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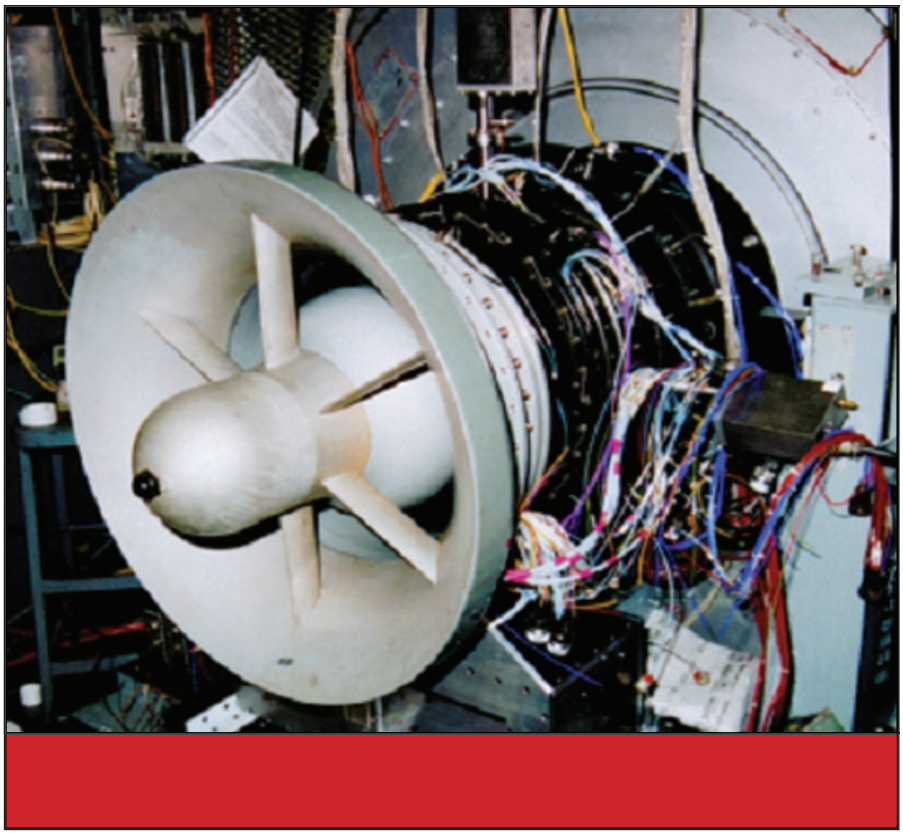
*Science and Technology for Tomorrow's Air and Space Force*

## *Success Story*

# IN-HOUSE RESEARCH REVEALS SOURCE OF PERFORMANCE LOSS IN TRANSONIC COMPRESSORS



The Propulsion Directorate's Compressor Research Group found that blade-row interactions have a significant impact on the performance of a transonic compressor stage. After extensive research utilizing experimental testing and numerical simulation, directorate engineers found a previously unidentified loss-producing mechanism, which was a result of close spacing between a stator blade-row and a transonic rotor blade-row. Loss refers to any fluid-flow feature that reduces the efficiency and pressure rise capability of a compressor.

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## Accomplishment

At the Compressor Aero Research Lab (CARL), directorate engineers documented how mass flow rate, pressure ratio, and efficiency all changed significantly as they reduced blade-row axial spacing from "far to close." Directorate engineers found two separate outcomes when they simulated interaction between a stator blade-row and a rotor blade-row at close and far spacing.

At close spacing, the stator trailing edge chops the rotor bow shock, forming a pressure wave on the upper surface of the stator, which turns nearly normal to flow and propagates upstream. The flow is supersonic relative to this pressure wave, producing additional loss.

Far spacing produces no additional loss due to the rotor bow shock degenerating into a bow wave before interacting with the stator trailing edge and, therefore, no significant pressure wave forms on the stator upper surface. These results demonstrate the importance of considering unsteady blade-row interactions when designing transonic fans and compressors due to the significant amount of loss produced.

## Background

The research performed at CARL is part of an in-house project named High Impact Technology. Some technical challenges make it difficult to meet Integrated High Performance Turbine Engine Technology (IHPTET) and Versatile Affordable Advanced Turbine Engines (VAATE) objectives of increased stage loading and efficiency. However, after much experimental and computational analysis of blade-row interactions, researchers better understood the losses, which proved to be a breakthrough analysis.

The IHPTET program is an ongoing national effort to double United States (US) military aircraft propulsion capability. The new VAATE program will develop versatile advanced gas turbine engines that are more affordable, where affordability is defined by a capability-to-cost ratio. These programs coordinate the gas turbine engine research and development activities of the Army, Navy, Air Force, National Aeronautics and Space Administration, Defense Advanced Research Projects Agency, and six US turbine engine manufacturers. VAATE builds on this team collaboration by adding the Department of Energy and US major weapon system manufacturers.

Propulsion
Emerging Technologies

## Additional information

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