Welcome to the ninth annual Formula Hybrid International Competition!

We’re thrilled to be back on track with Formula Hybrid, the educational competition that emphasizes drivetrain innovation and fuel efficiency in a high-performance application.

This year’s competition includes a new event: a project management presentation. The event focuses on how teams apply project management techniques to bring their racecars from design to completion.

Founded and hosted by Thayer School of Engineering at Dartmouth, Formula Hybrid is a member of the Formula SAE Collegiate Design Series and is endorsed by the IEEE. The competition is made possible by the generous support of the Thayer School community and the New Hampshire Motor Speedway, which has so graciously made this facility available to us. We profoundly appreciate the outstanding support of our sponsors, judges, and event volunteers—this event could not go on without them. A special shout-out to Ed March, co-director of Thayer School’s Master of Engineering Management program, who oversaw development of the new project management presentation event.

We commend the student teams that have boldly accepted the Formula Hybrid challenge. These young pioneers are directing their ingenuity and creativity to advancing plug-in hybrid and electric vehicle technologies, which will lead to improved applications in the future.

Enjoy the 2015 competition and know that planning for the tenth annual Formula Hybrid competition is already underway. We look forward to seeing you there!

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
603.646.6580
formula-hybrid.org

<table>
<thead>
<tr>
<th>Mon April 27</th>
<th>Tue April 28</th>
<th>Wed April 29</th>
<th>Thu April 30</th>
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<tbody>
<tr>
<td>8:00</td>
<td>Registration</td>
<td>8:00</td>
<td>Lunch Break</td>
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<td>9:00</td>
<td>Tech. Inspection</td>
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<tr>
<td>1:00</td>
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<td>2:00</td>
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<tr>
<td>9:00</td>
<td>Tech. Inspection</td>
<td>9:00</td>
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Subject to change—watch for postings.
Bob Wimmer, Formula Hybrid’s Chief Design Judge, has a not-so-secret secret: he’s been a kart racer for years.

“Within weeks of starting my first post-college job, I attended a local karting school and realized that you didn’t need a full-sized racecar to experience excellent wheel-to-wheel racing. Karts are relatively light on the budget and make logistics easy—requiring minimal garage space and only a pickup or small trailer to transport,” says the 2014 World Karting Association Road Race Grand Nationals champion.

“I stopped racing after my two boys were born. But when they showed an interest in racing, we formed Wild Wimmer Racing, and I spent the next decade being their crew chief. It was incredibly satisfying to see their skills and competitiveness grow over the years. My racing bug emerged after more than a decade in hibernation. The past three racing seasons have been the best, not only due to success on the track, but having the opportunity to spend quality time with two rapidly maturing young men competing in a sport you all love.”

Wimmer entered the motorsports world while earning his mechanical engineering degree from California State Polytechnic University, San Luis Obispo. An active SAE member, he competed in Mini Baja, off-road truck racing, and other events. He completed his M.S. degree in systems management at the University of Southern California, served as technical director of fuel-cell bus programs at Georgetown University for 12 years, joined Toyota in 2003, and now directs Toyota’s Energy and Environmental Research Group.

Wimmer brings personal and professional passion to Formula Hybrid. “I have always credited my collegiate SAE activities with jumpstarting my professional carrier. The hands-on engineering and project management experience is invaluable in landing that first job and adapting to the work world quickly,” he says. “I have seen firsthand how engineering graduates with cross-discipline knowledge and experience excel in the automotive industry. I know of few other college activities or competitions that provide the level of multidiscipline experience you receive in Formula Hybrid.”

Edward March, Co-Director of the Master of Engineering Management program at Thayer School of Engineering at Dartmouth, developed Formula Hybrid’s new Project Management Presentation requirement.

**What is the goal of the new project management requirement?**

By competing in Formula Hybrid, teams gain real-world experience in designing and producing a complex product. Their success is measured by the performance of their racecar and compliance to the design standards set by the Formula Hybrid Committee. The project management requirement extends this real-world experience further, giving Formula Hybrid participants practice in creating and executing a project plan and dealing with change and barriers to progress in a disciplined way. It places students in an environment similar to that in which they will operate professionally.

**Why is project management so important for Formula Hybrid teams?**

Project management is a tool to help teams succeed. Each team has a clear deadline, limited financial and human resources, and a rigorous set of requirements. The efficient use of resources and a focused effort on achieving the team’s goals are necessary to improve the team’s chances for success as team members work hard to meet the competition deadline. The project plan is a roadmap to successful completion of the work.

**What project management principles are most relevant to Formula Hybrid?**

First, the members of each team must agree upon the objectives. An obvious goal is to win the competition. But only one team wins, and if this is the only objective, all the other teams lose. Secondary goals—such as proving a new technology in race conditions or testing the reliability and endurance of a major new component—may be more important than winning in the current year.

Second, the project management plan acts as a roadmap to successful completion of the project, providing direction for the work and reducing the number of false starts. Third, all projects encounter problems and barriers during execution that require changes to be made in the plan. A formal change management process keeps team members aligned and up-to-date.

**What will the project management presentation include?**

The presentation is an assessment of how well the project was executed. For example: Did the plan help the team achieve its objectives? How were problems and barriers handled? Was change well managed? How successful was the project, considering all of the measures? What were the strengths and weaknesses in the project management? What recommendations does the team have for improvement in future years?
<table>
<thead>
<tr>
<th><strong>Vehicle Specifications</strong></th>
<th><strong>Team Data</strong></th>
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<th><strong>Team Data</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>REGEN BRAKING</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>DRIVE CONFIGURATION</strong></td>
<td>Parallel</td>
<td>Direct Drive Hub Motors</td>
<td>Parallel</td>
<td>Parallel</td>
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<tr>
<td><strong>ENGINE</strong></td>
<td>Kawasaki Ninja 250R</td>
<td>N/A</td>
<td>YASA-400, A/C Axial Flux, 35 kW, 345 Nm Peak</td>
<td>N/A</td>
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<tr>
<td><strong>FUEL TYPE</strong></td>
<td>Gasoline</td>
<td>Gasoline</td>
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<tr>
<td><strong>GENERATOR</strong></td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td><strong>DRIVE MOTOR</strong></td>
<td>Agni 95R</td>
<td>YASA Motors, YASA-400, A/C Axial Flux, 35 kW, 345 Nm Peak</td>
<td>2015 KTM 250 SX-F, EFI, 248cc</td>
<td>2015 KTM 250 SX-F, EFI, 248cc</td>
</tr>
<tr>
<td><strong>ACCUMULATOR</strong></td>
<td>Custom Pack with A123 Cells and custom AAM</td>
<td>A123 Systems, 2 x 2S1P1; 8.1 MWh</td>
<td>83 V / 26.5 kW, Prismatic Li-Ion</td>
<td>210 V / 2.5 kWh, Prismatic, Li-Ion</td>
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<tr>
<td><strong>WEIGHT</strong></td>
<td>628 lbs (289 kg)</td>
<td>572 lbs (260 kg)*</td>
<td>772 lbs (350 kg)*</td>
<td>992 lbs (450 kg)*</td>
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<tr>
<td><strong>UNIQUE FEATURES</strong></td>
<td>Swappable accumulator container placed underneath the driver, redesigned battery packs with team designed AAM, and a custom differential housing</td>
<td>Android-Based Cell Phone Cluster App</td>
<td>Electric SuperBoost/Cruise Function</td>
<td>Cast Aluminum Uprights</td>
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</tbody>
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<th><strong>School</strong></th>
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<th><strong>Car Name</strong></th>
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<tr>
<td>Milwaukee School of Engineering</td>
<td>Carnegie Mellon University</td>
<td>Blue Devil Motorsports</td>
<td>El Tiburón Diablo</td>
<td>Dr. Robert Fletcher</td>
</tr>
<tr>
<td>Illinois Institute of Technology</td>
<td>McMaster University</td>
<td>McMaster Formula Hybrid</td>
<td>Vapor Moosie</td>
<td>Dr. Ali Emadi</td>
</tr>
<tr>
<td>Rensselaer Polytechnic Institute</td>
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<td>Vapor Moosie</td>
<td>Casey Goodwin</td>
</tr>
<tr>
<td>Carnegie Mellon University</td>
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<td>CMR 15e</td>
<td>CMR 15e</td>
<td>Satbir Singh</td>
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<td>Casey Goodwin</td>
</tr>
<tr>
<td>Illinois Institute of Technology</td>
<td>Illinois Institute of Technology</td>
<td>Wiser TomaHawk</td>
<td>Wiser TomaHawk</td>
<td>Mahesh Krishnamurthy</td>
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<tr>
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<td>CMR 15e</td>
<td>CMR 15e</td>
<td>Satbir Singh</td>
</tr>
</tbody>
</table>

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1. **Vehicle Specifications**
   - **REGEN BRAKING**: Yes
   - **DRIVE CONFIGURATION**: Parallel
   - **ENGINE**: Kawasaki Ninja 250R
   - **FUEL TYPE**: Gasoline
   - **GENERATOR**: N/A
   - **DRIVE MOTOR**: Agni 95R
   - **ACCUMULATOR**: Custom Pack with A123 Cells and custom AAM
   - **WEIGHT**: 628 lbs (289 kg)
   - **UNIQUE FEATURES**: Swappable accumulator container placed underneath the driver, redesigned battery packs with team designed AAM, and a custom differential housing

2. **Vehicle Specifications**
   - **REGEN BRAKING**: Yes
   - **DRIVE CONFIGURATION**: Parallel
   - **ENGINE**: YASA Motors, YASA-400, A/C Axial Flux, 35 kW, 345 Nm Peak
   - **FUEL TYPE**: Gasoline
   - **GENERATOR**: N/A
   - **DRIVE MOTOR**: YASA Motors, YASA-400, A/C Axial Flux, 35 kW, 345 Nm Peak
   - **ACCUMULATOR**: A123 Systems, 2 x 2S1P1; 8.1 MWh
   - **WEIGHT**: 572 lbs (260 kg)*
   - **UNIQUE FEATURES**: Android-Based Cell Phone Cluster App | Electric SuperBoost/Cruise Function | Cast Aluminum Uprights

3. **Vehicle Specifications**
   - **REGEN BRAKING**: Yes
   - **DRIVE CONFIGURATION**: Direct Drive Hub Motors
   - **ENGINE**: Kawasaki Ninja 250R
   - **FUEL TYPE**: Gasoline
   - **GENERATOR**: N/A
   - **DRIVE MOTOR**: (4) Allied Motion MF210008-D01
   - **ACCUMULATOR**: 5.6 kWh LiPo 72x4p
   - **WEIGHT**: 463 lbs (210 kg)
   - **UNIQUE FEATURES**: Direct Drive Hub Motors

4. **Vehicle Specifications**
   - **REGEN BRAKING**: Yes
   - **DRIVE CONFIGURATION**: Parallel
   - **ENGINE**: Kawasaki Ninja 250R
   - **FUEL TYPE**: Gasoline
   - **GENERATOR**: N/A
   - **DRIVE MOTOR**: Agni 95R
   - **ACCUMULATOR**: Custom Pack with A123 Cells and custom AAM
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5. **Vehicle Specifications**
   - **REGEN BRAKING**: Yes
   - **DRIVE CONFIGURATION**: Direct Drive Hub Motors
   - **ENGINE**: Kawasaki Ninja 250R
   - **FUEL TYPE**: Gasoline
   - **GENERATOR**: N/A
   - **DRIVE MOTOR**: (4) Allied Motion MF210008-D01
   - **ACCUMULATOR**: 5.6 kWh LiPo 72x4p
   - **WEIGHT**: 463 lbs (210 kg)
   - **UNIQUE FEATURES**: Direct Drive Hub Motors

6. **Vehicle Specifications**
   - **REGEN BRAKING**: Yes
   - **DRIVE CONFIGURATION**: Parallel
   - **ENGINE**: Kawasaki Ninja 250R
   - **FUEL TYPE**: Gasoline
   - **GENERATOR**: N/A
   - **DRIVE MOTOR**: Agni 95R
   - **ACCUMULATOR**: Custom Pack with A123 Cells and custom AAM
   - **WEIGHT**: 628 lbs (289 kg)
   - **UNIQUE FEATURES**: Swappable accumulator container placed underneath the driver, redesigned battery packs with team designed AAM, and a custom differential housing

7. **Vehicle Specifications**
   - **REGEN BRAKING**: Yes
   - **DRIVE CONFIGURATION**: AWD - Parallel Through The Road
   - **ENGINE**: 2012 KTM 250 SXF, 35 HP
   - **FUEL TYPE**: Gasoline
   - **GENERATOR**: N/A
   - **DRIVE MOTOR**: Two Pieterburg Nova 15s, 15kW
   - **ACCUMULATOR**: 32 JR Micro Prismatic Capacitors
   - **WEIGHT**: 450 lb*
   - **UNIQUE FEATURES**: Carbon fibre monocoque, front in-hub planetary gear reduction, full aerodynamics package, in-car CAN Network

8. **Vehicle Specifications**
   - **REGEN BRAKING**: Yes
   - **DRIVE CONFIGURATION**: Parallel
   - **ENGINE**: 2015 KTM 250 SX-F, EFI, 248cc
   - **FUEL TYPE**: Gasoline
   - **GENERATOR**: N/A
   - **DRIVE MOTOR**: Agni 95R
   - **ACCUMULATOR**: A123 Systems, 2 x 2S1P1; 8.1 MWh
   - **WEIGHT**: 572 lbs (260 kg)*
   - **UNIQUE FEATURES**: Android-Based Cell Phone Cluster App | Electric SuperBoost/Cruise Function | Cast Aluminum Uprights

*Estimated Value

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<td>Vandal Hybrid Racing</td>
<td>Susan</td>
<td>Dan Gordon</td>
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<td>El Tiburón Diablo</td>
<td>Dr. Matt Schaefer</td>
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</table>
**Vehicle Specifications**

REGEN BRAKING: 9

DRIVE CONFIGURATION: Series

ENGINE: Bajaj Pulsar 220 DTSi, single cylinder, four stroke, natural air cooled, 220 ccm, carburetor, 14.71 kW @6500 rpm

FUEL TYPE: Gasoline

GENERATOR: N/A

DRIVE MOTOR: PMG 133

ACCUMULATOR: LiFePO4, Haiyin 5000mAh (15 packs), 22 KW @4000 rpm

WEIGHT: 661 lbs (300 kg)*

UNIQUE FEATURES: Electro-Pneumatic shifting, Mechanical Override.

**Vehicle Specifications**

REGEN BRAKING: 10

DRIVE CONFIGURATION: Series-Parallel hybrid

ENGINE: KTM SX-F, 53hp @ 12000rpm, KTM 650 Enduro R Electronic Throttle, Microsquirt-Controlled Custom EFI

FUEL TYPE: Gasoline

GENERATOR: N/A

DRIVE MOTOR: 100 kW (MAX) Induction Motor - 100 kW (MAX)

ACCUMULATOR: Hengdong LiFePO4, 76V, 2458J

WEIGHT: 728 lbs (330 kg)*

UNIQUE FEATURES: Custom lightweight uprights, front hubs, and inboard rear brakes.

**Vehicle Specifications**

REGEN BRAKING: 11

DRIVE CONFIGURATION: Rear

ENGINE: KTM 250 SX-F, 53hp @ 12000rpm, KTM 650 Enduro R Electronic Throttle, Microsquirt-Controlled Custom EFI

FUEL TYPE: Gasoline

GENERATOR: N/A

DRIVE MOTOR: N/A

ACCUMULATOR: Hengdong LiFePO4, 76V, 2458J

WEIGHT: 550 lbs

UNIQUE FEATURES: Sparkers act as rear rotors Motor Controller is adjusted from an in-dash touch screen display.

**Vehicle Specifications**

REGEN BRAKING: 12

DRIVE CONFIGURATION: Rear Wheel Drive

ENGINE: KTM 250 SX-F, 53hp @ 12000rpm, KTM 650 Enduro R Electronic Throttle, Microsquirt-Controlled Custom EFI

FUEL TYPE: Gasoline

GENERATOR: N/A

DRIVE MOTOR: No

ACCUMULATOR: N/A

WEIGHT: 16x SE100AHA LiFePO4 Prismatic Cells

12kW @ 48V Peak Output 30kW

UNIQUE FEATURES: Zero 75-5, 33kW, 95Nm @ 0-3000rpm

**Vehicle Specifications**

REGEN BRAKING: 13

DRIVE CONFIGURATION: Series-Parallel Hybrid

ENGINE: Kawasaki Ninja 250R

FUEL TYPE: Gasoline

GENERATOR: Water Cooled PMAC

DRIVE MOTOR: Water Cooled PMAC Constant Output 12kW @ 48W Peak Output 30kW

ACCUMULATOR: 16x SE100AHA LiFePO4, Prismatic Cells

WEIGHT: 550 lbs

UNIQUE FEATURES: Sparkers act as rear rotors

**Vehicle Specifications**

REGEN BRAKING: 14

DRIVE CONFIGURATION: Gasoline / Electric Parallel Hybrid

ENGINE: Kawasaki Ninja 250R

FUEL TYPE: Gasoline

GENERATOR: Water Cooled PMAC

DRIVE MOTOR: Water Cooled PMAC Constant Output 12kW @ 48W Peak Output 30kW

ACCUMULATOR: 16x SE100AHA LiFePO4, Prismatic Cells

WEIGHT: 550 lbs

UNIQUE FEATURES: Sparkers act as rear rotors

* Estimated Value
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<td>Tufts Racing</td>
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<td>University of Michigan</td>
<td>Ann Arbor</td>
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<td>Green Machine 2015</td>
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<tr>
<td>Advisor</td>
<td>Bill Messner</td>
<td></td>
<td>Advisor</td>
<td>Professor Murray, Professor Selleck, Mr. Pavlick, &amp; Professor DiGiacomo</td>
<td></td>
<td>Advisor</td>
<td>Heath Hofmann</td>
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**Vehicle Specifications**

**Team Data**

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<tr>
<th>REGEN BRAKING</th>
<th>DRIVE CONFIGURATION</th>
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<th>GENERATOR</th>
<th>DRIVE MOTOR</th>
<th>ACCUMULATOR</th>
<th>WEIGHT</th>
<th>UNIQUE FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Rear</td>
<td>Electric-Only</td>
<td>N/A</td>
<td>N/A</td>
<td>85 kW Electric Motor</td>
<td>EIG G020 Lithium-ion Pouch Cells</td>
<td>500 lbs (227kg)*</td>
<td>Custom Suspension System, Lithium-Titanate Batteries</td>
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</table>

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</thead>
<tbody>
<tr>
<td>university of Massachusetts Lowell</td>
<td>River Hawk Racing</td>
<td>The River Hawk Racer</td>
<td>Lawrence Thompson</td>
<td>Yes, when brakes are applied, regenerative braking occurs. Parallel Hybrid Configuration. Honda CBR 250R engine. Gasoline. AC 12 (AC Induction motor). Lithium Polymer - 55Ah. Approximated to 551 lbs (250 kg) without the driver. Weight distribution is about 40 : 60 front to rear. Major modifications from previous car includes a Pushrod Suspension, high performance fuel injected Engine, Lithium Ion batteries.</td>
</tr>
<tr>
<td>university of Houston</td>
<td>Team Red Devils</td>
<td>Shasta</td>
<td>Raresh Pascali</td>
<td>Yes, when brakes are applied, regenerative braking occurs. Parallel Hybrid Configuration. Honda CBR 250R engine. Gasoline. AC 12 (AC Induction motor). Lithium Polymer - 55Ah. Approximated to 551 lbs (250 kg) without the driver. Weight distribution is about 40 : 60 front to rear. Major modifications from previous car includes a Pushrod Suspension, high performance fuel injected Engine, Lithium Ion batteries.</td>
</tr>
<tr>
<td>Princeton University</td>
<td>Princeton Racing Electric</td>
<td>PREius</td>
<td>Jonathan Prevost</td>
<td>Yes, when brakes are applied, regenerative braking occurs. Parallel Hybrid Configuration. Honda CBR 250R engine. Gasoline. AC 12 (AC Induction motor). Lithium Polymer - 55Ah. Approximated to 551 lbs (250 kg) without the driver. Weight distribution is about 40 : 60 front to rear. Major modifications from previous car includes a Pushrod Suspension, high performance fuel injected Engine, Lithium Ion batteries.</td>
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At General Motors, we adhere to the same principles that underline the Formula Hybrid philosophy – unceasing collaboration, constant innovation and unrelenting spirit.

We invite you to bring your vision, talent and passion to GM and help us sustain our position as industry leaders. Through our internship, co-op and entry-level positions, outstanding students like you will have the opportunity to instill fresh thinking and implement new ideas at a global level. We believe your capabilities and ambition will propel us forward. Tackle challenges head on and test yourself at GM, and discover what our employees already know – that together, there’s no stopping us.
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David Currier, VP Strategic Engineering, Toyota Motor North America, Inc.
Adam Ing, Systems Engineer, LG Chem, Inc.
Doug Green, SAME Engineer, General Motors
Ryan Harrington, Senior Engineer, Velop Center USA

**TECHNICAL INSPECTORS / VOLUNTEERS**
Thor Johnson, Chief Marketing Officer, Intralinks
Lastname Lawrence, Electric Vehicle and Hybrid Battery Engineer, General Motors
Alan Martin, Lead Test Engineer, General Motors
Barry Moore, SAME Engineer, Fiat Chrysler Automobiles
Sheri Scharf, HV Battery Engineer, Ford Motor Company
Iva Shalhav, Engine Controls & Software Engineer, Fiat Chrysler Automobiles

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Milo Chapman, EP Program Manager, Intralinks
Bruce Fraser, United Technologies (Ret.)
Stephen Aebi, Brake Engineer, Fiat Chrysler Automobiles
Edward Elsner, Ph.D., Co-Director, Master of Engineering Management Program at Dartmouth
Anthony Modafferi, Engineering Group Manager, General Motors
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Risk Rajasek, Director of Engineering, LG Chem, Inc.
Joe Tolka, Senior Manager, Fiat Chrysler Automobiles
Kalei Zundel, Event Operations Manager, Automobiles

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Doug Van Citters, Ph.D., Assistant Professor, Thayer School of Engineering

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