Nick Delgass (ChemE)
Catalyst surface chemistry

Eric Dietz (PHSI)

Monika Ivantysynova
MAHA Fluid Power Systems

Chuck Krousgrill (ME)
Disc brake M&S

Greg Shaver (ME)
Engine design, modeling, & control; VVA; alt fuels

John Starkey (ME)
Powertrain/CVT design

Scott Sudhoff (ECE)
Motor/generator design, power electronics

Oleg Wasynczuk (ECE)
Distributed Heterogeneous Simulation, Motors, Power Electronics/Systems

DRAMATICALLY REDUCE:

Dependence on foreign oil
Oil consumption, and pollutants causing:
- global-warming (CO_2)
- smog (NO_x), and
- respiratory tract damage (soot)

Provide consumers with flexible fuel options and lower vehicle-use costs

COLLABORATING LABORATORIES

Ray W. Herrick Laboratories
140 S. Martin Jischke Dr.
West Lafayette, IN 47907-2031

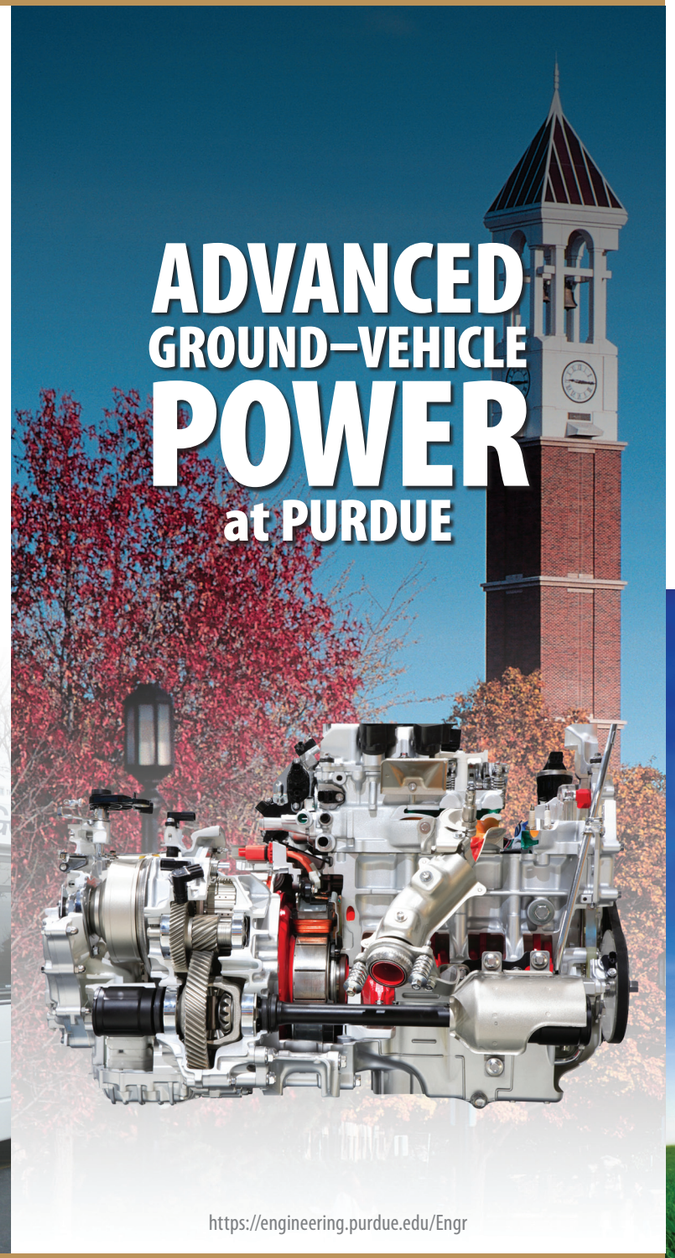
MAHA Fluid Power Research Center, and Purdue Center for Systems Integrity
1500 Kepner Drive
Lafayette, IN 47905

Catalysis Laboratory
Forney Hall of Chemical Engineering
480 Stadium Mall Drive
West Lafayette, IN 47907-2100

Energy Conversion Research and Energy Systems Simulation Laboratories
Electrical Engineering Building
465 Northwestern Avenue
West Lafayette, Indiana 47907-2035

Mechanical Engineering Tribology Laboratory
585 Purdue Mall
West Lafayette, IN 47907-2088

ADVANCED GROUND–VEHICLE POWER at PURDUE



https://engineering.purdue.edu/Engr

PEOPLE

John Abraham (ME)
Multidimensional spray/ combustion modeling

Doug Adams (ME)
Leak detection; valve, driveline & wheel M&S and diagnostics

Stuart Bolton (ME)
Noise control & source visualization

Patricia Davies (ME)
Sound quality

Ray Decarlo (ECE)
Power Management Control in Hybrid Vehicles

John Lumkes (ABE)
Design of hydraulic valve actuation systems

Peter Meckl (ME)
Engine and aftertreatment diagnostics

Steve Pekarek (ECE)
Motor/generator design, power electronics

Fabio Ribeiro (ChemE)
Catalyst kinetics

Farshid Sadeghi (ME)
Lube lab on a chip, tribology in transmission

Research to make **clean, efficient, fuel-flexible ground-vehicle powertrains**

ADVANCED ENGINE AFTERTREATMENT FOR ULTRA-LOW NO_x AND PM EMISSIONS

- Regeneration control algorithms for diesel particulate filters using high-bandwidth pressure sensing.
- Crack detection in diesel particulate filters using spectral signal processing techniques.
- Chemical and transport models for NO_x traps including the investigation of detailed kinetic and chemical transformation mechanisms.
- Experimental determination of kinetic parameters for processes occurring during NO_x trapping.
- Determination of benchmark parameter models of aftertreatment devices.

HYDRAULIC HYBRIDIZATION OF VEHICLE POWERTRAINS

The focus is on new transmission concepts including advanced power train control strategies for off-road and on-road vehicles The goal of the research is to investigate ways to drastically reduce fuel consumption and emissions for different kinds of vehicles. The research activities include:

- Modeling and simulating of power trains using PSDD, an in house MATLAB/Simulink Library.
- Performance prediction, including fuel consumption.
- New circuit solutions for continuously variable transmissions and hydraulic hybrids.
- Advanced power train controls.
- Hardware-in-the-loop testing of powertrains.
- Energy recovery.

POWERTRAIN PROGNOSTICS AND DIAGNOSTICS

Modeling and prediction for reliability in powertrain drivelines, transmissions, and wheel ends:

- Rotordynamic modeling of drivelines and wheels for hybrid vehicle development and torsional analysis.
- Fault diagnostics in powertrains to support durability testing and fault-tolerant control strategies.
- Prognosis of powertrain performance to enable durability predictions and life-extending control.

Development of On-Board Diagnostic (OBD) algorithms to detect and isolate emissions faults.

Crack detection in diesel particulate filters.

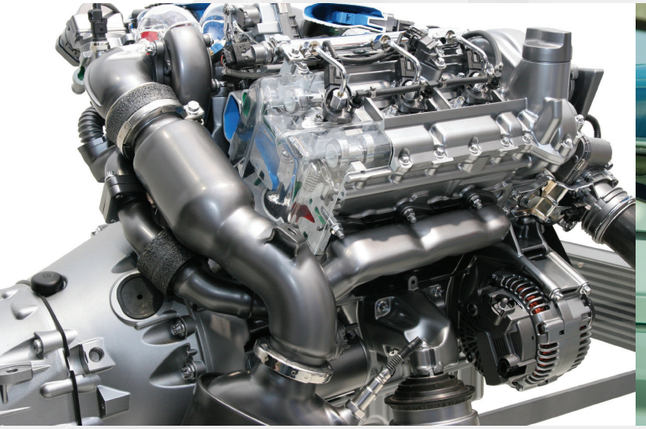
FACILITIES

Ray W Herrick Laboratory:

- 2007 and 2008 multi-cylinder Cummins diesel engines with full complement of exhaust emissions analyzers.
- Fully flexible variable valve actuation (VVA) system for camless engine research.
- Rolling chassis dynamometer and tire pavement test apparatus for driveline and wheel efficiency testing.
- Large semi-anechoic chamber with engine teststand.
- Microphone arrays for sound field visualization and sound power measurements.

MAHA Fluid Power Laboratory:

- Hardware-in-the loop testing of vehicle powertrain.
- Transmission and multiple pump and motor test rigs.
- 550 kW hydraulic power supply, 12,000 square foot lab area.



MODELING AND CONTROL OF ADVANCED INTERNAL COMBUSTION ENGINES

Closed-loop control and modeling (both multi-dimensional CFD and control-oriented) of advanced combustion for high efficiency and ultra-low NO_x/PM emissions:

- Premixed Charge Compression Ignition (PCCI).
- Homogeneous Charge Compression Ignition (HCCI).
- Camless valve actuation.

Fuel-flexible combustion for clean and efficient use of :

- Conventional fuels–gasoline, diesel.
- Alternative fuels–biodiesel, ethanol, coal-to-liquid fuels, gas-to-liquid fuels, natural gas, hydrogen.

Comprehensive multidimensional CFD modeling of sprays and combustion in engines and aftertreatment systems:

- Clean diesel engines.
- Alternative engine/aftertreatment concepts.
- Advanced spray strategies.

ELECTRIC HYBRIDIZATION OF VEHICLE POWERTRAINS

- Multi-objective design of electric machinery.
- Modeling and analysis of power electronic systems.
- Distributed heterogeneous computing.
- Minimization of acoustic noise and vibration from electric machinery.
- Prognostics and health management of electric drives.
- Electronically controlled continuously variable transmission (CVT) design.
- Powertrain control strategies for economy, emissions, and performance.
- Flywheel design and energy storage.
- Modeling for and control of power flow in hybrid systems and hybrid electric vehicles.

NOISE CONTROL FOR VEHICLE POWERTRAINS

- Acoustic modeling and noise control for vehicle powertrains.
- Modeling of sound sources and sound transmission.
- Experimental techniques for power train noise evaluation and model development.
- Pass-by noise diagnostics and visualization.
- Design of noise control materials, acoustic barriers and enclosures.
- Sound quality and environmental noise impact modeling.
- Evaluation of friction material for braking performance and reduction of friction-induced vibrations/noise in braking systems.

FACILITIES

Purdue Center for Systems Integrity (PCSI):

- Full-vehicle road simulator for vehicle chassis and suspension testing.
- Numerous sensing and acquisition systems including 3-D velocimeter for full-field vibration measurements.
- Component mechanical reliability test instrumentation for in-lab and on-vehicle performance testing.

Energy Conversion Research and Energy Systems Simulation Labs.

Mechanical Engineering Tribology Laboratory (METL).

Catalysis Laboratory:

- Full catalyst characterization, including chemical kinetics and material properties.
- Two dedicated test beds capable of simulating automotive exhaust emission treatment.