

Transition to Turbulence in Gas Turbine Geometries

by

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Wednesday, October 29, 2008
3:15 p.m. — Refreshments before the seminar
3:30 p.m. — Graduate Seminar
Room 1130 Mechanical Engineering

ABSTRACT — Transition from laminar to turbulent flow takes place in the boundary layers of compressor and turbine blades. It is induced by incident wakes and by ambient turbulence. Over the last several years, we have studied this process by computer simulation and Orr-Sommerfeld theory. Our work in this area will be reviewed.

The process by which free-stream, vortical disturbances induce transition to turbulence in an underlying boundary layer, without the intervention of instability waves, is called 'bypass transition'. In context of Orr-Sommerfeld theory, we call it 'continuous mode' transition. Instead of starting from the discrete modes of the Orr-Sommerfeld equation (Tollmien-Schlichting waves), transition by free-stream turbulence can be formulated as starting from its continuous modes. An examination of mode shapes leads to a theory of how free-stream disturbances penetrate the boundary layer and, ultimately, provoke transition. The basic idea is that low-frequency modes penetrate the boundary layer, while high frequencies do not --- a result referred to as shear filtering. While this is a route into the boundary layer, transition involves a subsequent interaction between low and high frequency modes, to produce break down near the top of the boundary layer. Numerical simulations of mode interaction illustrate continuous mode transition.

Computer simulations of transition in a compressor passage with incident turbulence will be presented. The processes seen in continuous mode transition have analogies on the pressure side of the blade. The suction side shows an interaction between free-stream turbulence and instability waves.

BIO — **Paul A. Durbin** is the Martin C. Jischke professor of Aerospace Engineering at Iowa State University. He was previously a professor in Mechanical Engineering at Stanford University. His research interests are in turbulence and transition, including computation, theory and analytical modeling. He is a member of AIAA, ASME, and a Fellow of APS. He is an associate editor of the ASME Journal of Fluids Engineering.

Informal Faculty Luncheon: Wednesday, October 29, 2008, 12:00 noon. Meet in 1100 ME and walk to lunch with other faculty. Prof. Paul Durbin will be able to attend. Host: Prof. Terry Simon