

# Current Projects

## Motor Grader Control Systems & Automation (w. J. Evans & D. Williams)

- Caterpillar is funding
- Automatic control system for operator assist functions.



Reduce fuel use, operator fatigue and machine damage.

## Ethanol/Biodiesel Blends as a low CO<sub>2</sub> Diesel Replacement for Off-road Engines (w/ E. Holloway)

- Funders: Deere & Fuels Groups
- Determine if fuel-adaptive control strategies enable ethanol/biodiesel blends w/o hardware changes



Reduce CO<sub>2</sub> >50% through use of a low CO<sub>2</sub> fuels

## Natural Gas Engine Controls for Data Center Power

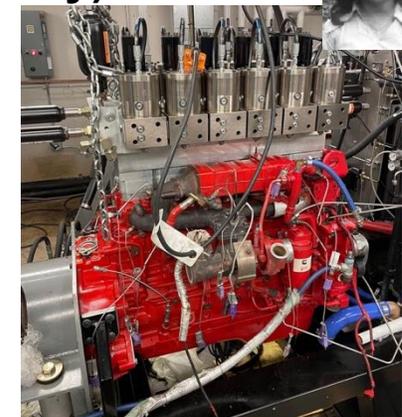
- Caterpillar is funding
- Advanced control development (MIMO, MPC, etc.) assessment for transient engine control



Resilient transient data center energy management.

## Natural Gas Engine VVA/CDA (w/ C. Goldenstein & E. Holloway)

- Cummins is funding
- Knock and throttling reduce performance & eff.
- Study merits of VVA/CDA In-cyl mass & composition estimation
- Engine testing at Purdue



~10% fuel savings w/ low-CO<sub>2</sub> fuel

# Current Projects

## Indy Autonomous Challenge (w/ D. Williams, S. Sundaram & S. France)

- Develop software to autonomously race the car
  - Perception
  - Planning
  - Motion control
- Racing on top tracks (Indy Motor Speedway, Laguna Seca, etc.)



Demonstrate Purdue/State of IN technical motorsports excellence; Develop high speed vehicle automation

## Automated Class 8 Truck Docking (w. D. Williams)

- Model-based control algorithm development & experimental validation for single, and two, trailer backing



Reduce trailer/dock damage & improve efficiency

## Energy Harvesting from Class 8 Truck Trailers (w. J. Gibert, A. Arrieta & J. Evans)

- Wabash is funding
- Design & test harvesting methods from trailer suspension, skin flex and aerodynamics



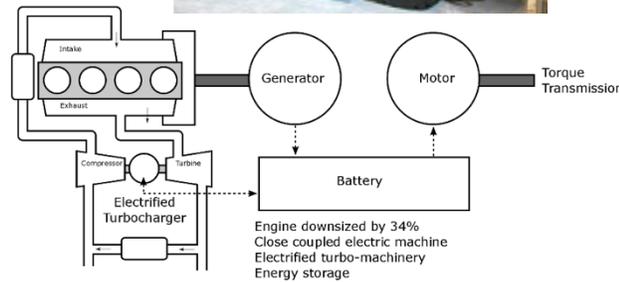
Reduce CO<sub>2</sub> and power advanced safety systems

# Previous Projects

## Heavy-duty Diesel Hybrid Electric Drivetrain

- DOE funded
- Collaboration with U. of Wisconsin and Deere
- Engine testing at UW
- Vehicle testing at Deere
- Purdue is leading control algorithm development for engine & powertrain

> 10% fuel/CO<sub>2</sub> reduction on full-sized wheel loader



## Autonomous Roadside Mowing (w. J. Evans)

- Funded by Indiana DOT
- Obstacle avoidance & path planning algorithms
- Unreal Engine to simulate photorealistic environment
- Pre-built mowing robot retrofitted for testing w. adv. algorithms



Improved road-side safety.

## Auto-Unload of Grain while Harvesting is Occurring (w. J. Evans)

- Deere funded
- Retrofits & experiments done at Purdue
- Camera & lidar-based perception
- Model-based control
- Unreal Engine to simulate photorealistic environment

Two patents with Deere & multiple journal papers



## Truck Platooning on Hilly Terrain (w. N. Jain, D. DeLaurentis & D. Bullock)

- ARPA-E & DOT funded
- collaborators: Peloton (start-up) & Cummins
- Model-based control

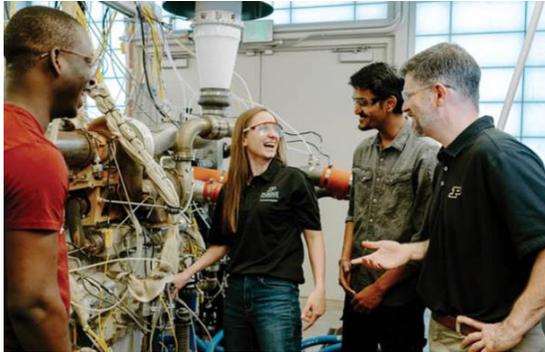


12.3% fuel/CO<sub>2</sub> savings + improved truck gap control

# Previous Projects

## High Efficiency Off-Road Engines (w/ E. Holloway)

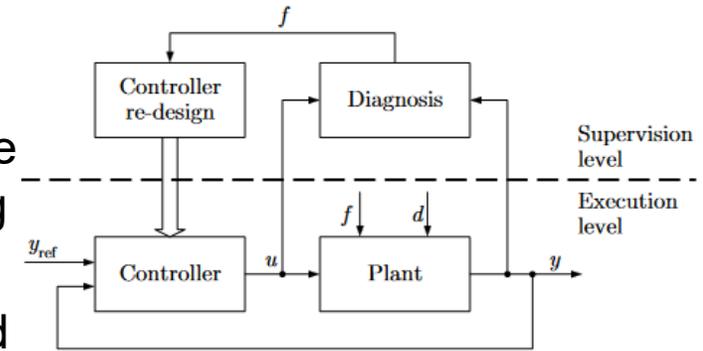
- Deere & Eaton funded
- Cylinder deactivation
- EGR pumping
- Steady-state & transient development



> 3% fuel/CO<sub>2</sub> reduction at high loads; > 30% at low loads

## Control and Sensing Resiliency in Navy Marine Diesel Engines

- ONR funded
- Reduce downtime due to control and sensing failures
- Develop model-based diagnosis and fault tolerant control algorithms



Increase up-time of remotely deployed engines.

## Improving Transmission Resilience to Driveline Resonance Through Detection & Control (w/ J. Evans & A. Bajaj)

- Allison funded
- Analyze Allison data
- Simulate resonant conditions
- Develop mitigation techniques



Algorithm detects anomalies and mitigates via control.

## Investigate methods to generate models for CTT Turbine maps using Machine Learning

- Cummins Turbo Technologies funded
- Turbine maps describe the product performance of turbines
- Use AI to enable evaluation of turbine performance at any speed & expansion ratio condition

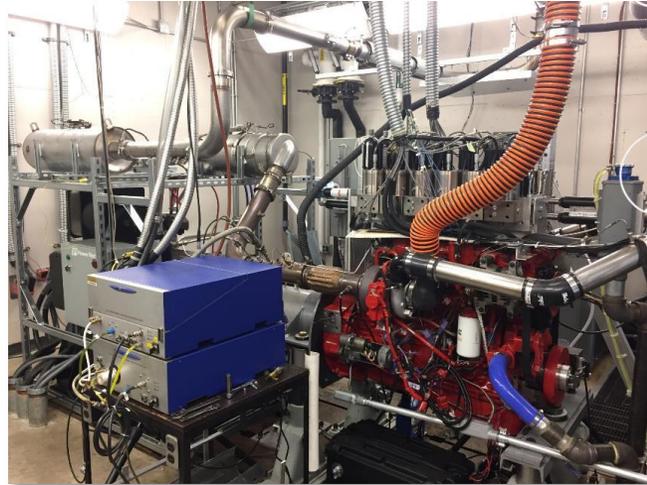


<1% error for turbo map model accuracy for flow & efficiency. 2.5x better than current approach.

# Previous Projects

## Improving Diesel Engine Efficiency & Thermal Management via Variable Valve Actuation (VVA)

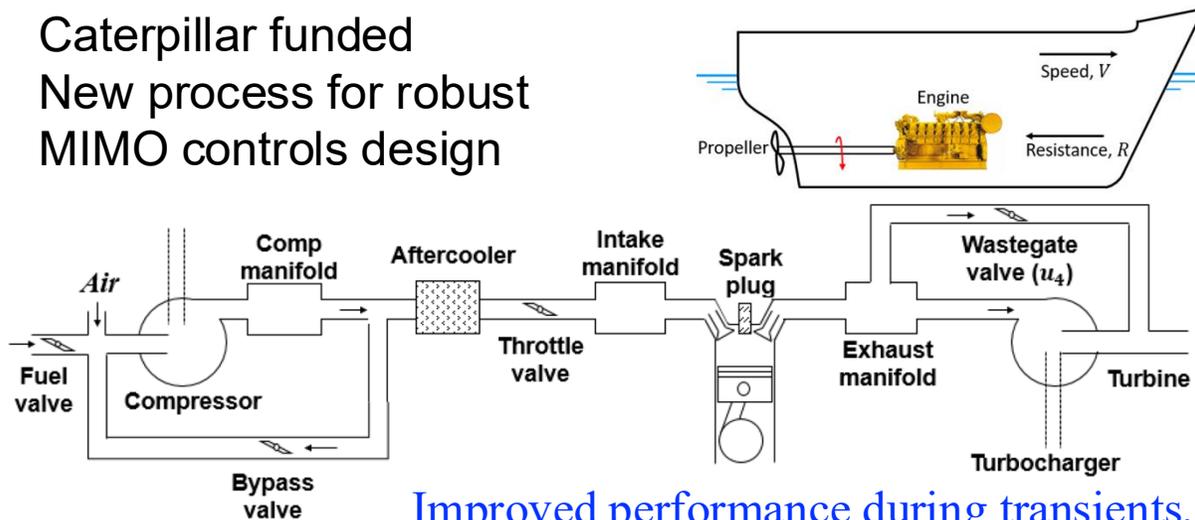
- Funded by Cummins, Eaton & DOE
- 7 papers cited by California Air Resources Board
- 3 papers cited by United States EPA



Helped drive new emissions regulations for CO<sub>2</sub> and NO<sub>x</sub>

## Robust Natural Gas Marine & Genset Engine Controls

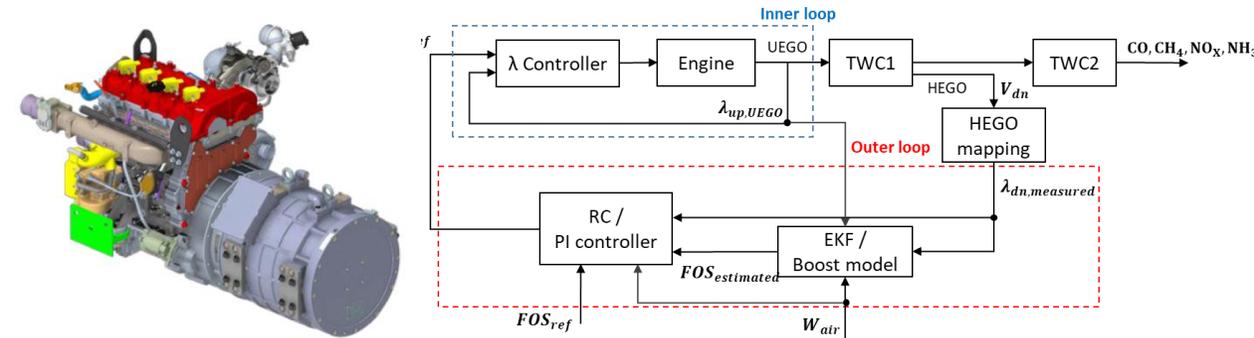
- Caterpillar funded
- New process for robust MIMO controls design



Improved performance during transients.

## Robust Control of Nat. Gas Engine Aftertreatment

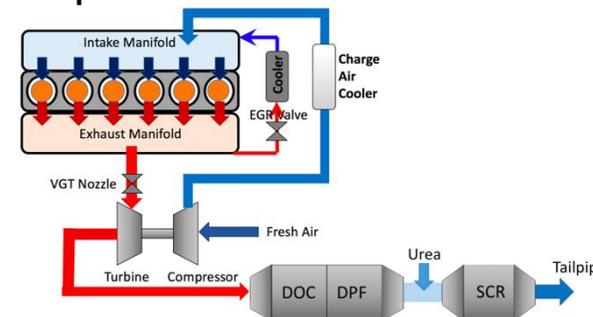
- DOE funded
- Collaboration with Cummins
- 2 journal papers with Cummins



Reduce CO<sub>2</sub> emission by 30% + ultra-low NO<sub>x</sub>

## Biodiesel Impact: Hvy-Duty Engine/Aftertreatment

- Demonstrated some issues w/ NO<sub>x</sub> and torque
- Can likely be mitigated via Purdue developed controls
- Sponsor: National Biodiesel Board



Identified challenges that need to be met for biodiesel

# Previous Projects

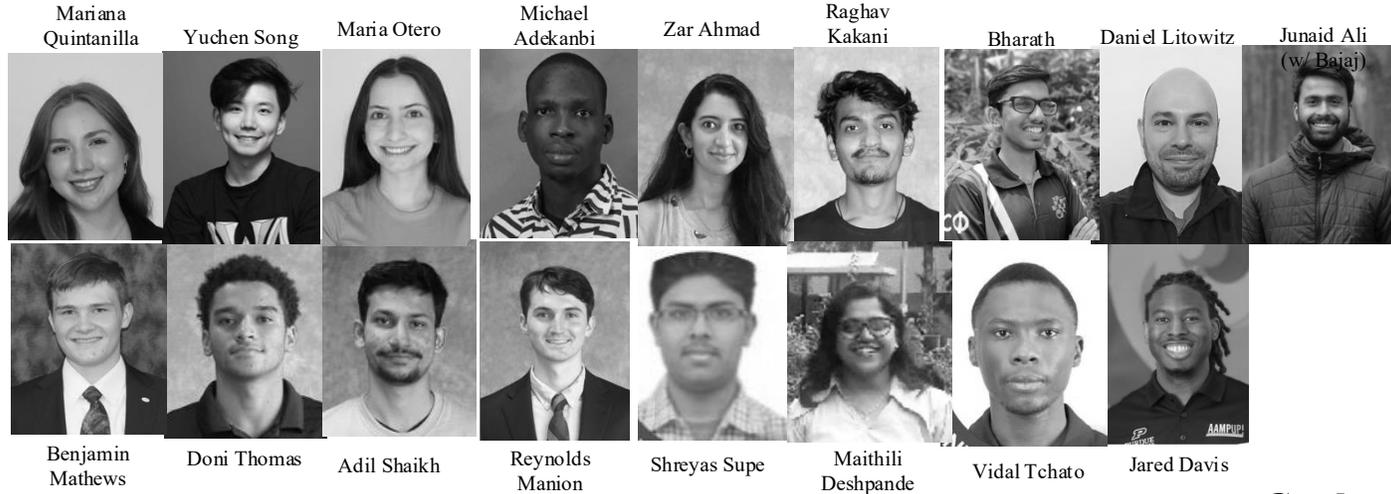
## H<sub>2</sub> Engine Powered Excavator (w/ A. Vacca, L. Shang & E. Holloway)

- DOE funded
- Collaboration w/ Cummins, Komatsu, & Bosch-Rexroth
- eBoosted engine & vehicle testing at Purdue
- Purdue is leading engine/powertrain control algorithm & fluid power system development



Reduce CO<sub>2</sub> emissions by 100%

# 16 Active Graduate Students (12 Phd, 4 MSME) + 1 post-doc



Greg Shaver, PhD  
*Faculty Lead*

Employed at industry partner company.

Tenure-track faculty.

# Graduated students – 26 PhDs & 36 MSME

