THE LATEST ADVANCED VEHICLE TECHNOLOGY COMPETITION

2009 MERIT REVIEW

MIKE WAHLSTROM
KRISTEN DE LA ROSA
ARGONNE NATIONAL LABORATORY
MAY 20, 2009

Project ID:
ti_11_wahlstrom

This presentation does not contain any proprietary, confidential, or otherwise restricted information

Overview

Timeline

- Started June 2008
- Ends June 2011
- 28% Complete
- Year 1 (vehicle design year) completion June 2009

Budget

Total over 3 years

- DOE: $4.72M
- Non-DOE $7.313M
- Industry In-Kind $75M

Barriers

- Vehicle System Analysis
  - Development of computer modeling tools
  - Establish University resources for unbiased vehicle benchmarking
  - Development of University programs and curriculum in the area of advanced vehicle technologies

Partners

- 34 Government and Industry Partners (see next page)
- Managed by AVTC team at Argonne National Laboratory

Finalized Sponsors as of 3/20

Headline

Diamond

Platinum

Gold

Silver

Bronze

Event Sponsors

Technical Objectives

- Overall Project Objectives
- EcoCAR challenges 17 North American universities to re-engineer a Saturn VUE to increase efficiency, reduce emissions and out perform its production counterpart while maintaining its consumer acceptability
- Train students for the work force in the areas of:
  - Vehicle testing, modeling, simulation design and optimization
  - Mechanical Integration
  - Electrical Integration
  - Control System Integration
  - Battery System Design
- Demonstration and testing of 17 distinct advanced technologies on a common vehicle platform

Technical Objectives

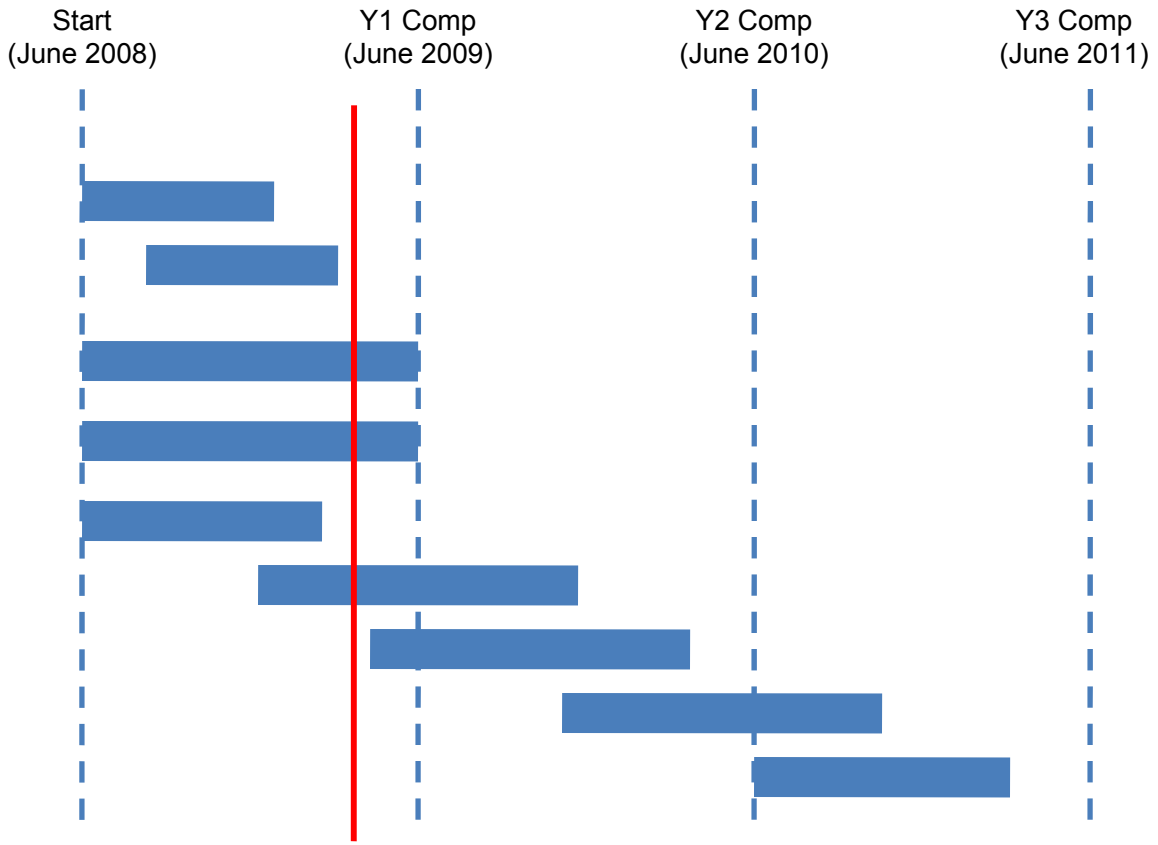
- Objectives of Year 1:
- Expand the control development program
  - Software in the loop Utilization
  - Hardware in the Loop Utilization
  - Increase support for control development tools
    - Software
    - Hardware
- Expand the possibilities for technology use
  - Hybrid technologies
  - Plug in Hybrid Technologies
  - Fuel Cell Technology

Technical Objectives

- Objectives of Year 1:
- Develop a Year 1 competition structure that will force Universities to finish full vehicle designs by June 2009
  - Mechanical design
  - Electrical design
  - Control system design and development
- Improve the Competition rules in the areas of:
  - Safety
  - Applicability to advancing technologies

Milestones

Task
Develop a new year 1 report format
Develop new vehicle build guidelines and year 1 event rules
Develop Custom Control for 2MH
Develop Custom Control for Project Driveway Fuel Cells
Develop HIL models and systems for schools
Design Year 2 Dynamic Events
Develop Year 2 Event Rules
Design Year 3 Dynamic Events
Develop Year 3 Event Rules

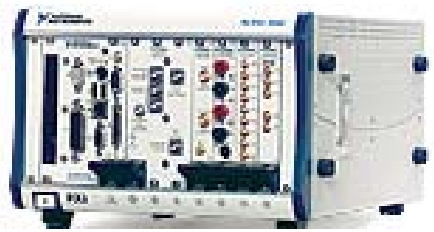


Approaches

- Objective 1: Expand the Control development program
- Offer HIL systems to each University to improve Rapid Control Prototyping
  - Provide standard vehicle model baseline with reduced fidelity to ensure the ability to run models in real-time on a relatively simple HIL system and introduce SIL models of some vehicle controllers to minimize I/O requirements of HIL systems
- Objective 2: Expand the possibilities for advanced technology use
- Offer FWD 2Mode hybrid transaxles and Fuel Cell systems to Universities
  - Coordinate development of a custom control interfaces for Universities to be able to utilize advance 2Mode and fuel cell systems while protecting the transaxle from damage during operation
- Objective 3: Improve the competition rules and guidelines in the areas of safety and applicability to advancing technologies
- Implement new rules that will protect against Torque Safety and Security issues and Safety critical systems
- Introduce new PHEV and EREV test methods for measuring and evaluating On Road Fuel Consumption, WTW GHG, WTW PEU using an upcoming SAE J1711 Utility Factor calculation
- Objective 4: Develop a Year 1 competition structure that will force Universities to finish full vehicle designs
- Implement progress report structure with Frequent deliverable deadlines to ensure teams stay on track throughout the design year

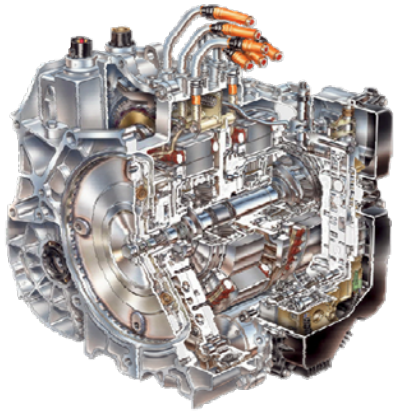
Technical Accomplishments

- Task 1: Development of Rapid Control Prototyping Systems
- Partnered with dSPACE and NI to design and deliver Hardware in the Loop systems to every university
  - Included: HIL Simulators, Controllers, Failure insertion units, power supplies, sufficient analog and digital I/O, HIL CPU sufficient to run models in real time
- Partnering with GM developed advanced controller and communication based models of production vehicle and some GM donated components
  - Leveraged EcoCAR model for use as the first model for Autonomie



Technical Accomplishments

- Task 2: Develop Custom Control Interface for GM advanced vehicle systems
- Chaired team that redesigned 2Mode software to allow the students to implement their own strategic optimization
  - Torque and Power limits are fed back to the university controllers to ensure safe operation
- Coordinated and chaired team that's redesigning GM Project Driveway fuel cell software
  - Allow students to utilize power command structure
  - Safeguard system against over-current damage



Technical Accomplishments

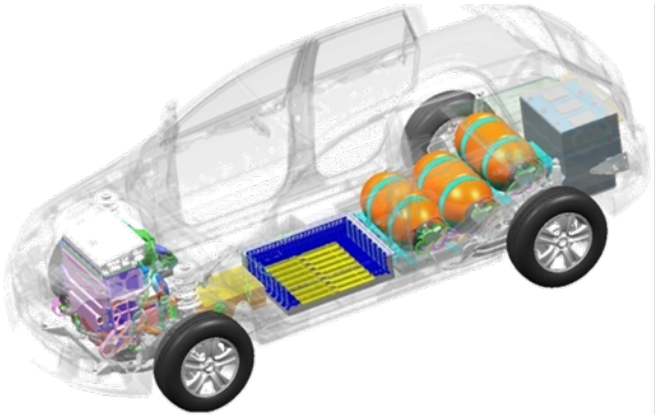
- Task 3: Improve the competition rules and guidelines in the areas of safety and applicability to advancing technologies
- Integrated Torque safety and security guidelines to be followed by teams
- Trained schools on safety critical system design
- Implemented J1711 Utility Factor structure into vehicle testing in the areas of
  - Well To Wheel Greenhouse Gases
  - Well To Wheel Petroleum energy use
  - Fuel Consumption

$$GHG = \left[\left(GHG_{CD}\right)_{WTP} + \left(GHG_{CD}\right)_{PTW}\right] \times UF + \left[\left(GHG_{CS}\right)_{WTP} + \left(GHG_{CS}\right)_{PTW}\right] \times \left(1 - UF\right)$$

Example equation for UF weighted GHG calculation

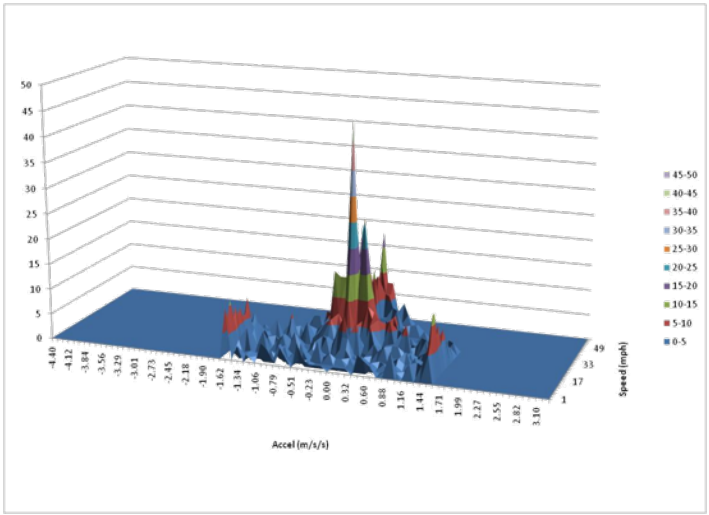
Technical Accomplishments

- Task 4: Develop year 1 competition structure to force students to have completed vehicle designs by June 2009
- Developed Progress Reporting structure that provides frequent deliverable deadlines to keep schools on track
- Schools have now completed vehicle designs in the areas of
  - Electrical systems
    - Including power electronics and battery systems
  - Mechanical Integration
  - Control systems



Future Work

- Drive Cycle development
  - The goal is to mimic the a combined UDDS and HWFET
  - There is a concern about universities “gaming” controllers if we copy the UDDS/HWFET exactly
  - Exploring techniques utilizing drive cycle parameterization to ensure adequate correlation to standard test procedures
  - Drive cycle selection criteria is currently being reviewed
  - Timeline: May 2009 – September 2009
  - Critical Milestones: July 15th for ANL approval of cycle and techniques, August 15th for TSC approval of cycle and techniques



Future Work

- 2Mode and Fuel Cell software testing
  - Implement final software on advanced systems and test in vehicle
  - Timeline: May 2009 – July 2009
  - Critical Milestones: June 2009 for Board review, Aug 1 2009 for university delivery

Future Work

- Competition event design and logistics
  - Finish design on all events including logistics to complete competition finals in Yuma, Az
  - New reporting templates
  - Finalize Year 2 rules
  - Timeline: May 2009 – January 2010