASA program coordinated by members of the Fan and Compressor Branch, Fluid System Components Division.

This program and a variety of Air Force activities are jointly planned to provide technology to avoid blade flutter problems in future engines.

Nine projects are being done in-house at Lewis, 19 are or will be contracted by Lewis and 10 by the Air Force.

These projects must be conducted so that they form a comprehensive body of information from which fan and compressor blading can be designed without flutter.

Included are short range programs aimed at improving design criteria and aero-structural instrumentation.

Long range programs include methods and computer codes for analyzing aerodynamics and vibration motions. Experiments are then conducted to verify the analytical methods in driven cascades and to excite structural vibrations with rotation, but no air loads.

These studies will provide information to further refine analytical procedures which can be applied to data from engines and other experiments.

It is also anticipated that it may be necessary to compile a summary of flutter technology to be used by turbomachinery designers.

LEWIS AWARENESS

Both full scale engine research and engine aeroelasticity programs are aimed at understanding blade flutter problems. Avoiding flutter problems in the design and development of advanced aircraft engines will prevent costly overruns and program delays.

Blade flutter has limited the application of high pressure, lightweight, and high speed fans and compressors.

Continued advances in the technology of flutter and aero-structural problems will provide bladed systems that are 'tailored' to achieve maximum performance at minimum weight consistent with life and mission requirements.

Improved propulsion systems for commercial and military aircraft should thus result from the combined efforts of Lewis and the Air Force.