Spring 5-2006

Challenge X--Crossover to Sustainable Mobility

Kevin C. Hansom
University of Tennessee-Knoxville

UNIVERSITY HONORS PROGRAM

SENIOR PROJECT–PROSPECTUS

Name: Kevin Hansom

College: Engineering

Department: Mechanical

Faculty Mentor: Dr. David K. Irick

Project Title:

Challenge X - Crossover to Sustainable Mobility

Project Description (attach not more than one additional page, if necessary):

For this project, we will be converting a 2005 Chevy Equinox from a 3.4L V-6 powered all-wheel-drive SUV into an equally capable Hybrid Electric Vehicle (HEV), powered by a 1.3L Fiat Engine in conjunction with a large electric motor. Once completed, our vehicle should perform comparably with the gasoline-only version, while remaining much more environmentally friendly and providing far superior fuel efficiency.

More specifically, I will be working on power systems integration. The added power demands of the large electric motor require the installation of an externally manufactured 288V battery pack. I will be responsible for modifying the vehicle chassis to accommodate the battery, integrating the battery into the current electrical system, and fabricating the cooling system required for full time operation of the unit.

Once completed, the vehicle should function just as any other vehicle on the road today. However, given the current global energy situation, the exploration of alternative power sources and the development of more efficient means of transportation are critically important.

This project should be completed by the end of the Spring 2006 semester, with the design competition taking place in July of 2006.

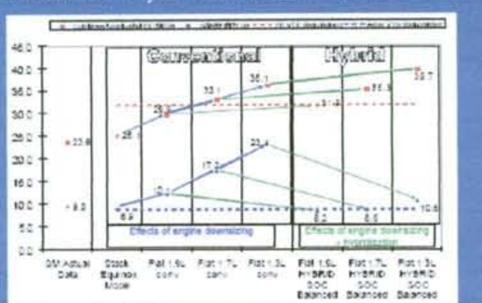
Seniors Honors Project
Kevin Hansom
University of Tennessee

ChallengeX – Cross-Over to Sustainability

Challenge X at the University of Tennessee

- Senior capstone design
  - Ground-up design and construction of a hybrid vehicle
- Sponsored Competition
  - General Motors
  - Argonne National Laboratory
  - Department of Energy
- Subdivided into teams / tasks
- Testing / Competition in June 2006
  - 17 schools compete
  - Different categories of awards / judging

Effects of Hybridization of a Vehicle



Integrated Vehicle Design

Thru-The-Road Hybrid

Thru-the-Road Configuration provides System Redundancy by Segregating the High Voltage System for the IC engine components

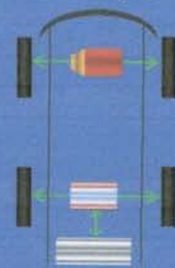
Integrated Vehicle design - components

- 1.9 Liter High Pressure, Common Rail, Turbo Fiat Diesel Engine Running on Bio-diesel (B20
  - Notably underpowered for vehicle size
- 75 kW Ballard Induction Traction Motor
  - Provides low-end torque and extra horsepower to compensate for smaller, more fuel-efficient diesel IC engine
- 344 Volt NIMH Cobasys Battery Pack
  - Cooling system under development in-house
  - Pack control strategy also under development
- Programmable Custom Vehicle Controller
  - Program algorithm devised by students

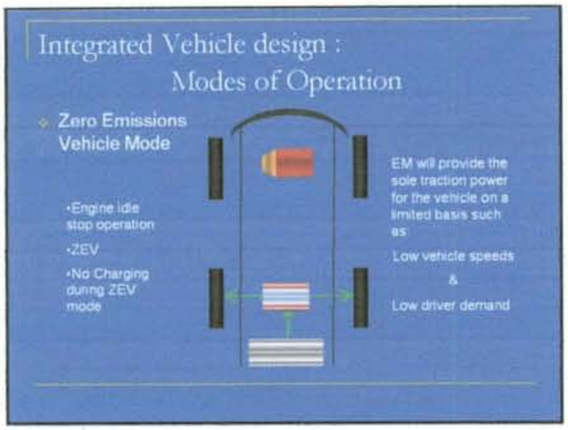
Integrated Vehicle design : Modes of Operation

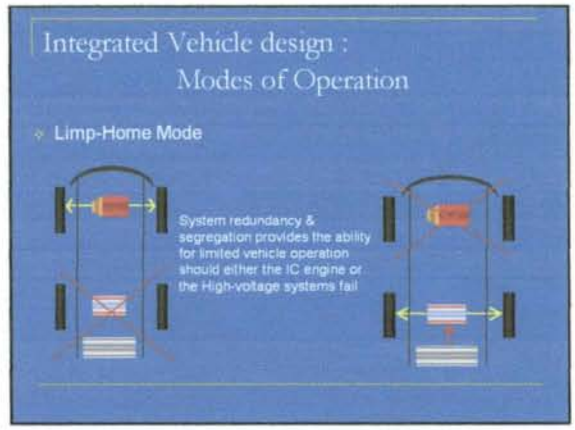
- Full Hybrid mode

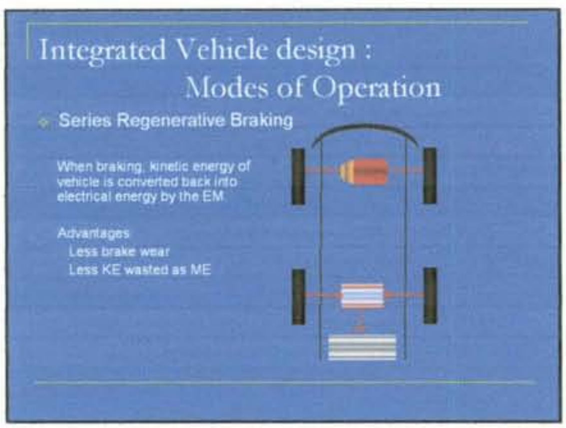
Both IC engine and ITM provide the traction power for the vehicle

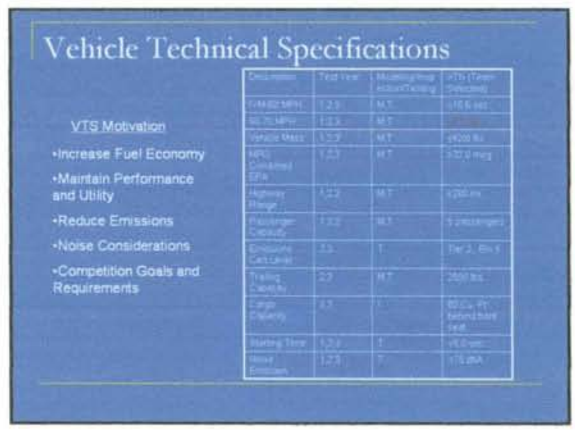


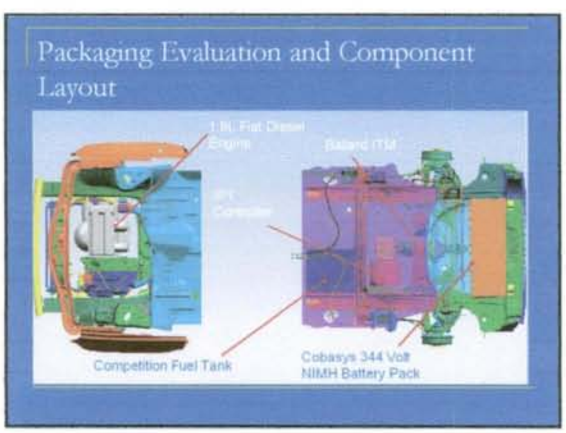
Battery Charging Occurs at Vehicle Cruising speeds when the IC engine can provide excess power to do so (i.e. steady state operation).


Integrated Vehicle design :
Modes of Operation
Zero Emissions Vehicle Mode
•Engine idle stop operation
•ZEV
•No Charging during ZEV mode
EM will provide the sole traction power for the vehicle on a limited basis such as
Low vehicle speeds
&
Low driver demand


Integrated Vehicle design :
Modes of Operation
Limp-Home Mode
System redundancy & segregation provides the ability for limited vehicle operation should either the IC engine or the High-voltage systems fail


Integrated Vehicle design :
Modes of Operation
Series Regenerative Braking
When braking, kinetic energy of vehicle is converted back into electrical energy by the EM.
Advantages
Less brake wear
Less KE wasted as ME


Vehicle Technical Specifications
VTS Motivation
•Increase Fuel Economy
•Maintain Performance and Utility
•Reduce Emissions
•Noise Considerations
•Competition Goals and Requirements


Packaging Evaluation and Component Layout
1.9L Fiat Diesel Engine
Ballard ITM
Controller
Competition Fuel Tank
Cobasys 344 Volt NIMH Battery Pack


Packaging Continued
Trouble Areas for THRU-the-Road
Battery Pack Compartment Modification
Pack interference with sub-frame
Cooling system in/out connections
Rear Sub-frame
Component to Frame interference

Unique Program Aspects

- Hands-On Experience
  - Cutting Edge Technology
    - Batteries
    - PSAT Software
    - Matlab + Simulink
  - All design and construction self-directed
- Bridge to employment with industry leaders

Project Completion Outlook

- ChallengeX Competition – June 2006
  - Arizona
  - All Team members go (expense-free)
  - Culmination of project / senior design work
- Car Shipping Deadline – May 1, 2006
  - Minor modification allowed at testing site
- Preliminary Tech Inspection – March 1, 2006
  - Done at each University by GM / ChallengeX
  - All vehicles must be running / driveable

Questions?

- The End! Thanks for your attention!