

ILLINI HYBRID RACING

February 2010

Newsletter

This month in Hybrid



The 2010 Formula Hybrid chassis on the frame table

This month we are modifying the back end of the old Formula SAE (FSAE) chassis based on the new design to compensate for the hybrid powertrain. In this process, we will remove many old structural members, update members in conflict with formula hybrid rules, and add new members to complete the conversion.

Additionally we are in the process of designing side

pods for the car to contain the accumulators and other power electronics being developed by the electrical team that will make up the powertrain. This process involves a significant amount of effort as we wish to keep the old chassis frame intact as much as possible such that we may reuse the maximum amount of existing FSAE suspension components.

We are also researching the different systems utilized in the

old FSAE car such as drivetrain, suspension, body work, brakes, and steering. We are in the process of submitting machine orders for missing components such that we can begin assembling the car in March.

While the mechanical systems are in the process of being modified and reconstructed, the electrical components have begun to be bench tested.

Frame table

Early in the month we finished designing and fabricating a frame table to which we will attach the chassis while making modifications. Constructing the frame table has provided many inexperienced team members with shop and welding experience. The frame table and experience has been vital in the process of modifying the rear end of the chassis to handle the combustion engine, electric motor and auxiliary components.



Team member Joseph Loesche MIG welding the frame table

Illini Hybrid: powered by LabVIEW

National Instruments supports Illini Hybrid Racing with donation of hardware and software to control key vehicle systems

Andrew Watchorn from National Instruments recently visited the Formula Hybrid team to show how LabVIEW and National Instruments hardware can be used to create a custom vehicle control unit (VCU). With this VCU we will be able to integrate all the major systems of our hybrid

race car. National Instruments donated a CompactRIO to provide measurement and control as well as a touch panel computer to provide driver feedback. With an FPGA, real-time processor, and modular I/O, the CompactRIO can easily interface with today's automotive

components. For our setup, we selected a variety of analog and digital I/O modules to gather data from sensors and a CAN bus module to interface with our motor controller. Having received the hardware and LabVIEW we have begun development on the central vehicle control unit.



Also in this issue

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Thanks Briggs & Stratton!

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Profile of the month:

Prof. Philip T. Krein

3 months
until competition day!

Battery selection: getting the chemistry just right

An important decision in building a formidable hybrid vehicle is the proper selection of batteries. However despite the many different battery chemistries available in today's market, the selection process is not straightforward. While it has been over two centuries since the crude battery model was invented, modern lithium battery technology has only been around for about two decades. Batteries have generally been tailored to small electronics use; but now, with the automotive industry converting to hybrid and full electric vehicles, battery technology must revolutionize for these new and more advanced applications.

To make the best battery selection for our car, we are evaluating many different battery chemistries, each with different strengths and weaknesses. Our final selections include two of the newer chemistries: Headway 38120S Lithium-Iron-Phosphate (LiFePO4) and AA

Portable Power 706285-8C Lithium Ion Polymer (LiPo).

The selection was made based on performance specifications developed for this year's vehicle as well as official cost limitations enforced by the competition.

A key specification for performance reasons is a high discharge rate, which allows for rapid accelerations required in formula racing. However, as with many state of the art products, those

with the best characteristics are prohibitively expensive. The two chosen meet the required power within the regulated budget. We are in the process of setting up a bench test in order to verify battery specifications. These primarily include charge/discharge rate, deterioration of the battery after numerous cycles, response to peak, pulsating, and constant load, and the effect of temperature on performance. Verifying the characteristics of the batteries is crucial to

creating an efficient battery management system which integrates well with the rest of the vehicle.

Battery technology is a rapidly evolving field and while our battery selection will most probably be between the two discussed, we are constantly in search of superior batteries that meet our specifications and cost. With many companies committing a vast amount of research into improved battery technology, funded by substantial capital from the U.S. Department of Energy towards vehicle applications, we are optimistic and excited to see how we can further optimize our car.

High Power Polymer Lithium-Ion Cell



Thanks Briggs & Stratton!

Briggs & Stratton Animal Engine is a key component in the series hybrid system

The team would like to thank Briggs & Stratton Racing for the generous donation of a Briggs & Stratton Animal Engine as well as numerous accessories. This small but powerful engine will provide the energy behind our powertrain by powering an electric generator onboard the car throughout the race. The Animal Engine is a 206cc karting engine that is lightweight and has a modified compression ratio of 9.5:1.

It can be packaged easily into the chassis and requires little to no tuning. It is also easily upgradable as we have found multiple aftermarket accessories for it via the web. With the engine currently in hand, we will soon have it tested on a dynamometer to find its optimal RPM for mechanical to electrical energy conversion.



Sizing the Electric Motor

The electric drive motor sizing has been completed. The team is now in the process of acquiring the equipment. To select the drive motor, first the target weight of the vehicle with driver was determined to be 750 lbs (341 kg). Second, during the 2009 Formula Hybrid Competition, Colorado State University scored first in the unrestricted acceleration test with a time of 5.011 seconds over 75 meters. The Colorado State car was a 975 lbs (442 kg) parallel hybrid vehicle driven by a 38 hp Kawasaki Ninja 250cc engine and 49 hp D&D ES-31B electric drive motor.

The team decided to attempt to design a vehicle capable of matching the Colorado State acceleration time. By using an AC induction motor rated at 10 hp at 1800 rpm, but rewinding for operation up to 8000 rpm, approximately 40 hp will become achievable. In general, an AC induction motor can also be driven to over 200% of its rated torque for very short periods of time. Thus, the team hopes to achieve approximately 80 hp with the selected motor for the 5 seconds required to complete the race.

Departmental funding update

In search of funds and in-kind support, the Hybrid officers submitted proposals to a number of engineering departments. The Mechanical Science and Engineering (MechSE) department kindly transferred \$1,500 into our registered student organization account. It was thanks to these funds that we were able to pay our registration fee (of \$1,500).

Shortly after, the Electrical and Computer

Engineering (ECE) department graciously offered some tools from their in-house machine shop. Among the donated items were two large rollaway tool boxes, an angle grinder, a corded drill, two sets of drill bits, assorted screwdrivers, wrenches, hammers, and more. These tools are a great start to our arsenal. Most recently, the ECE Annual Fund donated \$1,500. Three cheers for the MechSE and ECE departments!

Illinois Engineering Design Council funding

In early October, the team prepared and submitted a proposal to the University of Illinois Engineering Design Council, requesting \$18,747. While the team didn't receive all the funds requested, the team was excited to receive \$7,000 in matched funds. Thanks to the donations of our corporate sponsors, we have successfully matched and received all \$7,000 in funds from the Design Council.

The bulk of the Formula Hybrid teams funding comes in the form of in-kind donations, so having an accessible source of cash funds to satisfy the teams many immediate cash needs has been incredible. The full cash needs required by the team have not yet been met, but the Design

Council funds have been invaluable at getting the 2010 car moving forward. As a recipient of funds from Engineering Design Council, the Formula Hybrid team was able to secure space in the Engineering Student Project Lab, located at 1023 W. Western Ave., Urbana, IL 61801. The Formula Hybrid team is now housed alongside the Formula SAE team and Baja SAE team, where we are able to collaboratively work to reach our common goals.

The team would like to thank the Engineering Design Council for their support and guidance, providing the Formula Hybrid team with a home and significant financial support.

Yaskawa provides the drive for Illini Hybrid Racing

Yaskawa Motor Drive used for increased motor performance and efficiency
Yaskawa AC servo motor paired with Animal Engine as generator



Yaskawa has been working with us to select a generator and size a motor controller. We will be using one of Yaskawa's A1000 drives. These drives feature high performance vector control to increase motor performance and efficiency. This drive will allow us to extract the most

performance out of our induction motor. For our application, we will be modifying the drive to run off our DC bus.

Yaskawa's AC servo motors make great small permanent magnet 3 phase generators for matching with our Briggs & Stratton Animal

Engine. We are excited to soon have Rafi Wilkinson from Yaskawa Electric visit with the team to demonstrate and discuss the many capabilities of their motor drive. The team gives its sincere thanks to Yaskawa for their generous donation.

Team member profile Professor Philip T. Krein

Name: Professor Philip T. Krein **Department:** Electrical and Computer Engineering
Title: Grainger Endowed Director's Chair in Electric Machinery and Electromechanics
Education: B.S. Electrical Engineering, A.B. Economics and Business (1978) Lafayette College, M.S. Electrical Engineering (1980), Ph.D. Electrical Engineering (1982) University of Illinois
Research Interests: Electric and hybrid vehicles, alternative energy systems, power electronics, electric machinery, and electromechanics

In August of 2008, Dylan Erb (2010 Formula Hybrid President) was searching for an alternative vehicle based club to join. After going through the Registered Student Organization list (of nearly a thousand) and coming up with nothing, he eventually came to the desk of Professor Krein. Having been an advisor to these types of clubs in the past, Professor Krein had a lot of valuable advice. He suggested that Dylan look into starting a team to compete

in the Formula Hybrid International Competition. After a long year of rallying support with peers, professors, and administrators, the Formula Hybrid Team at the University of Illinois was born. In short, Professor Krein was instrumental in the foundation of the club and his continuing support has helped the team thrive. Illini Hybrid Racing is proud to have Professor Philip T. Krein as our faculty advisor.



Faculty Advisor Prof. Philip T. Krein

★ Minimum \$55,000 needed to compete

Goal
\$65,000



Current
\$35,000

Why you should support Formula Hybrid

The automotive industry has sought after students participating in Formula SAE since its conception in 1978. Qualifying for an internship at Ford Motor Company and Honda Motor Company specifically requires Formula SAE involvement. The competition has acknowledged educational value.

With an annual budget in excess of \$65,000, the Illini Hybrid Racing Team at the University of Illinois seeks out funding from a variety of resources in

order to keep the team rolling. Monetary and in-kind donations made by our corporate sponsors are often matched by either the University of Illinois College of Engineering or College of Engineering departments. The donations that our sponsors provide are essential to the team's success. The team expresses deep gratitude to our sponsors for making the whole project possible.

2010 Team Partners



ALL DONATIONS ARE FULLY TAX DEDUCTIBLE

Interested? Contact us today for more information

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Special thanks to the University of Illinois at Urbana-Champaign Formula SAE and Baja SAE teams for their invaluable contributions to Illini Hybrid Racing

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