

PROJECT PLAN
I PRO 342 – Fall '06
Hybrid Electric School Bus: Simulation, Design & Implementation

Submission Date: *Friday September 22nd 2006*
Team Advisors: *Dr. Ali Emadi, Prof. Fernango Rodriguez*
Team Members: *Preeti Abraham, Sonya M. Colletti, Joel Fenner, Ali Gowani, Eric M. Hope, Tyler K. Inouye, Mohammed Khader, Garrett T. Nielson, Aamer Saeed, Jatan Shah*

Objectives

IPRO 342 aims to create a workable test bed for a hybrid electric school bus. The initial work will include the planning and design of the test bed (carried out this semester), followed by the implementation and testing of the test bed (most of which will be carried out next semester). The goal will be to create a scaled model of the bus with correctly modeled electrical and mechanical systems. A parallel HEV (Hybrid Electric Vehicle) system with a permanent magnet electric motor will be used, and research by previous student teams will be utilized and expanded upon.

Background

One of the up and coming concepts in the modern world is the idea of hybrid electric vehicles. Unlike conventional vehicles, HEVs utilize a combination of an electric machine and an internal combustion engine (ICE) to propel the vehicle, but in a way that is more fuel efficient and better for the environment. There are numerous options for the hybridization of vehicles. This is where the development of a test bed becomes key to the furthering of this improved vehicle, both in terms of design and on the market.

Although the ICE performs very well at constant speeds, its efficiency at transient speeds is extremely poor. An electric machine, however, can be much more efficient and environmentally friendly at these changing speeds. Since school busses start and stop so frequently, they are one of the prime candidates for improvement by hybridization. The resulting improvement in fuel efficiency would be the savings of a tremendous quantity of resources. Additionally, the improved emissions would be better for the children.

Previous hybrid electric vehicle research has determined that there are some difficulties with the series HEV set up (i.e. the coupling of a generating electric machine and ICE to drive an outputting electric machine). These include the loss of power in multiple conversion locations, the higher cost, and lesser flexibility. One of the major advantages of a parallel HEV system (i.e. the ICE and electric machine output are combined into the drive shaft) is the ability to run on either the internal combustion engine (ICE), the electric machine, or both in various combinations. This is exactly why the team will implement the HEV test bed using a parallel configuration.

While there are several types of software programs already in use to look at fuel efficiency in automobiles, most of them are unable to take into account the modern ideas and functions of a hybrid electrical vehicle. Thus, the development of a test bed is necessary to improve and standardize the hybrid electric vehicle, something that many auto manufacturers are looking at as well.

Methodology

The team will begin by studying current configurations of parallel hybrid electric systems in order to determine the most useful organization to implement in a test bed. The overall, more complicated task of designing an optimal test bed will become more manageable by dividing larger system into multiple subsystems and, subsequently, having a group of students work on each subsystem. In particular, the IPRO team will divide into an electrical team and a mechanical team. Each team will first construct a high-level block diagram of its sub-system, highlighting the major components that need to be researched and the connections amongst those components. Team leaders from each team will then assign individual blocks from their team's block diagram to each of the team members based on the members' interest and skill set. For example, the electrical team leader may ask one team member to research batteries and another to compare electric motors.

Product specifications will then be considered by each team member in order to compare costs, benefits, and needs; these will be discussed within each sub-team. Throughout the design phase, however, there will be considerable dialogue between the electrical and mechanical teams. As selection of components for the electrical subsystem may impact or depend upon components in the mechanical subsystem or vice versa. The research of previous IPRO's and its data sheets will greatly assist in the designing the system as well as making decisions concerning which components to use.

Expected Results

The end product of this IPRO will be the design of a powerful yet cost effective test bed for a hybrid electrical school bus. This test bed will improve future testing of hybrid electrical vehicle systems and further the research on the current systems. A test bed will provide increased data on the hybrid electrical school bus in terms of drive cycles and ways that it improved upon the current non hybridized system.

Schedule of Tasks

The IPRO group will meet at least twice weekly to divide tasks, coordinate research, and share results. The teams will begin by dividing them selves equally into two groups. One group to study the electrical system and another to study the mechanical system. These groups will compare notes to combine them into a complete and effective system. There will be an electrical and mechanical team leader who will respond directly to the project advisor.

Budget

The estimated budget for this project is two to four thousand dollars. These funds will be used to purchase the necessary equipment for the test bed. For most of this semester however, there will be minimum costs associated with the research and design of this system. Possibly later in the semester the team will be able to begin purchasing

and configuring the actual test bed so that it can be fully implemented and tested in the following semester.

Deliverables

Project Plan 1 st Draft/Final	Sept 12/Sept 22
Prelim Subgroup Designs Due	Sept 29
Finalize/Review Designs	Oct 3
Mid-Term Progress Report (Final).....	Oct 20
One-Page Abstract (Final).....	Nov 22
Exhibition Poster Due (Final).....	Nov 22
Final Oral Presentation (Final).....	Nov 29
Final Project Report (Final).....	Nov 30
Comprehensive Deliverables CD.....	Dec 1
IPRO Debriefing Session.....	Dec 4

Responsibilities

—Electrical Team—

- 1.) Shan Colletti: Electric Motor
- 2.) Ali Gowani: Team Leader, Electric Motor
- 3.) Eric Hope: Batteries
- 4.) Tyler Inovye: Power Electronics
- 5.) Garrett Nielson: Power Electronics

—Mechanical Team—

- 1.) Preeti Abraham: Driveshaft
- 2.) Joel Fenner: Underbody, Model Kit
- 3.) Mohammed Khader: Team Leader, Input Differential, Model Demonstrations
- 4.) Aamer Saeed: Drive Differential
- 5.) Jatan Shah: Pedal Controls, Sensory Devices