2016 COMPETITION
MAY 2 – 5
### Competition Schedule

**Mon May 2**
- **8:00**
  - Registration
  - Main Gate
- **9:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **10:00**
  - Lunch Break
- **11:00**
  - Mechanical
  - Tech. Inspection
  - North Garage Bay 1
  - Electrical
  - Building
- **12:00**
  - Lunch Break
- **1:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **2:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **3:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **4:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **5:00**
  - Mandatory Elect. Safety Class
  - Center Garages
- **6:00**
  - Recruiting Presentations
  - FCA | Ford
  - GM | LG Chem
  - Pizza for Students
  - Jack Ratta Media Center
- **7:00**
  - VIP Reception
  - For Officials and VIPs
  - Bruton's Suite Overlooking the Speedway

**Tue May 3**
- **8:00**
  - Registration
  - Main Gate
- **9:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **10:00**
  - Lunch Break
- **11:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **12:00**
  - Lunch Break
- **1:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **2:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **3:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **4:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **5:00**
  - Mandatory Elect. Safety Class
  - Center Garages
- **6:00**
  - Recruiting Presentations
  - FCA | Ford
  - GM | LG Chem
  - Pizza for Students
  - Jack Ratta Media Center
- **7:00**
  - VIP Reception
  - For Officials and VIPs
  - Bruton's Suite Overlooking the Speedway

**Wed May 4**
- **8:00**
  - Registration
  - Main Gate
- **9:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **10:00**
  - Lunch Break
- **11:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **12:00**
  - Lunch Break
- **1:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **2:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **3:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **4:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **5:00**
  - Mandatory Elect. Safety Class
  - Center Garages
- **6:00**
  - Recruiting Presentations
  - FCA | Ford
  - GM | LG Chem
  - Pizza for Students
  - Jack Ratta Media Center
- **7:00**
  - VIP Reception
  - For Officials and VIPs
  - Bruton's Suite Overlooking the Speedway

**Thu May 5**
- **8:00**
  - Registration
  - Main Gate
- **9:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **10:00**
  - Lunch Break
- **11:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **12:00**
  - Lunch Break
- **1:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **2:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **3:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **4:00**
  - Tech. Inspection
  - Mechanical
  - North Garage Bay 1
  - Electrical
  - Building
- **5:00**
  - Mandatory Elect. Safety Class
  - Center Garages
- **6:00**
  - Recruiting Presentations
  - FCA | Ford
  - GM | LG Chem
  - Pizza for Students
  - Jack Ratta Media Center
- **7:00**
  - VIP Reception
  - For Officials and VIPs
  - Bruton's Suite Overlooking the Speedway

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**Endurance Event**
- NHMS Road Course
- Note: A half-hour lunch break will be scheduled based on track activity

**Awards Ceremony**
- Victory Lane

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On the cover: Hybrid category winners, 2007–2015

Schedule subject to change—watch for postings.
Welcome to the tenth annual Formula Hybrid International Competition!

As Formula Hybrid celebrates its tenth year, we’re proud that the competition is thriving as a unique part of the SAE Collegiate Design Series. Encouraging students to collaborate across disciplines to develop greener automotive technologies, Formula Hybrid continues to be one of the most challenging engineering design projects that university students can undertake.

To help teams succeed, Formula Hybrid now provides project management guidance and opportunities to work with professional mentors throughout the year. This year we have added another way of helping teams get their vehicles on track: We’re kicking off the competition with Tech Day, an optional extra day of electrical tech inspection.

Founded and hosted by Thayer School of Engineering at Dartmouth, Formula Hybrid is made possible by the generous support of our many underwriters and our hundreds of volunteers—including mentors, judges, technical inspectors, and event assistants. We greatly appreciate their dedication to making the competition a success. And we commend the students who have taken up the Formula Hybrid challenge with creative and innovative gusto.

Enjoy the tenth annual competition—and stay tuned for details about a new Spring Break 2017 tech event in Florida, hosted by Embry-Riddle Aeronautical University.

Doug Fraser   Amy Keeler

Doug Fraser   Amy Keeler

doug@formula-hybrid.org   amy@formula-hybrid.org

Formula Hybrid Competition Organizers

Thayer School of Engineering at Dartmouth • 14 Engineering Drive • Hanover, NH 03755 • 603.646.5580 • formula-hybrid.org
2007
Formula Hybrid hosts the inaugural event with nine teams participating in the international competition.

2008
Teams from around the globe gather to compete. Lead sponsors Chrysler, General Motors and Toyota join FH.

2009
The weather dampens the track but not the spirit of the competition. Texas A&M shines with first place across events.

2010
FH increases to 4 days. The Italian team wins first place, and the Russian team, MADI, lights up the competition.

2011
“School Visit Day” is added, and FH is invited to “Indy 500 Emerging Tech Day.” Sweden wins the FH Design Event.

Celebrating 10 Years:
Formula Hybrid on Track
2012
Electric-only category and electrical pre-inspection are added. Sustainability is included in design and presentation events.

2013
FH launches new website and logo. Endurance is moved to the NHMS road course, doubling the distance to 44 km.

2014
The Mentor Program is initiated with team mentors from General Motors and Tesla Motors.

2015
Project Management replaces marketing as presentation event. Waterloo breaks endurance record with 33 km.

2016
FH adds a Sunday Tech Day to help teams pass inspection and celebrates 10 years of competition.
Doug Fraser is the man behind Formula Hybrid. A professional engineer, licensed in both electrical and mechanical engineering, he began his career building race car engines—ultimately powering cars to five national championships. Since then he has spent more than 30 years teaching at Thayer School of Engineering at Dartmouth.

In creating Formula Hybrid 10 years ago, Fraser wanted the competition to be educational—and to appeal to practical-minded engineers. “In my experience, there are two types of engineers,” he says. “At one extreme are the scientist-engineers and at the other extreme are the artist-engineers. I’m somebody who leans more toward the artist-engineer end of the spectrum. Formula Hybrid is tailored towards people like me, those who learn through hands-on, practical experience.”

“I wanted to put together a competitive program that was attractive and interesting to our students who were more responsive to an experiential engineering education. I also wanted the results of the competition to be obvious—everyone watching would know who the winner is. So the rules committee and I came up with a formula for the endurance event where everybody started with the same amount of energy on-board. The trick is to go farther, faster than anyone else without running out.”

Fraser also has a formula for the success of the competition: “the dedicated and amazing group of people—the rules committee, judges, mentors, sponsors, volunteers, and the students—without whom Formula Hybrid never could have happened.”

He is happy with the results. “Many Formula Hybrid alums are now working in industry, and a lot of them are returning to the competition as judges and inspectors,” Fraser says. “We hear great feedback from these alums about the value of Formula Hybrid in their careers. One of them went to work for Tesla, and he said everything he had learned in the Formula Hybrid competition applied to his work at Tesla.”

When he’s not focused on Formula Hybrid, Fraser pursues his own vehicular interests: racing his Jaguar E-Type in vintage races and restoring his Triumph Bonneville, his favorite motorcycle from the sixties.

Above: Fraser racing his Jaguar E-Type at the 2014 Lime Rock Historic Festival race.

Above Left: Fraser takes a turn in the very first Formula Hybrid race car, which was built by Dartmouth students in 2006.
<table>
<thead>
<tr>
<th>Team Data</th>
<th>University of Windsor</th>
<th>Lancer Motorsports</th>
<th>Team Flash</th>
<th>Dr. Robert W. Fletcher</th>
</tr>
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<tbody>
<tr>
<td><strong>Vehicle Specifications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REGEN BRAKING</td>
<td>N/A</td>
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</tr>
<tr>
<td>DRIVE CONFIGURATION</td>
<td>Parallel</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>ENGINE</td>
<td>Ninja Twin 250CC EFI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FUEL TYPE</td>
<td>Gasoline</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>GENERATOR</td>
<td>N/A</td>
<td></td>
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</tr>
<tr>
<td>DRIVE MOTOR</td>
<td>DLC-20 Brushless Liquid Cooled PMAC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACCUMULATOR</td>
<td>Boston Power Lithium Polymer 4.3KJ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEIGHT</td>
<td>750 lb*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNIQUE FEATURES</td>
<td></td>
<td></td>
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<tr>
<th>Team Data</th>
<th>Milwaukee School of Engineering</th>
<th>MSOE Motorsports (Hybrid)</th>
<th>MP-38</th>
<th>Dr. Matt Schaefer</th>
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<td>REGEN BRAKING</td>
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<tr>
<td>DRIVE CONFIGURATION</td>
<td>RWD, Custom parallel hybrid chain drive</td>
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<tr>
<td>ENGINE</td>
<td>Honda CBR250R, fuel injected Power: 18.65 kW, Torque: 23.0 N·m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FUEL TYPE</td>
<td>Gasoline</td>
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<td></td>
<td></td>
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<tr>
<td>GENERATOR</td>
<td>N/A</td>
<td></td>
<td></td>
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<tr>
<td>DRIVE MOTOR</td>
<td>Agni 95R, Power: 12.7 kW Torque: 26 N·m</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>ACCUMULATOR</td>
<td>EnerDel EC654P0, 64.8V, 3421Wh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEIGHT</td>
<td>882 lb (400 kg)*</td>
<td></td>
<td></td>
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<tr>
<td>UNIQUE FEATURES</td>
<td>Pneumatic shifting, stand-alone ECU, award-winning front suspension uprights (SAE World Congress 2015), custom racing seat, custom battery management system</td>
<td></td>
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<table>
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<tr>
<th>Team Data</th>
<th>Lawrence Technological University</th>
<th>Blue Devil Motorsports</th>
<th>Phenex</th>
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<tr>
<td>REGEN BRAKING</td>
<td>TBD</td>
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<td></td>
</tr>
<tr>
<td>DRIVE CONFIGURATION</td>
<td>Parallel Dual-Chain</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>ENGINE</td>
<td>2014 KTM 250 SX-F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FUEL TYPE</td>
<td>Gasoline</td>
<td></td>
<td></td>
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<tr>
<td>GENERATOR</td>
<td>N/A</td>
<td></td>
<td></td>
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<tr>
<td>DRIVE MOTOR</td>
<td>YASA Motors YASA-400</td>
<td></td>
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<tr>
<td>ACCUMULATOR</td>
<td>A123 Lithium Iron Phosphate, Prismatic Cells, 661p</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>WEIGHT</td>
<td>750 lbs (340 kg)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNIQUE FEATURES</td>
<td>Powertrain Integration Module controls both gasoline and electric drive</td>
<td></td>
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</table>

* Estimated Value
### Vehicle Specifications

#### Team Data

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<tr>
<th>School</th>
<th>SRM Engineering College</th>
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<tr>
<td>Team Name</td>
<td>HYBRUTOS RACING</td>
</tr>
<tr>
<td>Car Name</td>
<td>TBD</td>
</tr>
<tr>
<td>Advisor</td>
<td>Mr. C. Prabhu</td>
</tr>
</tbody>
</table>

**Vehicle Specifications**

- **REGEN BRAKING**: N/A
- **DRIVE CONFIGURATION**: Parallel hybrid
- **ENGINE**: KTM 200 DUKE, SI Engine, 199.5cc, 19.12kW @ 10,000 RPM, Electronic fuel injection
- **FUEL TYPE**: Gasoline
- **GENERATOR**: N/A
- **DRIVE MOTOR**: PMDC, AGNI-95R, 30kW (Max)
- **ACCUMULATOR**: LiFeYPO4 Battery, Winston LLC-WBLYP40AHA, 7.37 MJ*
- **WEIGHT**: 551 lbs (250 kg)*
- **UNIQUE FEATURES**: Custom designed differential casing

#### Team Data

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<thead>
<tr>
<th>School</th>
<th>Amrita Institute of Technology and Science</th>
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<tr>
<td>Team Name</td>
<td>Formula Hybrid</td>
</tr>
<tr>
<td>Car Name</td>
<td>Aghora</td>
</tr>
<tr>
<td>Advisor</td>
<td>Sambhu. R</td>
</tr>
</tbody>
</table>

**Vehicle Specifications**

- **REGEN BRAKING**: N/A
- **DRIVE CONFIGURATION**: Parallel drive
- **ENGINE**: KTM Duke 200
- **FUEL TYPE**: Gasoline
- **GENERATOR**: N/A
- **DRIVE MOTOR**: AGNI 95
- **ACCUMULATOR**: Winston Accumulators
- **WEIGHT**: 662 lbs (300 kg)*
- **UNIQUE FEATURES**: Regenerative drag

#### Team Data

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<thead>
<tr>
<th>School</th>
<th>R.V College of Engineering</th>
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<tr>
<td>Team Name</td>
<td>Ashwa Racing</td>
</tr>
<tr>
<td>Car Name</td>
<td>RZX6-H</td>
</tr>
<tr>
<td>Advisor</td>
<td>Dr. Ravindra S. Kulkarni</td>
</tr>
</tbody>
</table>

**Vehicle Specifications**

- **REGEN BRAKING**: None
- **DRIVE CONFIGURATION**: Series hybrid
- **ENGINE**: Bajaj Pulsar 220 DTSi, Single Cylinder, Spark ignition engine, 220cc, power- 15.44kW, Carburated.
- **FUEL TYPE**: Gasoline
- **GENERATOR**: Kalbhorz electric, Agni 95, 15kW
- **DRIVE MOTOR**: Kalbhorz electric, Surek 9, 20kW
- **ACCUMULATOR**: Liyuan Batteries (custom made), Lithium-ion, LY72AH_LPF, 19.68MJ
- **WEIGHT**: 595 lbs (270 kg)
- **UNIQUE FEATURES**: Solid fixture for the chassis with accuracy 0.01mm

#### Team Data

<table>
<thead>
<tr>
<th>School</th>
<th>North Carolina State University</th>
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<tbody>
<tr>
<td>Team Name</td>
<td>PackHybrid</td>
</tr>
<tr>
<td>Car Name</td>
<td>The Chief</td>
</tr>
<tr>
<td>Advisor</td>
<td>Dr. Eric Klang and Gary Lofton</td>
</tr>
</tbody>
</table>

**Vehicle Specifications**

- **REGEN BRAKING**: None
- **DRIVE CONFIGURATION**: Parallel
- **ENGINE**: Honda GX200 Clone (196cc)
- **FUEL TYPE**: Gasoline
- **GENERATOR**: N/A
- **DRIVE MOTOR**: 2 x PERM PMG-132 Brushed DC Motors
- **ACCUMULATOR**: 6 x GBS 12V (4-Cell) 60Ah LiFeMnPO4 Modules
- **WEIGHT**: 650 lbs*
- **UNIQUE FEATURES**: Wireless data acquisition, custom EM clutch, modular powertrain unit, endurance lap strategy algorithm, adjustable pedal box
### Team Data

**School**  
University of Michigan  

**Team Name**  
Michigan Hybrid Racing  

**Car Name**  
MHR16  

**Advisor**  
Heath Hoffman  

### Vehicle Specifications

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
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<tbody>
<tr>
<td><strong>REGEN BRAKING</strong></td>
<td>None</td>
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<tr>
<td><strong>DRIVE CONFIGURATION</strong></td>
<td>Parallel rear wheel drive</td>
</tr>
<tr>
<td><strong>ENGINE</strong></td>
<td>250cc 2014 KTM SX-F</td>
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<td><strong>FUEL TYPE</strong></td>
<td>Gasoline</td>
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<tr>
<td><strong>GENERATOR</strong></td>
<td>Stock KTM alternator</td>
</tr>
<tr>
<td><strong>DRIVE MOTOR</strong></td>
<td>Continental 3-phase Induction motor, from GM BAS+ system</td>
</tr>
<tr>
<td><strong>ACCUMULATOR</strong></td>
<td>32s Elite Power Solutions LiFeMnPO4 cells, 102.4V nominal, 20Ah</td>
</tr>
<tr>
<td><strong>WEIGHT</strong></td>
<td>775 lbs (352 kg) with driver*</td>
</tr>
</tbody>
</table>
| **UNIQUE FEATURES**      | Team-built virtual accumulator containers  
                            | Electronic clutch, shifting, and throttle control |

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**Team Data**

**School**  
Middle Tennessee State University  

**Team Name**  
MTSU Motorsports  

**Car Name**  
PONY SE100AH  

**Advisor**  
Saeed Foroudastan  

### Vehicle Specifications

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
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<tr>
<td><strong>REGEN BRAKING</strong></td>
<td>None</td>
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<tr>
<td><strong>DRIVE CONFIGURATION</strong></td>
<td>Parallel hybrid</td>
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<tr>
<td><strong>ENGINE</strong></td>
<td>Ninja 250R</td>
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<tr>
<td><strong>FUEL TYPE</strong></td>
<td>Gasoline</td>
</tr>
<tr>
<td><strong>GENERATOR</strong></td>
<td>Motenergy 0913</td>
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<tr>
<td><strong>DRIVE MOTOR</strong></td>
<td>Custom Ultracapacitor Pack</td>
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<tr>
<td><strong>ACCUMULATOR</strong></td>
<td>PONY SE100AH</td>
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<tr>
<td><strong>WEIGHT</strong></td>
<td>900 lbs (408 kg)</td>
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<tr>
<td><strong>UNIQUE FEATURES</strong></td>
<td>Over 100 combined peak horsepower, dSPACE MicroAutoBox II supervisory controller for advanced energy management</td>
</tr>
</tbody>
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**Team Data**

**School**  
University of Victoria  

**Team Name**  
UVic Hybrid  

**Car Name**  
UVH2016  

**Advisor**  
Zuomin Dong  

### Vehicle Specifications

<table>
<thead>
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<th>Feature</th>
<th>Details</th>
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<tbody>
<tr>
<td><strong>REGEN BRAKING</strong></td>
<td>Rear</td>
</tr>
<tr>
<td><strong>DRIVE CONFIGURATION</strong></td>
<td>Parallel hybrid</td>
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<tr>
<td><strong>ENGINE</strong></td>
<td>2014 KTM SX-F 250</td>
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<tr>
<td><strong>FUEL TYPE</strong></td>
<td>Gasoline</td>
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<tr>
<td><strong>GENERATOR</strong></td>
<td>Stock KTM alternator</td>
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<tr>
<td><strong>DRIVE MOTOR</strong></td>
<td>40kW Zero 75-5</td>
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<tr>
<td><strong>ACCUMULATOR</strong></td>
<td>Custom Ultracapacitor Pack</td>
</tr>
<tr>
<td><strong>WEIGHT</strong></td>
<td>573 lbs (260 kg)</td>
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<tr>
<td><strong>UNIQUE FEATURES</strong></td>
<td>Over 100 combined peak horsepower, dSPACE MicroAutoBox II supervisory controller for advanced energy management</td>
</tr>
</tbody>
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**Team Data**

**School**  
University of Idaho  

**Team Name**  
Vandal Hybrid Racing  

**Car Name**  
Susan  

**Advisor**  
Dr. Michael Santora  

### Vehicle Specifications

<table>
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<tbody>
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<td><strong>REGEN BRAKING</strong></td>
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<tr>
<td><strong>DRIVE CONFIGURATION</strong></td>
<td>Parallel hybrid</td>
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<td><strong>ENGINE</strong></td>
<td>Yamaha, YZ250F, 27 kW @ 11,500 rpm</td>
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<tr>
<td><strong>FUEL TYPE</strong></td>
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<td><strong>GENERATOR</strong></td>
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<td><strong>DRIVE MOTOR</strong></td>
<td>Lynch, DCPM LEM 200-D135RAGS, 18 kW @ 4400 rpm</td>
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<td><strong>ACCUMULATOR</strong></td>
<td>Haiyin Technologies, 28 Ultra-Power Lithium Ion Polymer Cells</td>
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<tr>
<td><strong>WEIGHT</strong></td>
<td>525 lbs (238 kg)</td>
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<tr>
<td><strong>UNIQUE FEATURES</strong></td>
<td>Titanium muffler, titanium uprights, dynamic EMS, drive-by-wire, custom accumulator housing</td>
</tr>
</tbody>
</table>

* Estimated Value
<table>
<thead>
<tr>
<th>Team Data</th>
<th>Team Data</th>
<th>Team Data</th>
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<tbody>
<tr>
<td>School</td>
<td>School</td>
<td>School</td>
<td>School</td>
</tr>
<tr>
<td>Dartmouth College</td>
<td>Yale University</td>
<td>Rensselaer Polytechnic Institute</td>
<td>Yale University</td>
</tr>
<tr>
<td>Team Name</td>
<td>Team Name</td>
<td>Team Name</td>
<td>Team Name</td>
</tr>
<tr>
<td>Dartmouth Formula Racing (DFR)</td>
<td>Bulldogs Racing</td>
<td>Rensselaer Formula Hybrid</td>
<td>Bulldogs Racing</td>
</tr>
<tr>
<td>Car Name</td>
<td>Car Name</td>
<td>Car Name</td>
<td>Car Name</td>
</tr>
<tr>
<td>Lynn</td>
<td>TBD</td>
<td>Vapor Moose</td>
<td>TBD</td>
</tr>
<tr>
<td>Advisor</td>
<td>Advisor</td>
<td>Advisor</td>
<td>Advisor</td>
</tr>
<tr>
<td>Raina White</td>
<td>Chris Lee, Oscar Mur-Miranda</td>
<td>Frank Wright</td>
<td>Joseph Zinter</td>
</tr>
<tr>
<td>Vehicle Specifications</td>
<td>Vehicle Specifications</td>
<td>Vehicle Specifications</td>
<td>Vehicle Specifications</td>
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<tr>
<td>REGEN BRAKING</td>
<td>REGEN BRAKING</td>
<td>REGEN BRAKING</td>
<td>REGEN BRAKING</td>
</tr>
<tr>
<td>N/A</td>
<td>YES</td>
<td>Yes</td>
<td>Independent rear-wheel braking</td>
</tr>
<tr>
<td>DRIVE CONFIGURATION</td>
<td>DRIVE CONFIGURATION</td>
<td>DRIVE CONFIGURATION</td>
<td>DRIVE CONFIGURATION</td>
</tr>
<tr>
<td>Parallel hybrid</td>
<td>Parallel hybrid</td>
<td>Electric rear-wheel drive with independently driven wheels and a virtual differential</td>
<td>Independent rear-wheel drive</td>
</tr>
<tr>
<td>ENGINE</td>
<td>ENGINE</td>
<td>ENGINE</td>
<td>ENGINE</td>
</tr>
<tr>
<td>Kawasaki EX250</td>
<td>Kawasaki EX250</td>
<td>KGM 250 SX-F</td>
<td>N/A</td>
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<tr>
<td>FUEL TYPE</td>
<td>FUEL TYPE</td>
<td>FUEL TYPE</td>
<td>FUEL TYPE</td>
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<tr>
<td>Gasoline</td>
<td>Gasoline</td>
<td>Gasoline</td>
<td>N/A</td>
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<td>GENERATOR</td>
<td>GENERATOR</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>DRIVE MOTOR</td>
<td>DRIVE MOTOR</td>
<td>DRIVE MOTOR</td>
<td>DRIVE MOTOR</td>
</tr>
<tr>
<td>Emrax 228</td>
<td>Zero Z-force motors, peak torque of 170ft-lbs.</td>
<td>2 x Enstroj Emrax 207 Medium Voltage</td>
<td>2 x Enstroj Emrax 207 Medium Voltage</td>
</tr>
<tr>
<td>ACCUMULATOR</td>
<td>ACCUMULATOR</td>
<td>ACCUMULATOR</td>
<td>ACCUMULATOR</td>
</tr>
<tr>
<td>M20 Lithium-Ion 20Ah Prismatic Cells</td>
<td>100V 60kW accumulator composed of 12 Nissan Leaf Modules (LiMnO2)</td>
<td>Custom pack with A123 cells and custom AMS</td>
<td>8651P A123 AMP20 LiFePO4 cells</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>WEIGHT</td>
<td>WEIGHT</td>
<td>WEIGHT</td>
</tr>
<tr>
<td>86S1P A123 AMP20 LiFePO4 cells</td>
<td>750 lbs*</td>
<td>Custom accumulator with team designed AMS, and a custom differential housing</td>
<td>225 lbs (225 kg)</td>
</tr>
<tr>
<td>UNIQUE FEATURES</td>
<td>UNIQUE FEATURES</td>
<td>UNIQUE FEATURES</td>
<td>UNIQUE FEATURES</td>
</tr>
<tr>
<td>Rear-wheel drive parallel hybrid, in-car CAN network, vehicle data display on web app, central hybrid controller to increase efficiency</td>
<td>Vintage aesthetic style Electronic differential</td>
<td>Five link rear suspension, chain drive steering system, custom CAN vehicle communication system, custom accumulator management system.</td>
<td>Five link rear suspension, chain drive steering system, custom CAN vehicle communication system, custom accumulator management system.</td>
</tr>
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</table>
### Team Data

<table>
<thead>
<tr>
<th>School</th>
<th>Atilim University</th>
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<tbody>
<tr>
<td>Team Name</td>
<td>Devrim Hybrid</td>
</tr>
<tr>
<td>Car Name</td>
<td>Devrim</td>
</tr>
<tr>
<td>Advisor</td>
<td>Dr. Demir Bayka</td>
</tr>
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### Vehicle Specifications

<table>
<thead>
<tr>
<th>REGEN BRAKING</th>
<th>N/A</th>
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</thead>
<tbody>
<tr>
<td>DRIVE CONFIGURATION</td>
<td>Parallel hybrid</td>
</tr>
<tr>
<td>ENGINE</td>
<td>Yamaha YBR 250CC 15.15KW/CARP</td>
</tr>
<tr>
<td>FUEL TYPE</td>
<td>Gasoline</td>
</tr>
<tr>
<td>GENERATOR</td>
<td>N/A</td>
</tr>
<tr>
<td>DRIVE MOTOR</td>
<td>Lynch LEM 200-D127, 12.5 Kw</td>
</tr>
<tr>
<td>ACCUMULATOR</td>
<td>LifePO4 24x1p 40 Ah, 3072 Wh</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>811 lbs (368 kg)</td>
</tr>
<tr>
<td>UNIQUE FEATURES</td>
<td>TBD, Stieber Bearing</td>
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### Team Data

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<thead>
<tr>
<th>School</th>
<th>Georgia Institute of Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Name</td>
<td>HyTech Racing</td>
</tr>
<tr>
<td>Car Name</td>
<td>Claire</td>
</tr>
<tr>
<td>Advisor</td>
<td>Dr. Jonathan Rogers</td>
</tr>
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### Vehicle Specifications

<table>
<thead>
<tr>
<th>REGEN BRAKING</th>
<th>TBD</th>
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</thead>
<tbody>
<tr>
<td>DRIVE CONFIGURATION</td>
<td>Electric-only</td>
</tr>
<tr>
<td>ENGINE</td>
<td>N/A</td>
</tr>
<tr>
<td>FUEL TYPE</td>
<td>N/A</td>
</tr>
<tr>
<td>GENERATOR</td>
<td>N/A</td>
</tr>
<tr>
<td>DRIVE MOTOR</td>
<td>Enstroj 207 PMAC motor</td>
</tr>
<tr>
<td>ACCUMULATOR</td>
<td>300 V battery pack made out of 82 individual aluminum-cased Lithium Iron battery cells.</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>560 lbs (254kg)</td>
</tr>
<tr>
<td>UNIQUE FEATURES</td>
<td>Android Dashboard, accessibility, spacing, and robust electronics PCB design</td>
</tr>
</tbody>
</table>

---

### Team Data

<table>
<thead>
<tr>
<th>School</th>
<th>Bingham University</th>
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<tbody>
<tr>
<td>Team Name</td>
<td>Bearcat motorsports</td>
</tr>
<tr>
<td>Car Name</td>
<td>Green mashine 2.0</td>
</tr>
<tr>
<td>Advisor</td>
<td>Gary DiGiacomo</td>
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### Vehicle Specifications

<table>
<thead>
<tr>
<th>REGEN BRAKING</th>
<th>Yes, option of a Curtis motor controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRIVE CONFIGURATION</td>
<td>Electric</td>
</tr>
<tr>
<td>ENGINE</td>
<td>N/A</td>
</tr>
<tr>
<td>FUEL TYPE</td>
<td>N/A</td>
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<tr>
<td>GENERATOR</td>
<td>N/A</td>
</tr>
<tr>
<td>DRIVE MOTOR</td>
<td>3 phase 40 hp</td>
</tr>
<tr>
<td>ACCUMULATOR</td>
<td>Lithium titanate</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>500 lbs</td>
</tr>
<tr>
<td>UNIQUE FEATURES</td>
<td></td>
</tr>
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### Team Data

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<thead>
<tr>
<th>School</th>
<th>University of Waterloo</th>
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<tbody>
<tr>
<td>Team Name</td>
<td>Waterloo Hybrid-Electric</td>
</tr>
<tr>
<td>Car Name</td>
<td>uwFH16</td>
</tr>
<tr>
<td>Advisor</td>
<td>Dr. Andrew Trivet, Dr. Amir Khajepour</td>
</tr>
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### Vehicle Specifications

<table>
<thead>
<tr>
<th>REGEN BRAKING</th>
<th>N/A</th>
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</thead>
<tbody>
<tr>
<td>DRIVE CONFIGURATION</td>
<td>All-Electric</td>
</tr>
<tr>
<td>ENGINE</td>
<td>N/A</td>
</tr>
<tr>
<td>FUEL TYPE</td>
<td>N/A</td>
</tr>
<tr>
<td>GENERATOR</td>
<td>N/A</td>
</tr>
<tr>
<td>DRIVE MOTOR</td>
<td>x2 Brushless DC motors with custom planetary gearboxes</td>
</tr>
<tr>
<td>ACCUMULATOR</td>
<td>~250V Lithium Polymer Accumulator pack</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>661 lbs (300 kg)</td>
</tr>
<tr>
<td>UNIQUE FEATURES</td>
<td>In-Hub motors with torque vectoring, custom designed BMS and all new HV system</td>
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</tbody>
</table>

* Estimated Value
### Team Data

<table>
<thead>
<tr>
<th>School</th>
<th>Illinois Institute of Technology</th>
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</thead>
<tbody>
<tr>
<td>Team Name</td>
<td>IIT Motorsports</td>
</tr>
<tr>
<td>Car Name</td>
<td>Wiser Tomahawk</td>
</tr>
<tr>
<td>Advisor</td>
<td>Mahesh Krishnamurthy</td>
</tr>
</tbody>
</table>

#### Vehicle Specifications

- **REGEN BRAKING**: Yes
- **DRIVE CONFIGURATION**: Direct drive
- **ENGINE**: N/A
- **FUEL TYPE**: N/A
- **GENERATOR**: N/A
- **DRIVE MOTOR**: Allied-Motion MagnaFlux 210
- **ACCUMULATOR**: 8051P A123-AMP20 pouch cells
- **WEIGHT**: 485 lbs (220 kg)
- **UNIQUE FEATURES**: 4 in-wheel hub motors, carbonfiber monocoque

---

### Team Data

<table>
<thead>
<tr>
<th>School</th>
<th>University of Illinois at Urbana-Champaign (UIUC)</th>
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</thead>
<tbody>
<tr>
<td>Team Name</td>
<td>Illini Formula Electric</td>
</tr>
<tr>
<td>Car Name</td>
<td>TBD</td>
</tr>
<tr>
<td>Advisor</td>
<td>Mike Philip, Bruce Flachsbart</td>
</tr>
</tbody>
</table>

#### Vehicle Specifications

- **REGEN BRAKING**: Yes
- **DRIVE CONFIGURATION**: Electric RWD
- **ENGINE**: YASA-400 Axial Flux Motor
  - 3:1 Gear Ratio
  - 7500 rpm, 360 Nm Peak
  - 85 kW Continuous, 90 kW Peak
- **FUEL TYPE**: N/A
- **GENERATOR**: N/A
- **DRIVE MOTOR**: Sevcon Gen4 Size 8
  - 60 kW Continuous, 100 kW Peak
- **ACCUMULATOR**: Four 300 V packs in parallel,
  - 26650 Cylindrical cells
- **WEIGHT**: 600 lbs (340 kg)
- **UNIQUE FEATURES**: 4130 Chromoly Spaceframe Chassis, adjustable suspension, modularized batteries

---

### Team Data

<table>
<thead>
<tr>
<th>School</th>
<th>University of Vermont</th>
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<tbody>
<tr>
<td>Team Name</td>
<td>Alternative Energy Racing Organization</td>
</tr>
<tr>
<td>Car Name</td>
<td>GreenSpeed 4</td>
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<tr>
<td>Advisor</td>
<td>Dr. Jeff Frolik</td>
</tr>
</tbody>
</table>

#### Vehicle Specifications

- **REGEN BRAKING**: Front only
- **DRIVE CONFIGURATION**: Electric
- **ENGINE**: N/A
- **FUEL TYPE**: N/A
- **GENERATOR**: N/A
- **DRIVE MOTOR**: Two DLC-28’s, and an AMD FB0-4001G
- **ACCUMULATOR**: Lithium Polymer Batteries
- **WEIGHT**: 1200 lbs
- **UNIQUE FEATURES**: Custom battery pack using pouch cells, with a custom BMS. The ability to switch between FWD, RWD and AWD.

---

### Team Data

<table>
<thead>
<tr>
<th>School</th>
<th>Rochester Institute of Technology</th>
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</thead>
<tbody>
<tr>
<td>Team Name</td>
<td>RIT Hot Wheezels Formula SAE Electric</td>
</tr>
<tr>
<td>Car Name</td>
<td>Phoebe</td>
</tr>
<tr>
<td>Advisor</td>
<td>Jodi Carville, Sarah Burke, Marty Schooping</td>
</tr>
</tbody>
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#### Vehicle Specifications

- **REGEN BRAKING**: N/A
- **DRIVE CONFIGURATION**: Electric-only
- **ENGINE**: N/A
- **FUEL TYPE**: N/A
- **GENERATOR**: N/A
- **DRIVE MOTOR**: HPEVS AC 35-26.25
  - Power: 82 hp
- **ACCUMULATOR**: Enerdel PB10S2P
  - Capacity: 5084 Wh
- **WEIGHT**: 650 lbs (295 kg)*
- **UNIQUE FEATURES**: Vehicle build by an all-female engineering team

---
### Team Data

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<tr>
<th>School</th>
<th>Princeton University</th>
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<tbody>
<tr>
<td>Team Name</td>
<td>Princeton Racing Electric</td>
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<tr>
<td>Car Name</td>
<td>PREV2</td>
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<tr>
<td>Advisor</td>
<td>Luigi Martinelli</td>
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### Vehicle Specifications

<table>
<thead>
<tr>
<th>REGEN BRAKING</th>
<th>TBD - Regen capable (rear)</th>
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<tr>
<td>DRIVE CONFIGURATION</td>
<td>Electric-only, RWD</td>
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<tr>
<td>ENGINE</td>
<td>N/A</td>
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<tr>
<td>FUEL TYPE</td>
<td>N/A</td>
</tr>
<tr>
<td>GENERATOR</td>
<td>N/A</td>
</tr>
<tr>
<td>DRIVE MOTOR</td>
<td>2x Brushless DC Motors. Neumotors 4440. 20 kW cont.</td>
</tr>
<tr>
<td>ACCUMULATOR</td>
<td>Batteries. 4x EnerDel MP310-049 module. 19.368 MJ</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>600 lbs*</td>
</tr>
<tr>
<td>UNIQUE FEATURES</td>
<td>Lightweight motors from model airplane industry, electronic differential and torque vectoring, thermoelectric energy recovery system*, solar</td>
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* Estimated Value

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### Team Data

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<tr>
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<th>Ferris State</th>
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<tr>
<td>Team Name</td>
<td>Ferris State Hybrid</td>
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<tr>
<td>Car Name</td>
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<tr>
<td>Advisor</td>
<td></td>
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### Vehicle Specifications

<table>
<thead>
<tr>
<th>REGEN BRAKING</th>
<th>Rear only</th>
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<tbody>
<tr>
<td>DRIVE CONFIGURATION</td>
<td>Electric-only; rear wheel drive</td>
</tr>
<tr>
<td>ENGINE</td>
<td>N/A</td>
</tr>
<tr>
<td>FUEL TYPE</td>
<td>N/A</td>
</tr>
<tr>
<td>GENERATOR</td>
<td>N/A</td>
</tr>
<tr>
<td>DRIVE MOTOR</td>
<td>YASA-750 Axial Flux Electric Motor, 75 kW continuous power</td>
</tr>
<tr>
<td>ACCUMULATOR</td>
<td>80 LiFePO4 Cylindrical Cells</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>650 lbs*</td>
</tr>
<tr>
<td>UNIQUE FEATURES</td>
<td>Rear hubs with integrated tripod joints, custom pouch cell repeating frame design</td>
</tr>
</tbody>
</table>

* Estimated Value
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We support the Formula Hybrid Teams

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Acknowledgements

**DESIGN JUDGES**
Kamran Arshad-ali, Powertrain Engineer, Fiat Chrysler Automobiles
David Currier, VP, Strategic Engineering, Toyota Motor North America, Inc.
Pavel Dutoy, Systems Engineer, LG Chem Power, Inc.
Dave Dvelley, Product Line Manager, Linear Technology
Adam Ing, Systems Engineer, LG Chem Power, Inc.
Stephen Gross, Design Release Engineer, General Motors
Ryan Harrington, Senior Engineer, Volpe Center
Thor Johnson, Chief Marketing Officer, IntraLinks
Scott Lananna, Electric Vehicle and Hybrid Battery Engineer, General Motors
Kris Lokere, Strategic Applications Manager, Linear Technologies
Alan Martin, Lead Test Engineer, General Motors
Barry Mason, Analysis Engineer, Fiat Chrysler Automobiles
Sjoon Moore, Product Architect, Mentor Graphics
Jay Muehloer, Chief Marketing Officer, IntraLinks
Ben Nault, Electrified Powertrain Manager, Ford Motor Company
Cody Rheinbergen, Mechanical Engineer, Fiat Chrysler Automobiles
Shane Schulze, HV Battery Engineer, Ford Motor Company
Emily Wu, Senior Systems Engineer, BOSCH

**PRESENTATION JUDGES**
Kristen MacCartney, University Partnership Program Manager, IEEE
Lucas Amber, Battery Engineer, Ford Motor Company
Leigh Anderson, Business Development Manager, Mentor Graphics
David Aronson, Commercial Director, Hyspeed, LLC
Steve Burke, HEV Systems Energy Analysis Engineer, Ford Motor Company
Nathalie Capati, Battery Engineer
Mike Chapman, ISM Program Manager, IntraLinks
Alba Colon, Program Manager, NASA's Sprint Cup Series, General Motors
Joe Fabiano, Powertrain Engineer, Fiat Chrysler Automobiles
Bruce Fraser, United Technologies (Ret.)
David Hsu, Director of Product Management, Levant Power Corp.
Daniel Kok, Electrified Powertrain Systems Manager, Ford Motor Company
Edward March, Ph.D., Co-Director, MEM Program at Dartmouth
Barry Mason, Analysis Engineer, Fiat Chrysler Automobiles
Brian Shields, District Service Manager, BOSCH
Joe Tolkacz, Senior Manager, Fiat Chrysler Automobiles
Ricky Wester, Associate Data Scientist, National Grid

**SPECIAL JUDGES**
Hal Flescher, IEEE
Mike Kelly, Society Executive Director, IEEE
Bill Tonti, Future Directions, IEEE

**DYNAMIC EVENTS**
Wiley Cox, New England Region, SCCA
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