Cummins Active Noise Control

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Team 7

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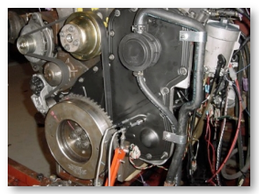
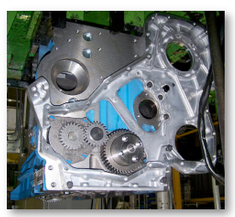
Project Description

- Problem Statement:
  - Propagation of vibrations in valve or gear covers in mid-sized diesel engines result in radiated noise
  - Use active and passive materials to reduce noise
- Constraints:
  - Size and space limitations of engine
  - Broadband frequency control
  - Overall durability and long life



Gear Cover Mounted on Diesel Engine

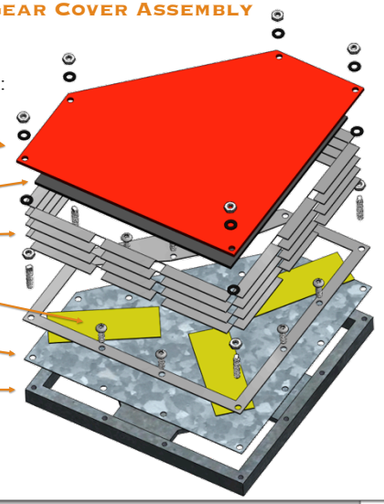


Gear Housing and Engine Components

- Project Specs:
  - Thin, cost-efficient, and lightweight vibration control devise utilizing both active and passive materials
  - Device should complement existing engine components
    - Cannot exceed 15mm from top of cover
    - Cannot surpass the existing perimeter of cover
  - Develop working model
    - Comparison of design vs. existing cover and dual-layer cover

Scale Model of Gear Cover Assembly

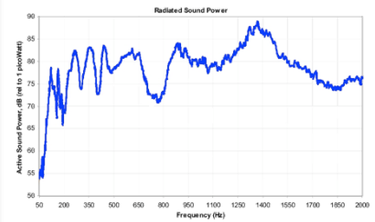
- Scale Model Components:
  - Sound Barrier Panel
  - Sound Absorbing Foam
  - Vibra Block
  - MFC Actuators
  - Gear Cover
  - Gear Housing



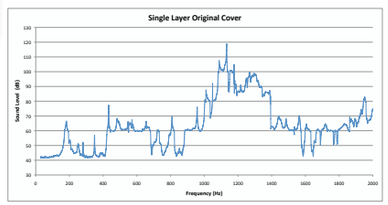
Shaker Table Testing Apparatus

- Shaker Table
  - Proven as accurate testing platform for substitution of diesel engine
  - Provides source of steady state perturbations

Sound Data



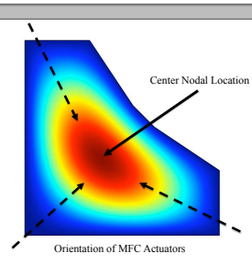
Radiated Sound of Gear Cover Mounted on Diesel Engine



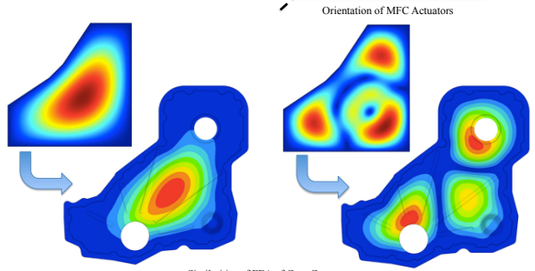
Radiated Sound of Gear Cover Mounted on Shaker Table

Modal Analysis

- FEA of Scale Model Design
  - Adaptation of gear cover shape for nodal location similarities
  - Nodal shape and location characterizes vibration propagation
  - Determine orientation of patch actuators (in direction of vibrations)



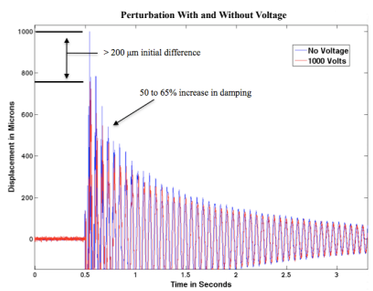
Orientation of MFC Actuators

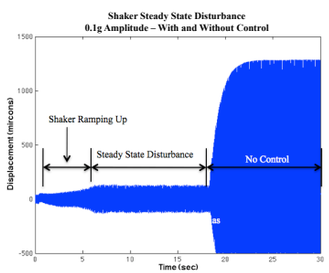


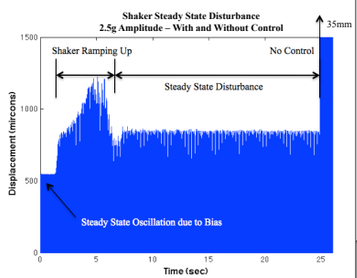
Similarities of FEA of Gear Covers

Active Control

- Cantilever Beam Testing
  - Provides dynamic characteristics of materials
  - Implementation of lead lag filter / integral controller
  - Results:
    - Increase in damping and stiffness
    - With control, 35 mm peak-to-peak reduced to 1.5 mm peak-to-peak displacement
    - Proof of concept



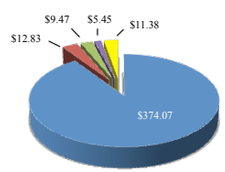




Results

Layering	Increase/Decrease	Sound Level	Frequency Range
Vibra Block	Decrease	3-5 dB	Broadband
MFCs (no voltage)	Decrease	20 dB	700-800 Hz
	Decrease	10-20 dB	1800-2000 Hz
	Decrease	Constant 5 dB	After 700 Hz
Control vs. No Control	Decrease	5 dB	@ 1150 & 1400
Sound Barrier	Decrease	10 dB	@ 300, 450, 750
	Decrease	10 dB	1250-1400 Hz
	Decrease	5 dB	1700-2000 Hz
Sound Absorbing Foam	Decrease	5 dB	Main Drop @ 500
	Decrease	5 dB	1400-2000 Hz

Model Cost (Per Component)



dB Drop (Per Component)