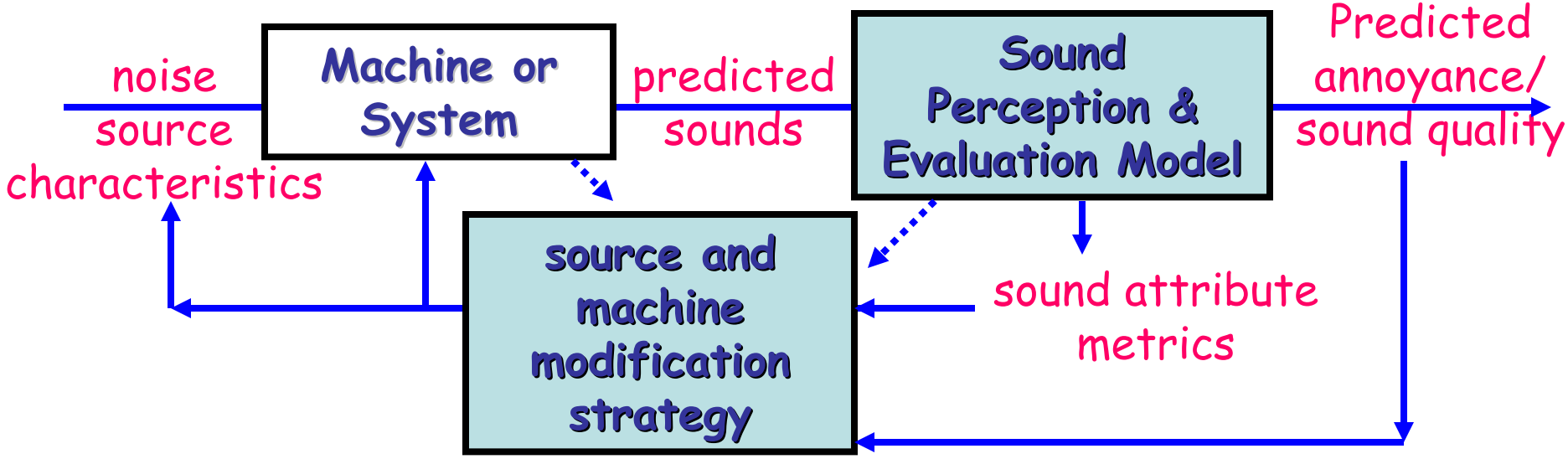
Sound Quality Research

Patricia Davies, School of Mechanical Engineering, Purdue University.

Goal: Understand how people perceive and evaluate sound in order to optimize noise control strategies and product sound.



New and Future Topics of Interest:

1. **Metrics for prediction of the impact of aircraft noise on communities**
2. **Relationship between annoyance, task performance, physiological responses, and sleep disturbance.**
3. **Haptic and acoustic feedback in switches and their relationship to safe operation and performance (with Hong Tan, ECE).**

Sound Quality Research

Patricia Davies, School of Mechanical Engineering, Purdue University.
Collaborator: Aimee Surprenant, Psychological Sciences, Purdue University.

On-going Projects:

1. **Relationship between combustion variability and quality of diesel engine noise.**
   Application: combustion control criteria for diesel engines.

2. **Modeling the perceptual attributes of motor-driven device noise. Relating perceptual attributes to impressions of quality and durability.**
   Application: automobile interior noise.

3. **Modeling perception of sounds with tonal components. Understanding the relationship between tonality and annoyance.**
   Application: cab noise in large earth moving machinery.

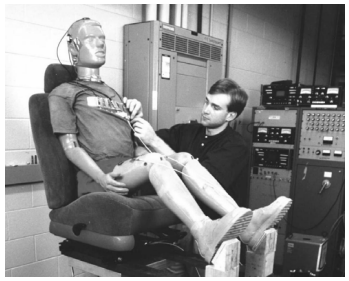
4. **Understanding and prediction of Speech Intelligibility for aging drivers.**
   Application: car interior noise design.

5. **Development of Nonlinear Annoyance Models**
   Application: widely applicable criterion to predict noise impact.

Seat-Occupant and Polyurethane Foam Modeling

Anil Bajaj & Patricia Davies, School of Mechanical Engineering,
Purdue University. Contact: bajaj@ecn.purdue.edu & daviesp@ecn.purdue.edu

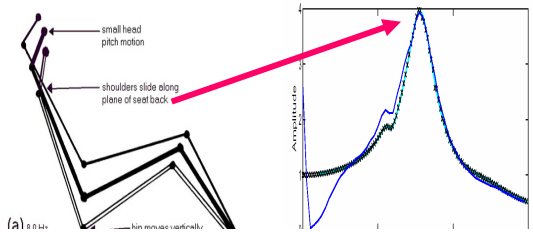
Goal: Relate seat materials and construction to occupant settling point and vibration.



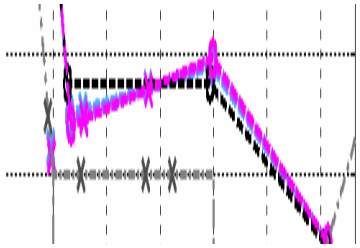
Future Goals: Relate settling point and vibration levels to static and vibration comfort.

Seat Occupant Models:

Simplified models that include material properties to facilitate seat design and understanding of seat-occupant dynamics.



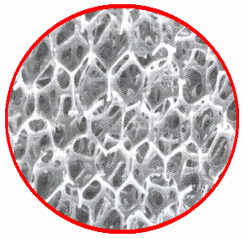
deflection shapes and frequency response prediction



static settling point prediction

Models of Foam Behavior:

Micro → Macroscopic Modeling



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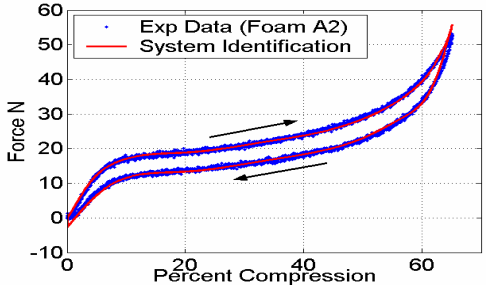


Ogden and polynomial nonlinear elastic models.

Hereditary and fractional derivative models of viscoelasticity.

System identification techniques.

On-going and Future Work:

Modeling seat-occupant interfacial forces and shear effects.

More global models of foam to predict response over a larger range of excitations.

Sound Quality of Diesel Engines

Sponsor: Isuzu Motor Company
PI: Patricia Davies, Grad. Student: Aaron Hastings

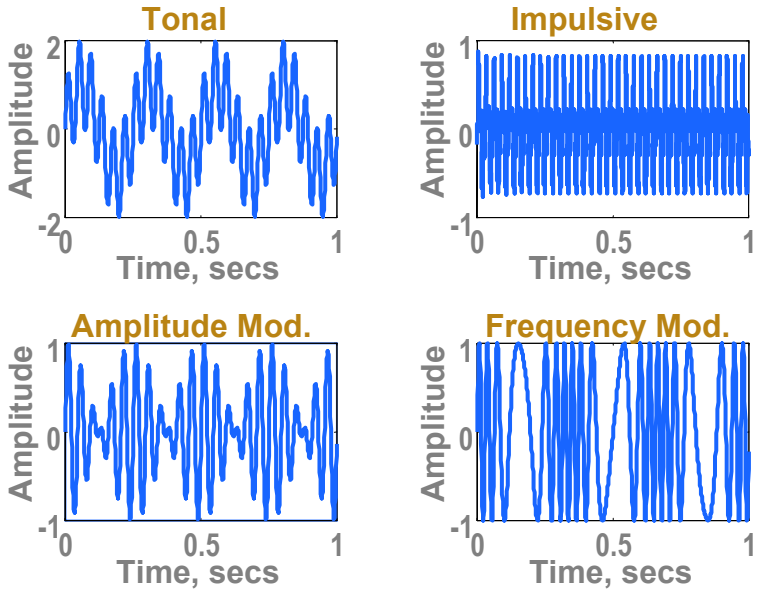
Goal:

To develop a model relating diesel engine operating conditions to sound quality.

Intermediate Objectives:

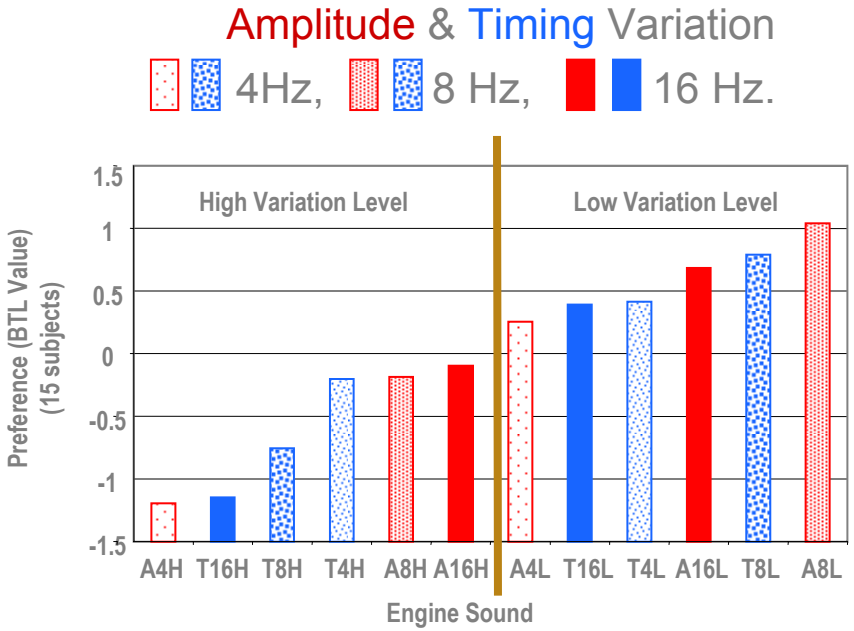
- Produce realistic simulations of diesel engine sound to generate controlled sets of sounds for subjective testing
- Validate and improve existing models of tonality
- Quantify the influence on sound quality of non-stationary sound characteristics caused by combustion variation.

Diesel Engine Sound Characteristics



Diesel Engine Sound Quality:
Tonality and Combustion Variation Test Results

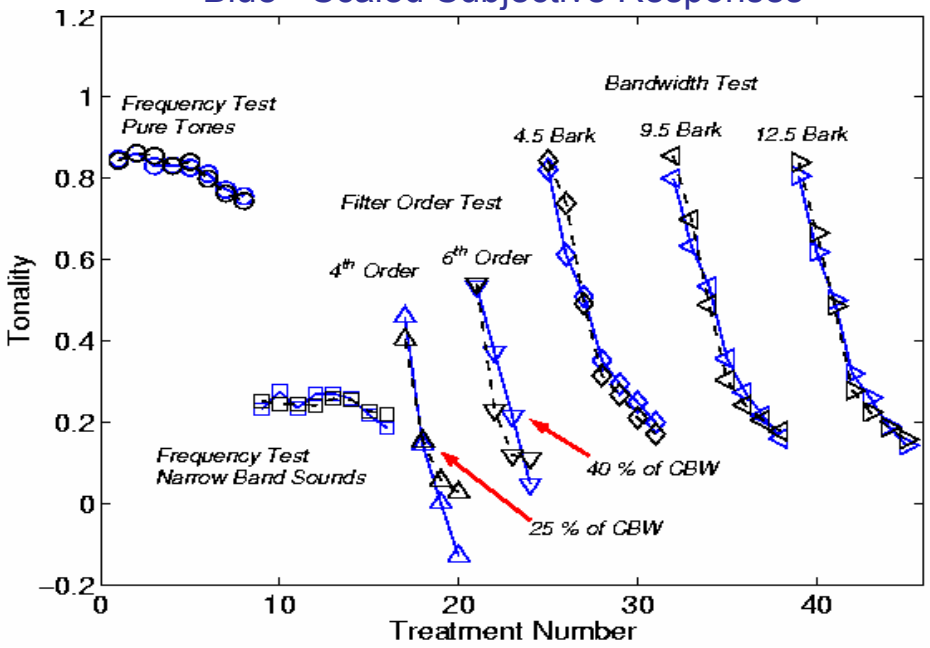
Combustion Variation: Preliminary Test Results



- Lower level modulations preferred.
  - 4 Hz modulations not preferred.
    - No consistent difference in preference between 8 and 16 Hz modulations.

Aures's Tonality Validation Results:

Black - Aures's Model Predictions
Blue - Scaled Subjective Responses



Bandwidth of narrow-band noise features:
Bandwidth definition unclear in Aures's model.

Improvements to tonality model (bandwidth and roll-off influences) being developed.