Team Tennessee 8

Shaun Hinds
Scott Curran
Courtney Lindwurm
Presentation Outline

- ChallengeX Overview
- The RevolutionX
- Engine and Emissions
- Hybrid and Controls
- Outreach
What is ChallengeX

- Minimize Energy Consumption
- Reduce Emissions
- Maintain/Exceed Vehicle Performance

Competition

- Year 1 – Modeling, Simulation, Powertrain testing
- Year 2 – Integrate & Develop Powertrain
- Year 3 – 99% Buy-Off
- Year 4 – Detroit - DC
Points Breakdown for Year 3

- Outreach: 4%
- Engineering: 28%
- Safety: 5%
- Performance: 15%
- Emissions: 14%
- Fuel Economy: 14%
- Consumer: 20%

Progress Report #2
Outreach

Consumer
20%

Emissions
14%

Fuel Economy
14%

Safety
5%

Performance
15%

Engineering
28%
Engineering Challenges

- Maximizing packaging efficiency
- Preservation of BFI vehicle integrity
- Sub-system module interfacing and communication (Controls)
- Scheduling component substitutions
Integrated Vehicle Design

- 1.9 Liter GM Turbo Diesel (B20)
- 67 kW Ballard IPT (Electric Motor)
- 336 Volt NIMH Cobasys Battery
- National Instruments Compact Rio*
Component Layout

1.9L Diesel Engine

Fuel Tank

NiMH Battery Pack

IPT

IPT Controller
Packaging

Battery Pack Compartment Modification

• IPT interference with sub-frame
### Design Goals
- Increase fuel economy
- Maintain performance and utility
- Reduce emissions
- Noise considerations

*MPG = 34% over stock!

#### 6th Place Overall
Engine + Aftertreatments

- Turbo Diesel Engine
- Oxidation Catalyst
- DPF
- Urea SCR

Fuel Economy + Emissions = 24% Points
Progress Report #2

MPG = 34% over stock
Volatile Organic Compounds (VOC)

Oxidation Catalysts

• Remove up to 90% of VOC

• Counteract DPF

Catalyst Pathways

• CO + ½O₂ → CO₂
• [HC] + O₂ → CO₂ + H₂O
**Particulate Matter (PM)**

**Diesel Particulate filters**

**Benefits**
- Remove ~90% of Soot

**Drawbacks**
- HC regeneration ~ <20%
- Require surface regeneration or replacement
Oxides of Nitrogen (NOx)

**Benefits**
- Very high efficiency 85-96% conversion
- Improved Fuel Economy

**Drawbacks**
- Requires Urea infrastructure
- Urea Slip
- Reduced effectiveness due to:
  - Poisoning
  - Deposition
Urea – SCR

BlueTec® functionality

AdBlue tank
Exhaust gas containing nitrogen oxides

Ammonia + water vapour + nitrogen oxides

SCR-Kat
Nitrogen + water to the environment

Metering unit
Programmed Control
Using dynamometer data
Programmed output

SCR Control Strategies

Advanced Diesel Emission Control System (ADEC I)

UREA/AMMONIA CONTAINERS
ECU
REGULATOR
SOLENOID VALVE
SENSORS
DIFFUSER
SCR
DPF
EXHAUST MANIFOLD
ENGINE
**B20 and Emissions**

**Emission Reductions (at the Tail Pipe)**

- CO₂  – 10%
- PM    – 15%*
- THC   – 10%
- SOₓ   – 20%
- NOₓ   – ~0%
Control System

- Redundant signal connections for safety
- Extensive subsystem handshaking
- CAN communication is inherently secure
- Closed loop battery control ensures integrity/longevity
Control Strategy Development

PSAT – Year 1

Labview – Year 2

Mototron – Year 3
Through-The-Road Parallel Hybrid

**Advantages**
- Complete redundancy
- Simple to implement
- Only one electric machine needed

**Disadvantages**
- No stationary charging
- Engine must always be running
Through The Road

Front

Rear

WHEEL

FUEL → ENGINE → TRANSMISSION → FINAL DRIVE → WHEEL

WHEEL

FINAL DRIVE → MOTOR/GENERATOR → POWER ELECTRONICS → BATTERIES
Outreach

• Previous Events
  – Make Orange Green
  – Engineers Day
  – Alt Fuel Odyssey
  – Catholic High
  – Heska Amuna
  – SCCA Autocross

• Upcoming events
  – Earth Fest
  – Girl Scouts
  – Technology Club
  – ORHS
  – Web School
Outreach – Media

UT Engineering Students Compete in Challenge X

Members of the University of Tennessee student chapter of the Society of Automotive Engineers, along with faculty mentor Dr. Bench Irwin (left), gathered around their Challenge X vehicle. The event is an annual contest sponsored by General Motors that pits engineering students from colleges and universities around the country in a contest to build a mock vehicle. This year’s contest involves rebuilding a Chevrolet Equinox to run as a hybrid vehicle powered by biodiesel and electricity, while still maintaining safety and carbon standards.

The turbo-diesel engine was installed in a Chevy Equinox by the SAE members. The engine is built to run on biodiesel fuel, as part of the hybrid system used to power the vehicle.

The engine of the hybrid system in the Challenge X vehicle, the electric motor boosted by the students, enhances the storage space in the back, which helps move the vehicle.

UT students design energy saving car, run test in Oak Ridge
Outreach Materials

- Shirts
- Mugs
- Pens
- Brochures

apcsi.tennessee.edu
Thank you Oak Ridge ASME
East Tennessee ASME

For More Info
apcsi.utk.edu
## EPA Guidelines

### 0.07 g/mi NOx fleet average

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Delphi emissions handbook + challenge X
# Dynamic Events

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