



**Kettering SnowDogs  
Spark Ignited**

# Kettering UNIVERSITY 2018 Design Approach

## **1. Versatility**

- **Ski-Doo MXZ Sport 600 ACE**

## **2. Advanced Controls**

- **Full Authority Engine Management with Electronic Throttle**

## **3. Emissions and Noise Controls**

- **Three-way catalytic muffler**
- **Switching O2 control**

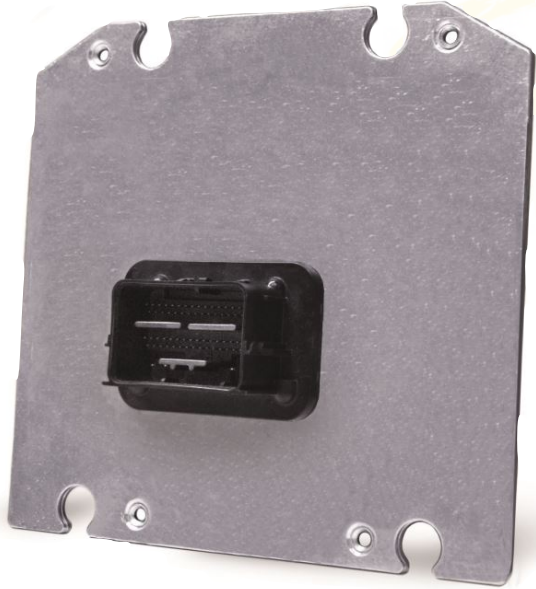
## **4. Simple, Reliable design**



# Rotax 600 ACE engine

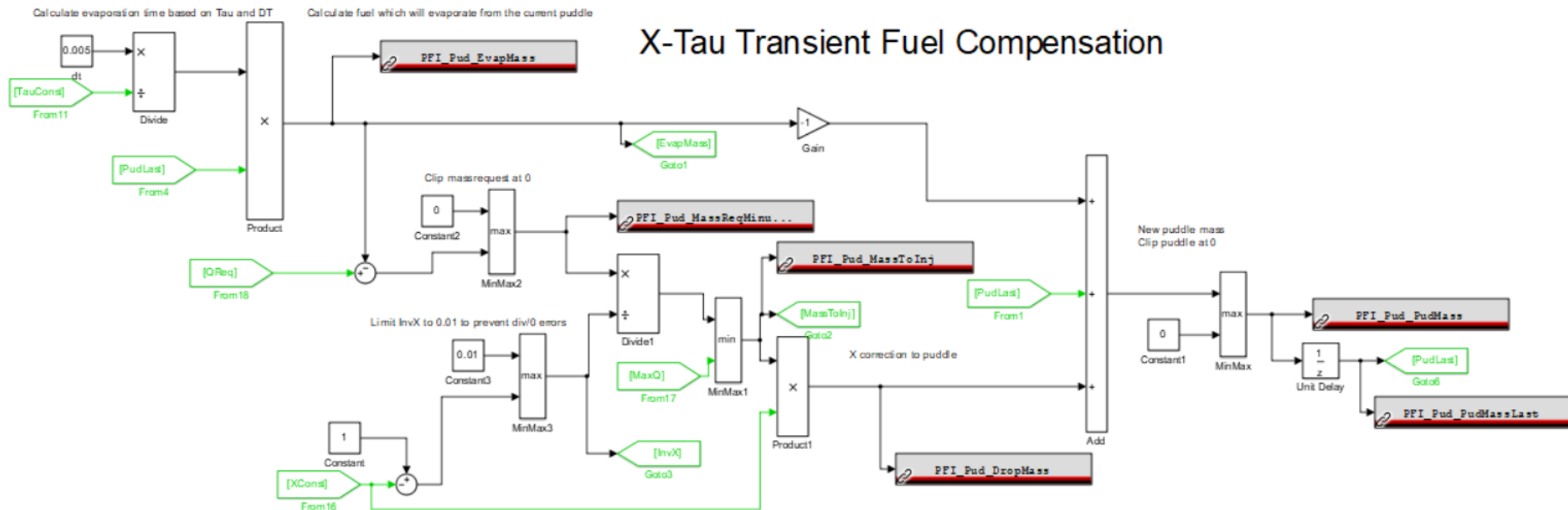
Model	600 ACE
Displaced volume	599cc
Compression ratio	12:1
Number of cylinders	2 in-line
Combustion chamber	Four-valve pent roof
Valvetrain	Chain-driven DOHC
Rated Power	42kW @ 7200rpm
Rated Torque	55Nm @ 6000rpm
Fuel System	Returnless Port Fuel Injection
Throttle Control System	Electronic
Engine Control Unit	Woodward MotoTron SECM70
Control Model	Student-Developed
Catalyst	1/0/1 600cpi 33 g/cu-ft loading

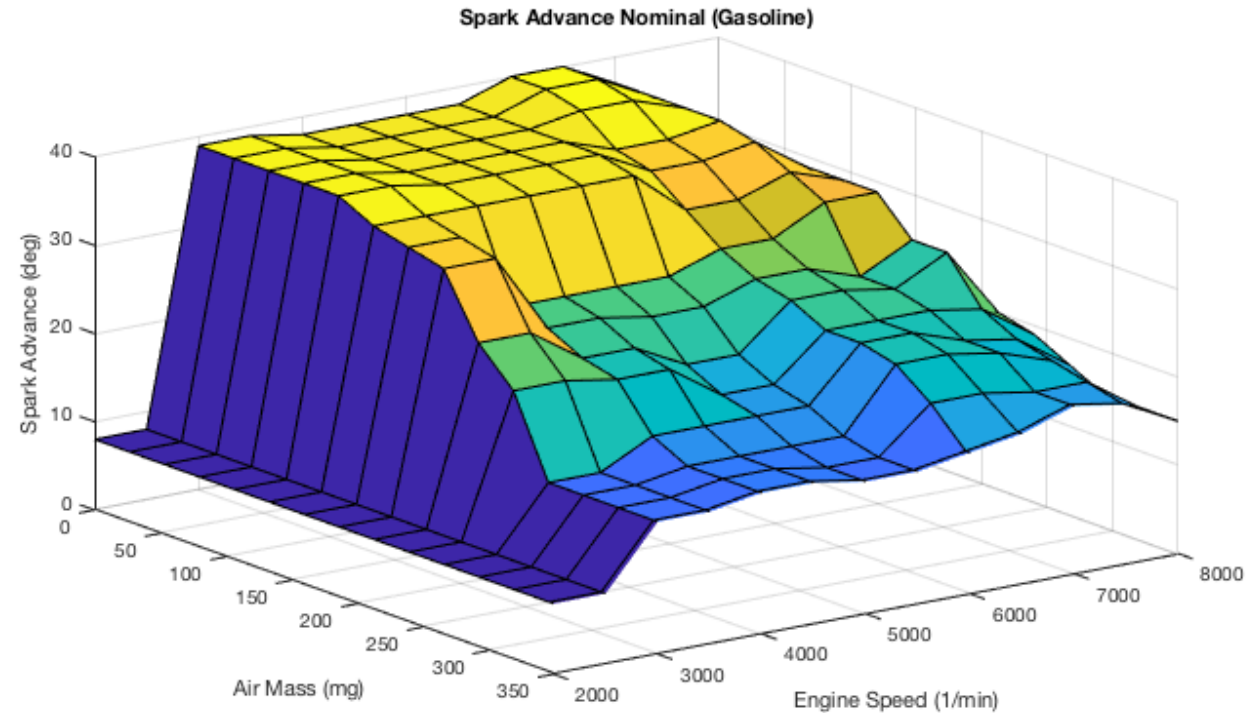
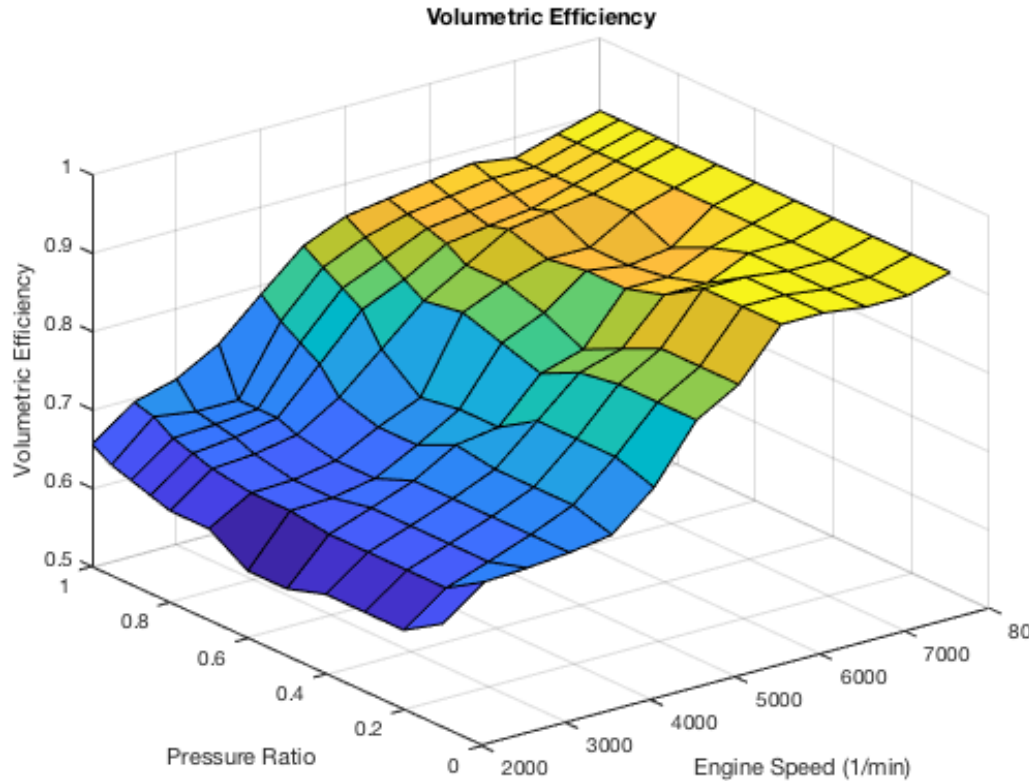




- **Student developed**
- **Rapid prototype ECU hardware**
- **Engine control algorithms developed in Simulink**
- **Full authority including throttle control**
- **Flexible fuel equipped**
- **Decel Fuel Cut**
- **Clean and Efficient focus**

- Engine control algorithms are air mass based
- Air mass modeled from MAP
- Fuel mass calculated from air mass and fuel-air ratio target



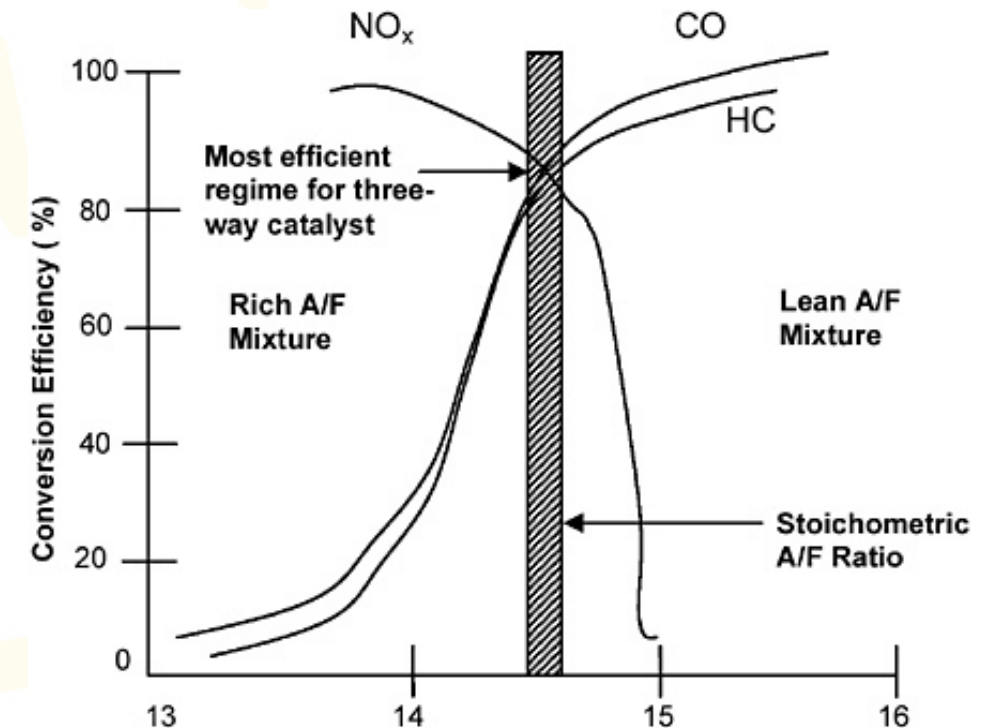


**Dynamometer mapped for best BSFC - 260g/kWh best**

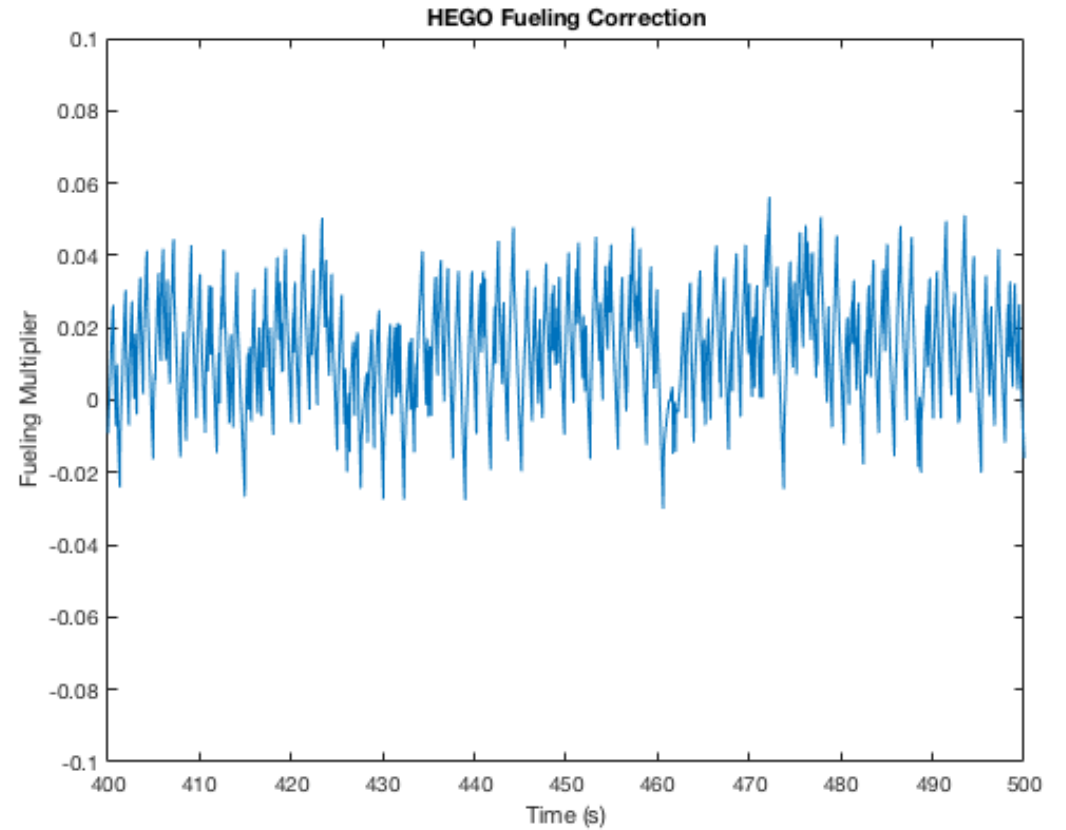
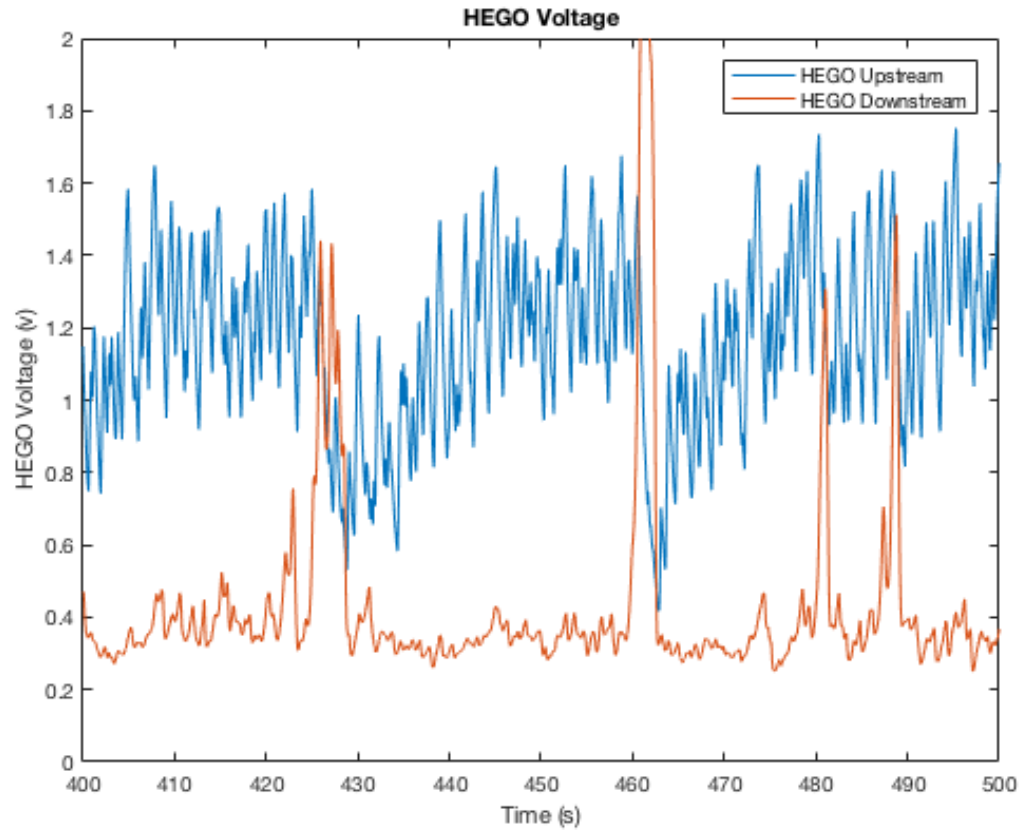


# Kettering UNIVERSITY Aftertreatment

- **Three-Way Catalyst**
  - **Oxidizes HC and CO**
  - **Reduces NO<sub>x</sub>**
  - **High conversion efficiency when oxygen is controlled**
- **Switching oxygen sensor control**
  - **‘Upstream’ control of engine-out oxygen**
  - **‘Downstream’ control of catalyst-out oxygen to moderate oxygen storage on brick**
- **Engine must enrich at high load for catalyst protection**



# Kettering UNIVERSITY Aftertreatment



**EPA 5 mode E-Score: 189**



# Kettering UNIVERSITY Noise

- **Focus on all sources of noise**
  - Engine intake and exhaust
  - Radiated engine noise
  - CVT/Chaincase/Driveline
  - Track
- **Attenuation strategy**
  - Dynamat Xtreme dampening of all chassis panels and bodywork, tunnel, and CVT cover
  - Dynamat Hoodliner absorptive foam on all bodywork surfaces
  - Short 120" track selected for minimal track noise





- **Exhaust silencer**
  - **Two-chamber muffler design**
  - **Low frequency resonator**
  - **High frequency fiberglass muffler**
- **Passive acoustic valve**
  - **Resistive tuning for low frequency attenuation at low mass flow**
  - **Valve opens at high load to reduce engine performance penalty**
- **Catalyst integrated into muffler**

# Kettering UNIVERSITY Questions?

