Acoustics Research at the University of Notre Dame

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Program Overview

Acoustics research at Notre Dame resides in the Aerospace and Mechanical Engineering department. The Center for Flow Physics and Controls (FlowPAC), within the larger department directs most of the research. Primary areas of interest include aeroacoustics, wind turbine noise, and active flow control. Notre Dame's Hessert Lab for Aerospace Engineering is extensively equipped with experimental facilities for research, housing numerous high-quality subsonic, transonic, and supersonic wind tunnels.

Inside Notre Dame's Anechoic Wind Tunnel

Cutting edge experimental facilities and ambitious faculty have forged great relationships with many leading industry partners, providing funding for a wide range of research. This funding along with the dedication of the Notre Dame Graduate School allows all students accepted to the program to have full funding to complete their degree.

Quick Facts

- Offers both Masters and PhD track programs in aerospace and mechanical engineering
- PhD program accepts applicants directly from Bachelors completion or with Masters degree
- Approximately 25% Acceptance Rate (2002-2011)
- Graduates have 21% placement in tenure track positions, 66% in industry five years after graduation (see graduateschool.nd.edu for more)
- Approximately 60 current graduate students
- Average completion time for PhD from bachelor degree is 5.2 years

Facilities

Anechoic Wind Tunnel

The anechoic open jet wind tunnel is a draw-down design with the test section placed inside a large anechoic chamber. Air enters the anechoic chamber through a series of turbulence management screens and a large area-ratio contraction. A fan at the opposite end of the anechoic chamber draws air through the wind tunnel.

- Maximum velocity: 35 m/s
- Anechoic room dimensions: 30'x24'x12'
- Acoustical fiberglass wedges on all six sides
- Normal incidence absorption coefficient 0.99+
- Low frequency cutoff of 150 Hz
- Multiple phased microphone arrays

Notre Dame's Mach 0.6 Wind Tunnel motor (left), and test section (right)

Mach 0.6 Wind Tunnel

This facility features a large-scale, low turbulence, high-subsonic Mach number wind tunnel for fundamental aerodynamic research. Maximum freestream mach number: 0.6

- Test section dimensions: 3'x3'x9'
- Two-stage fan with variable pitch blades
- 1750 h.p. variable r.p.m. AC motor
- Very low turbulence intensity level of 0.05%
- Closed-loop design with active temperature control
- Modular window panels cover 60% of test area
- Enables LDV, PIV, hotwire and flow visualization

Wind Energy Lab

The Notre Dame wind energy lab is an outdoor research facility that utilizes real world conditions to provide an environment to test rotor designs and control techniques.

- Two JIMP 25 kW turbines
- One serves as 'control' turbine and other is modified for experimental purposes
- Built by Jonica Impianti in Italy
- Active yaw control
- 10m diameter rotor
- 18m hub height

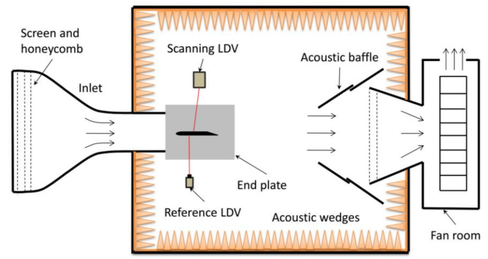
The West Turbine

Research

Partnerships with NASA, Boeing, and GE among others have brought interesting projects to the acoustics researchers at Notre Dame. Some current projects include:

Flow Induced Structural Vibration

At Notre Dame's Anechoic Wind Tunnel, scanning Laser Doppler Vibrometers (LDV) measure structural vibration of an airfoil induced bv flow.



LDV test setup schematic and photograph from graduate student Yaoyi Guan

Wind Turbine Noise

Notre Dame's Wind Energy Lab is recording data 24/7, monitoring the sound pressure level and electric power generated by the turbines as well as recording wind speed temperature and pressure from the Lab's meteorological tower.

ND's West and East Turbines and meteorological tower at the Wind Energy Lab

NASA Partnership in Aeroacoustics

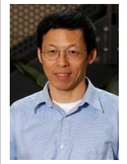
Using Notre Dame's Mach 0.6 wind tunnel, ND has teamed up with NASA's Langley Research Center to begin evaluating modern acoustic liner concepts for how much drag they produce and determine the physical mechanism by which drag is produced. Loudspeakers embedded in the test section produce up to 140dB of tonal noise to mimic aircraft engine conditions.

Personnel

Approximately 60 graduate students conduct research at Hessert Labs. Several of these students are active in acoustics. Here are some key faculty that drive the research and serve as advisors to students interested in acoustics research:

Dr. Thomas Corke is the Director of the Notre Dame Hessert Laboratory for Aerospace Research and founded the Center for Flow Physics and Controls. Current interests include wind turbine noise, liner aeroacoustics, and active flow control using DBD plasma actuators

Dr. Scott Morris directs many projects for the department in aeroacoustics. He is primarily interested in experimental research, and much of his work is conducted in the Anechoic Open Jet Wind Tunnel. Current research projects include airfoil generated noise and vibration, fan noise, and the sound associated with active flow control devices.



Dr. Meng Wang is primarily interested in the use of numerical tools to solve engineering fluid dynamics problems. Using LES, DNS, and hybrid RANS/LES methods, he and his students solve problems related to flow-generated sound, including noise-reduction using plasma-based flow control.

For more information:

Visit http://www.nd.edu/~flowpac/

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FlowPAC