SAE INTERNATIONAL

MOMENTUM

THE MAGAZINE FOR STUDENT MEMBERS OF SAE INTERNATIONAL™

VALEO INNOVATION CHALLENGE

Canadian teams excel

Colorado State University

Fuel-cell plug-in hybrid for EcoCAR2

Cal State Fullerton

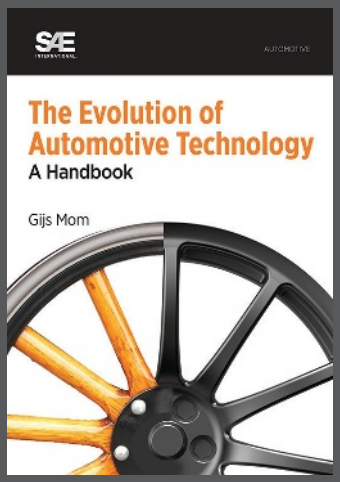
combining art and engineering

NONPROFIT ORG
US POSTAGE
PAID
HARRISBURG, PA
PERMIT 1174

SAE INTERNATIONAL®

CONCISE BOOK PROVIDES A TECHNICAL, ECONOMIC AND SOCIAL PERSPECTIVE

THE EVOLUTION OF AUTOMOTIVE TECHNOLOGY: A HANDBOOK



By Gijs Mom

This book covers one and a quarter century of the automobile, conceived as a cultural history of technology. It examines the impact of technology development and the influence of the past upon the present.

Topics include:

- Phases of car technology, starting in 1880
- Car's basic layout, engine, ignition, drivetrain, chassis, suspension, brakes
- Impact of automation and the importance of safety
- Co-evolution of engineering knowledge
- Sustainability

SAE Member Price: $63.96*
List Price: $79.95
Product Code: R-435
ISBN: 978-0-7680-8027-8
Published: November 2014

*Discount based on Elite Member level. For more information on member levels, visit www.sae.org/membership/benefits.

Order today! Visit books.sae.org/r-435
Email: CustomerService@sae.org
Actual shipping charges will be applied.

P150044

CONTENTS

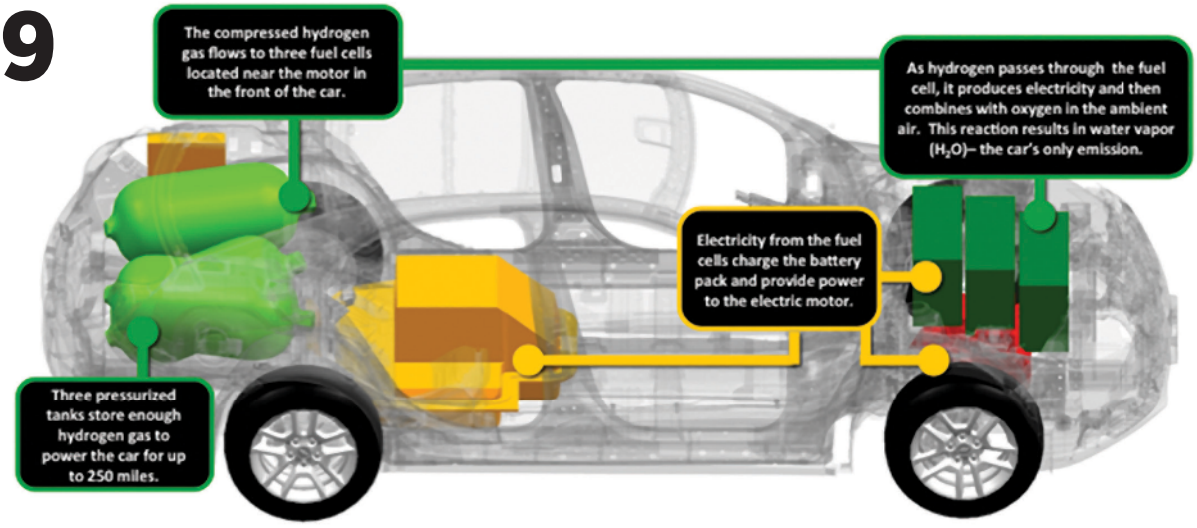
ON THE COVER

THE UNIVERSITY OF OTTAWA TEAM TOOK SECOND PLACE IN THE VALEO INNOVATION CHALLENGE. (PHOTO: DAVIDTAYLORPHOTOSTUDIO.COM)

Vol 6
Issue 1

FEBRUARY 2015

9



EDITORIAL

TRADE-OFFS—NO GETTING AROUND THEM

Patrick Ponticel, Editor, SAE Member Magazines

Although we aren't always keenly aware of it, humans are making trade-off decisions and compromises pretty much nonstop during our waking life. If you are reading these words, clearly you made a decision to open this magazine and read it, rather than do one of the infinite number of other things you could have opted to do.

A lot or our decisions are easy ones. Chocolate or strawberry? That's a low-ramifications conundrum if ever there were one, but the theory holds: You have to give up one thing in order to get the other (you can verify this with **Penn State** students in Happy Valley who have to live with the famous Berkey Creamery's rigorously enforced "no-mixing, no-exceptions" policy on flavors; just for the record, chocolate is the correct choice).

Closer to the other end of the ramifications spectrum regarding trade-off decisions is engineering. I don't know if anyone's ever estimated it, but the number of trade-off decisions involved in engineering and building an airplane or a car or a farm tractor or any other vehicle must be in the many thousands, or even millions. I suspect millions, given that there are multiple compromises involved with every part and every system of a vehicle, down to the nuts and bolts. On top of that there are upstream and downstream considerations regarding budgets, distribution/logistics, repair, recycling, and other facets impacting the vehicle's design. Imagine the challenge of being a chief engineer and having to make the final calls on a myriad of major trade-off decisions with direct impact on the company's bottom line. Talk about pressure!

But that's why they get paid the big bucks, isn't it?

College engineering students are exposed to these same kinds of pressure, albeit on a smaller scale, with their **SAE** Collegiate Design Series vehicles or similar projects. But the same kind of creativity, analysis, perseverance, and other "professional" attributes are at work. It's not a mere platitude to say a professional engineer could learn something from a student engineer.

We at *MOMENTUM* want you to express those attributes by submitting articles about your trade-off trials. What did you give up over there to get this over here? And why?

We'll pay you 25 cents/word. Not chief-engineer-sized compensation, certainly. But we believe that getting your article published in a magazine run by one of the world's preeminent engineering organizations justifies whatever trade-offs might be required. Submit to momentum@sae.org.

GET INVOLVED

- Become a *MOMENTUM* contributor by submitting an article. Add that achievement to your resume and impress future employers. Send an email to **momentum@sae.org** expressing your interest in contributing.
- Submit a Student Selfie, complete with photo and 150-word caption. Send to **momentum@sae.org.**
- Spread the word about this magazine to other engineering students and faculty, and encourage them to join SAE today by visiting **www.sae.org/membership.**

SAE INTERNATIONAL

400 Commonwealth Drive
Warrendale, PA 15096
www.sae.org/update
1.724.772.8577
Fax: 1.724.776.3393
update@sae.org

SUBSCRIPTIONS

1-877.606.7323
1.724.776.4970 (Outside U.S. & Canada)
Fax: 1.724.776.0790
customerservice@sae.org

SAE Sections and Affiliate Activities

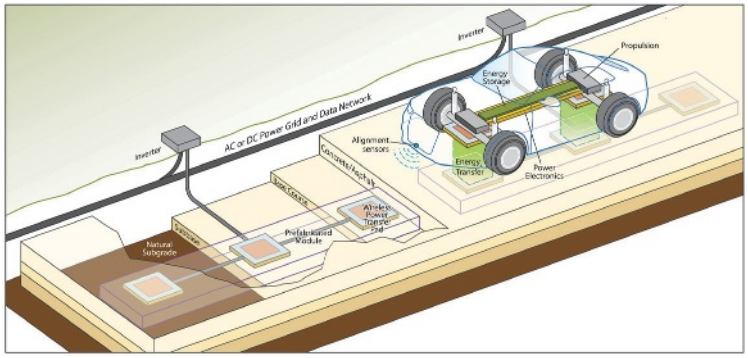
SAE International offers educational and networking opportunities at the grassroots level through more than 80 sections around the world. Sections are currently located in Belarus, Canada, Columbia, Ecuador, Egypt, Hong Kong, Israel, Italy, Malaysia, Mexico, Romania, Russia, Taiwan, U.K., Ukraine, U.S., and Venezuela. SAE also operates affiliates in Brazil and India. More information about sections, along with a complete listing and links, can be found at www.sae.org/sections.

MOMENTUM, The Magazine for Student Members of SAE International®, February 2015, Volume 6, Number 1. *MOMENTUM* (ISSN 2152-4106) is published six times a year in Feb, Mar, Apr, Sept, Oct, and Nov by SAE International,® 400 Commonwealth Dr., Warrendale, PA 15096-0001.

Annual print subscription for SAE International student members in North America: first subscription $10 included in dues; additional single copies $15. Prices for nonmember subscriptions are $30 North America, $50 overseas. Postmaster: Send address changes to Momentum, 400 Commonwealth Dr., Warrendale, PA 15096-0001.

UTAH STATE U BUILDING EV TEST TRACK

Utah State University says the Electric Vehicle and Roadway (EVR) research facility and test track now under construction is the first facility of its kind in the United States. The complex will include a research building and electrified quarter-mile oval-shaped test track designed to demon-



strate in-motion wireless power charging for electric vehicles. Using wireless inductive power transfer pads embedded in the roadway, electric vehicles can seamlessly charge while in motion, drastically reducing the need for large battery packs and cumbersome charging stations. The new facility will have a 750-kW power capacity, complete with ac and dc power distribution to the roadway and throughout the facility.

A TIME FOR PARODY

Acting on the idea that engineering should be fun, **SAE International** is sponsoring the #CDSparody Video Contest, open to all Collegiate Design Series teams (registered or not). Video entries will be uploaded to the CDS Facebook pages, where voting for the winner will take place. The winner gets a $250 Visa gift card and loads of laughs. Entries are due Feb. 8 and must be submitted via email (collegiatecompetitions@sae.org). Break a leg.

PREPARING LEADERS IN ENGINEERING

Rice University is offering engineering students an unusual opportunity to show potential employers that they're graduating with the right stuff to lead. In May, it will begin awarding a Certificate in Engineering Leadership to graduates who complete an internship, 10 credit hours of required courses and labs, and a portfolio and final presentation. The program is the first of its kind in Texas and one of only a handful in the U.S.

FASTENING CHALLENGE AT FSAE MICHIGAN

MacLean-Fogg will award $1000 to the Formula **SAE** Michigan team that has the best story to tell about how it conquered a fastening challenge on its competition vehicle. Teams have the creative freedom to present the story however they choose (Powerpoint, video, etc.). Entries are due by May 6. For more information, contact formulasae@macleanfogg.com.

TOKAI UNIVERSITY ECLIPSES SOLAR COMPETITORS

Tokai University finished a 1082-km (672-mi) course in 15 h and 20 min to place first in November's Carrera Solar Atacam 2014 solar car race in Chile. In all, 25 teams from

six countries competed in the race that was held in stages over several days and featured elevation changes from sea level to 3400 m (11,000 ft). **Panasonic** supplied the team's solar modules and high-capacity lithium-ion batteries.

NEW ENGINEERING BUILDING APPROVED FOR UNIVERSITY OF WATERLOO

An indoor flight arena for testing autonomous and robotic vehicles will be among the facilities in a new engineering building to be erected at the University of Waterloo in Canada. Called E7, the $88 million building will accommodate expansion of the Faculty of Engineering's highly popular mechatronics engineering program. It

will also house the faculty's new multidisciplinary teaching innovation called the Engineering Ideas Clinic, where undergraduate students starting from first year integrate classroom theory with hands-on learning as they design, build, test, and refine ideas.

FEATURE

TAKING ON THE VALEO INNOVATION CHALLENGE

Nearly 1000 university teams from 55 countries around the globe entered the first Valeo Innovation Challenge, the goal of which was to 'design the product or system that will make the cars of 2030 smarter and more intuitive.'

The Universidade Federal de Minas Gerais of Brazil's team consisted of Ana Carla Sà Campos and Alexandre Marques Bemquerer, shown here being presented with their €100,000 first-place award by Valeo executives.

THE **UNIVERSIDADE FEDERAL DE MINAS GERAIS** OF BRAZIL TOOK FIRST PRIZE, and a cash award of €100,000, in the first **Valeo** Innovation Challenge. Tying for second place and taking home €10,000 each were Canadian teams: the **University of Ottawa** and the **University of Waterloo**.

The Brazilian team's project aims to reinvent the mechanical transmission system by coupling together the pump and the hydraulic motor. This innovation would enable the transmission to adjust to engine rpm continuously and automatically, thereby improving fuel efficiency and reducing CO_2 emissions.

The University of Ottawa team proposed an end-to-end hybrid-electric powertrain system combining onboard technology and connectivity. The innovation uses geolocation and traffic data to shift from city to highway mode, thereby optimizing fuel efficiency.

The University of Waterloo team's project concerns an innovative, totally secure vehicle-to-vehicle communication system. It is based on the GPS and the time synchronization of data from each vehicle's GPS sensors. Naturally, one of the initial applications would be to transmit road safety information, such as hazardous road conditions, emergency braking, accidents, or rain.

Go to valeoinnovationchallenge.valeo.com for information on the 2015 Valeo Innovation Challenge.

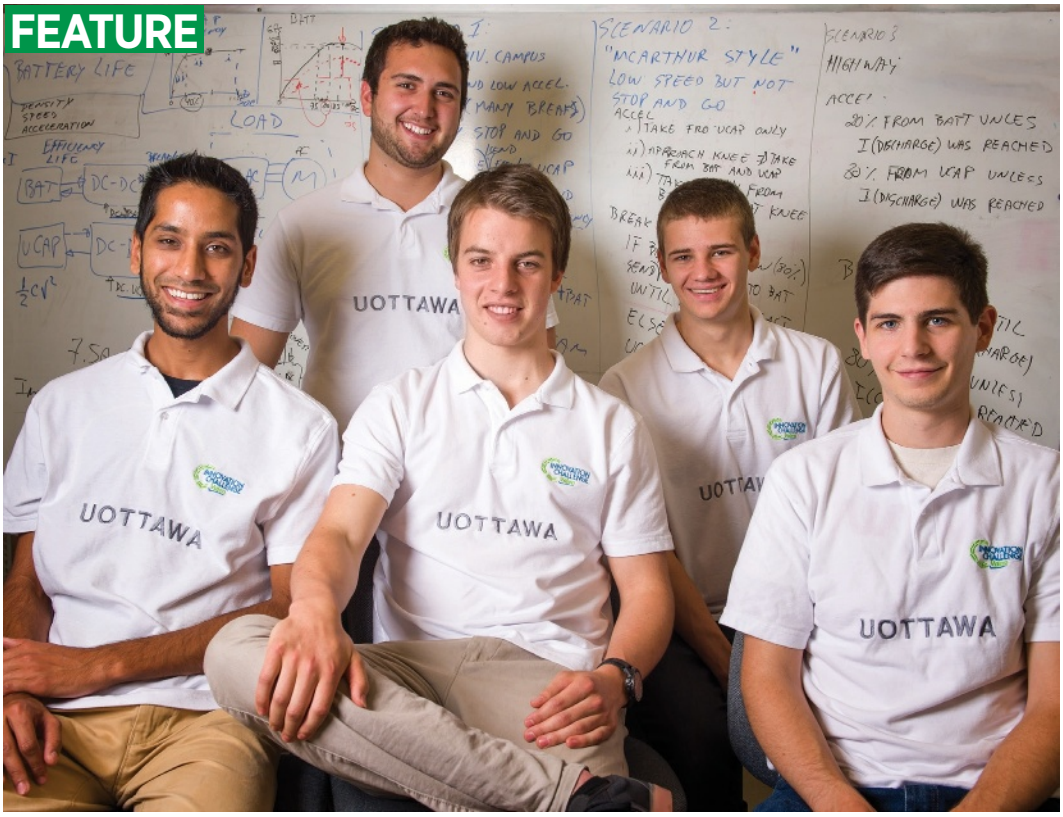
The field of nearly 1000 teams was winnowed throughout the year to 7 finalists, and the top 3 finishers were announced in October in conjunction with the Paris Motor Show.

Projects were judged by Valeo based on the following criteria:

- The idea's boldness, originality, and innovation
- Importance and relevance of the challenge addressed and inclusion of social needs
- Presentation value of the submission
- Mastery of required technical aspects
- Demonstration of feasibility of the project through the mock-up.

Momentum wasn't able to make contact with the Brazilian team so it could tell its winning story on these pages. We'll keep trying. We had better luck with the two Canadian teams, and you can read their stories on the following pages. ■

FEATURE



The University of Ottawa team consisted of (left to right) Shawn Bashir, an electrical engineering student who completed his studies in December 2014; Daniel Lutz, electrical engineering, completed his studies in December 2014; Cedric Eveleigh, mechanical engineering, third year; Frank Lefebvre, mechanical engineering, third year; and Eric Vierich, mechanical engineering, fourth year. Missing from photo is Mitchell Geis, mechanical engineering, third year. (Photo: davidtaylorphotostudio.com).

UNIVERSITY OF OTTAWA TEAM USES **'LOCATION-AWARE' TECHNOLOGY** TO HELP IMPROVE HYBRID-ELECTRIC VEHICLE EFFICIENCY

(Editor's note: The following is based on an email exchange between *MOMENTUM* and the University of Ottawa's Valeo Innovation Challenge team.)

Why did you decide to enter the Valeo Innovation Challenge?

The students became interested after our professor, Riadh Habash, approached us. We hadn't heard of it before, since it was introduced this year. After further research and brainstorming, the team had an innovative idea that we felt would have a lot of potential in the competition. Competitions such as these, regardless of how you place, play an important role since they allow for the students to apply theoretical knowledge in a hands-on way. With that in mind, we wanted to capitalize on the great opportunity given by Valeo.

Please summarize your invention that improves the efficiency of a hybrid-electric system.

Without giving out too much sensitive information, our "dual" innovation primarily revolves around the optimization of efficiency for a hybrid-electric storage system. Essentially, we've developed a prototype to allow for a car to be "location aware," and to use its location to control the flow of energy between the supercapacitor and battery within it. Secondly, further optimization was done by modifying the winding configuration on the motor.

The team's technology controls the flow of energy between the supercapacitor and the battery within it, based on the car's location. It also involves optimization of the motor via modification of its winding configuration. (Photo: davidtaylorphotostudio.com).

Describe your experience in the competition.
When submitting the proposal and realizing there are 968 other teams worldwide in the same competition, it's a mixed feeling. Your confidence is simultaneously mixed with curiosity of what the other teams proposed. However, after finding out we made the top 20 in April, and were given €5000 to develop our idea, we became ecstatic. We hit the drawing board immediately, thinking of how we can possibly further improve our idea, while simultaneously implementing the idea we proposed.

Our laboratory meetings became more frequent, and the amount of time we spent per meeting increased as well. After several months of hard work for development, we submitted our paper and video in hopes that we would be selected in the top 7. On September 17, at 6:00 a.m., we received word that we were selected in the top 7, and that we would be going to France to present our idea. Despite the lack of sleep the night before, we were unable to sleep afterwards due to the amount of excitement. Our accomplishment as of then was a big enough win for us and our university.

It was interesting seeing such a diverse group of professionals on the jury. We managed to deliver a successful presentation and answer the questions the best that we could.

As we said, regardless of how we would have placed in the competition, it was an extremely valuable experience. The prize money we obtained came nowhere close to how valuable this competition was to us. It was an absolute honor taking part in this competition, and we'll be sure to do it again in the future. A special thank you to Valeo for their support for innovation and engineering for students.

How did you come up with your winning idea?
The group, with significant help from Dr. Habash and Julio Pimentel (an industrial partner of the university), came up with two separate ideas. A lot of literature review was done prior to the start of the competition, as well as early in the competition, and the group came up with the idea of optimizing the efficiency of a vehicle. This idea was inspired by the current market of hybrid-electric vehicles, and we wanted to build something simple and easy to implement with today's technology in order to improve efficiency, and therefore increase range of a hybrid-electric vehicle.

How has the university supported you in this process?
Firstly, our supervising professor continuously offered his support throughout the duration of the competition. With his efforts and those of the University of Ottawa, the students were able to build in two separate laboratories: Advanced Robotics Innovations Society in Engineering (ARISE) as well a large development shop in the Brunsfield Center.

Secondly, Professor Habash nominated a mentor for the project, Julio Pimentel. His company, Kylowave, is an industrial partner of the University of Ottawa. The University and Kylowave combined efforts to donate a fast prototyping platform, which played a significant role in the testing and development. Despite Julio's busy schedule, he dedicated his own time throughout the summer to offer theoretical help when needed.

Finally, the Dean of Engineering, Claude Lague, gathered together a variety of professors to simulate a mock jury (similar to the professionals that were on the Valeo jury) to better help our presentation. These professors gave us extremely constructive criticism that helped us strengthen and perfect our presentation.

How have your courses prepared you to succeed in such a competition?
The undergraduate courses that we have taken have proved to play a big role in the development that took place. It was interesting seeing another level of application of the courses taken, rather than a typical laboratory experiment. Hardware- and software-based classes, as well as the development of problem-solving skills, are significant reasons why we were so successful.

What reaction did you receive to your invention at the Valeo Challenge?
The jury, consisting of a wide variety of professionals, showed their interest in our idea. They thought of interesting questions, technical and nontechnical, for the team to answer during the presentation. Additionally, after the presentation, some members of the jury came up to the team asking additional questions that demonstrated their interest. Altogether, their positive attitude showed how supportive they are as an organization, especially towards students.

Are there any next steps planned for your research?
We are currently in the process of patenting the idea, and simultaneously developing a larger prototype where we can actually test the technology on a driveable model. ■

Hassan Aboubakr Omar (left) is a postdoctoral fellow in the Electrical and Computer Engineering department. He started on his Ph.D. in January 2010 and completed it last April (when he applied for the contest he was still a student, which is one of the requirements of the contest). Sailesh Bharati (middle) is a fourth-year Ph.D. student in the Electrical and Computer Engineering department. Ning Lu is a fourth-year Ph.D. student in the electrical and computer engineering department. All are members of the Broadband Communications Research (BBCR) Group (http://bbcr.uwaterloo.ca/), working under supervision of Prof. Weihua Zhuang (http://bbcr.uwaterloo.ca/~wzhuang/) and Prof. Sherman Shen (http://bbcr.uwaterloo.ca/~xshen/).

INNOVATION CHALLENGE Valeo

FEATURE

UNIVERSITY OF WATERLOO TEAM CREATES A **WIRELESS NETWORKING PROTOCOL FOR V2V AND V2R COMMUNICATION**

(Editor's note: The following is based on an email exchange between *MOMENTUM* and team member Hassan Aboubakr Omar.)

Why did you decide to enter the Valeo Innovation Challenge?
Before the Valeo Innovation Challenge was announced, we had an idea of a wireless networking protocol, called VeMAC, which can make future cars safer by realizing reliable wireless communications among vehicles driving nearby each other [vehicle-to-vehicle (V2V) communications] or among vehicles and especially deployed roadside units [vehicle-to-road side unit (V2R) communications]. Before the Challenge, we have extensively evaluated VeMAC via mathematical analysis and computer simulations, and when Valeo announced the challenge, we thought it would be an excellent opportunity to implement VeMAC and test it via real experiments. Our main motivations were to deliver our idea to a well-known automotive supplier like Valeo, and, of course, the huge value of the first prize, which is 100,000 euros.

Please summarize your invention that helps vehicles communicate with each other to enhance passenger safety.
Our innovation is a wireless networking protocol, called VeMAC, which allows a vehicle to reliably broadcast safety messages to all the surrounding vehicles periodically and in case of an unexpected event, such as a sudden brake or dangerous road condition detection. Such reliable broadcast of periodic and event-driven safety messages provided by VeMAC enables a variety of sophisticated safety applications which can effectively reduce the risk and severity of a traffic accident.

Describe your experience in the competition.
I heard about the contest last December when I was visiting Egypt (Valeo has a development center in Cairo). When I came back to Canada, I took permission from my supervisor, Professor Weihua Zhuang, to participate in the contest, then I contacted my colleagues Ning and Sailesh, and we formed our team, called Three VeMAColleagues (combining the name of the project, VeMAC, with the word Colleagues).

The team's solution involves using a microcontroller, GPS, LCD, and radio module to implement the VeMAC protocol.

We submitted the first proposal for Phase1 of the contest (there were 969 projects submitted from around 450 universities from 55 different countries), and a few months later (in April), we were selected among the top 20 teams to advance to the prototyping phase of the contest. Each of the 20 teams received 5000 euros to create a mock-up for the project.

Then we began working very hard to implement the VeMAC protocol on hardware, test the protocol via different lab and on-road experiments, write a high-quality technical report, and prepare an attractive video for the project mock-up presentation. By late August, we submitted the technical report and the mock-up presentation video, and two weeks later we were selected among the 7 finalists which traveled to Paris to present their projects to the contest jury.

The jury consisted of people who are very well recognized for their experience and professional expertise, including scientists, astronauts, economists, as well as the Valeo CEO, COO, and VPs of innovation, research, and development. It was a real challenge for us to prepare the 15-minute project presentation in a way that was comprehensive for all the jury members, who have very diverse backgrounds. On Oct. 16, we presented the project to the jury. It was one of the most important presentations we have done in our lives so far, and the results were announced to the public the next day in a press conference, with many journalists attending from different agencies.

The Valeo Innovation Challenge was a truly beneficial experience for us to develop our technical and interpersonal skills. We had to plan for the project within the available time duration, work hard to realize the project objectives, manage the expenses according to the project budget, and take crucial decisions at the correct times. The Challenge has allowed us to bring our ideas from technical papers to real-world implementation. We were very glad to feel that a big industrial organization like Valeo is interested in and supportive of our innovation. Although we didn't win first prize, we were all happy and convinced that we'd done our best.

How did you come up with your winning idea?

We first studied the existing communication standards currently proposed for wireless communications in a vehicular environment. Then, given the significant limitations of the current standards in supporting road safety applications, we tried to think of a suitable alternative that is more efficient, simple, and implementable.

How has the university supported you in this process?

Our supervisors, Prof. Weihua Zhuang and Prof. Sherman Shen, were really supportive to us throughout the project. Prof. Zhuang allowed me to give 100% of my time to the project, and that is in addition to what we learned from her during our Ph.D. programs in terms of dedication to the work, technical writing skills, and targeting the highest-quality outputs.

On the other hand, Prof. Shen always encourages us and follows up with the project progress from time to time. He made us feel that this Challenge is a real opportunity that we have to work very hard to benefit from. At the last phase of the contest, Prof. Shen provided very useful advice in terms of writing the technical report and preparing the final presentation to the jury. Also, the University of Waterloo Commercialization Office was really helpful in providing useful consultations to us throughout the project.

How have your courses prepared you to succeed in such a competition?

The graduate courses that we took at the Electrical and Computer Engineering department as part of our Ph.D. programs were definitely helpful, especially in the evaluation of our project (the VeMAC protocol) via mathematical analysis.

What reaction did you receive to your invention at the Valeo Challenge?

Our project received great interest from many Valeo experts, which is verified by the second prize that the project was awarded. As well, different Valeo research and development leaders have indicated the interest of Valeo to collaborate with our team in the future. We were very glad to feel that a huge automotive supplier like Valeo is supporting our innovation.

Are there any next steps planned for your research and, if so, what?

We are currently studying the remaining research issues with the VeMAC protocol and thinking of improving the developed VeMAC prototype for commercialization. ■

FEATURE

COLORADO STATE UNIVERSITY DESIGNS

The Colorado State University team, shown here with its modified Chevy Malibu, placed 8th in the 3-year EcoCAR2 competition that wrapped up in 2014. CSU has been selected as one of the universities to participate in the upcoming EcoCAR3 competition, which will run through 2018.

FUEL-CELL PLUG-IN HYBRID SYSTEM

CSU team designed a novel system as part of the EcoCAR2 competition sponsored by General Motors and the U.S. Department of Energy.

ECOCAR2 WAS A THREE-YEAR COLLEGIATE COMPETITION established by the **U.S. Department of Energy** and **General Motors** to offer an unparalleled hands-on, real-world experience to educate the next generation of automotive engineers. The competition challenged 15 qualifying universities across North America to reduce the environmental impact of a 2013 **Chevrolet** Malibu (donated by GM) without compromising performance, safety, and consumer acceptability. Specific goals for the teams were to:

- Reduce fuel consumption
- Reduce well-to-wheel greenhouse gas emissions
- Reduce criteria tailpipe emissions.

As a way of ensuring that the modified Malibus would retain the vehicle's attributes of consumer acceptability, performance, and safety, the teams followed a vehicle-development process modeled after the one used by GM.

Colorado State University's team designed, built, and demonstrated a fuel-cell plug-in hybrid electric system featuring a 15-kW polymer electrolyte membrane fuel-cell system, an 18.9 kW·h/177 kW lithium-ion battery, and a 145-kW motor for all-electric drive. The **UQM** Powerphase motor and **BorgWarner** eGeardrive with 7.17:1 reduction are located in the bottom of the underhood compartment. The motor can provide up to 400 N·m of torque and is limited to 8000 rpm.

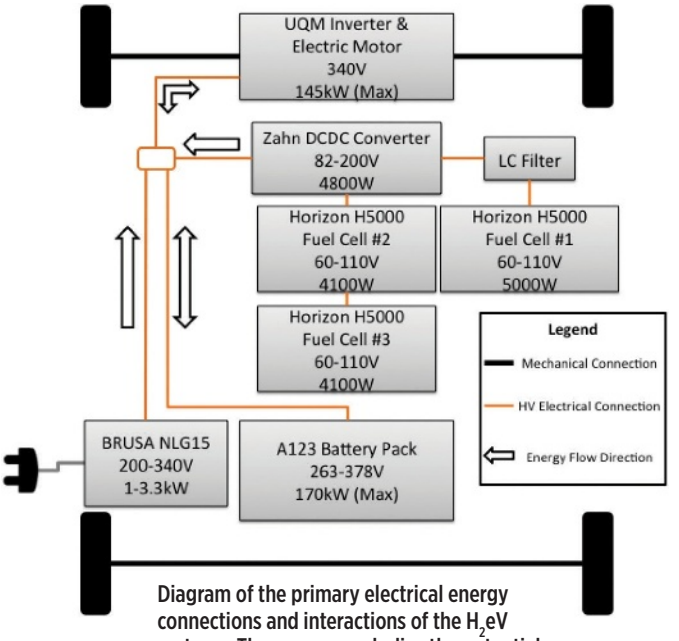
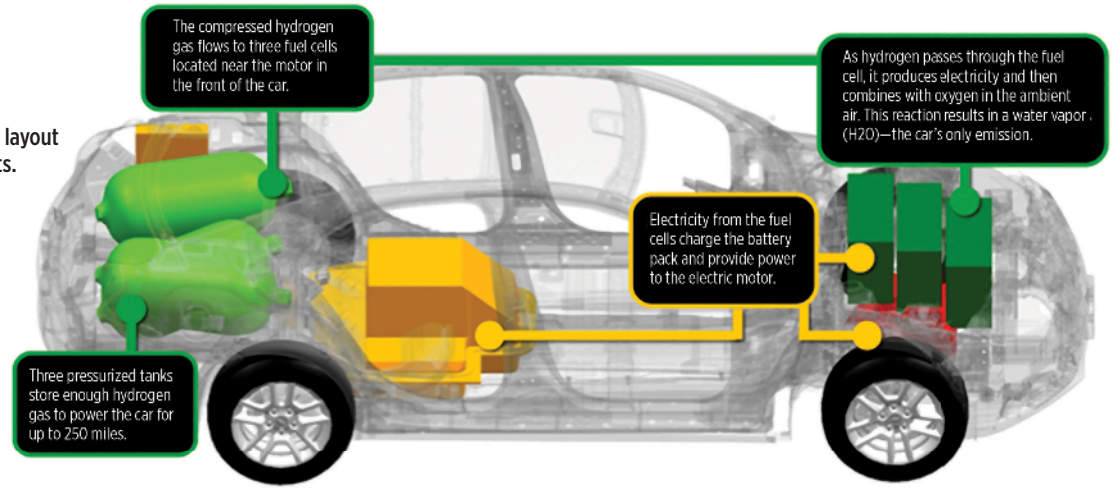


Diagram of the primary electrical energy connections and interactions of the H_2eV systems. The arrows symbolize the potential energy pathways during normal vehicle operation. Component sizing and locations are not to scale.

The battery pack, using cells provided by **A123 Systems**, is more than capable of meeting the maximum power requirements of the motor. The battery pack is located under the rear seats and protrudes into the passenger cabin where the rear middle seat



Ghost view showing layout of major components.

would be in a stock Chevy Malibu. This battery placement requires a portion of the vehicle's unibody structure to be removed. A custom structural carbon-fiber battery enclosure was manufactured to contain the battery pack and maintain the strength specifications from the stock vehicle.

The battery pack is rechargeable through a **BRUSA** NLG 513 onboard charger. This charger uses the **SAE** J1772 protocol and can provide up to 3.3 kW of dc power to the battery pack from either a Level 1 (120 V ac) or Level 2 (240 V ac) home or commercial charger.

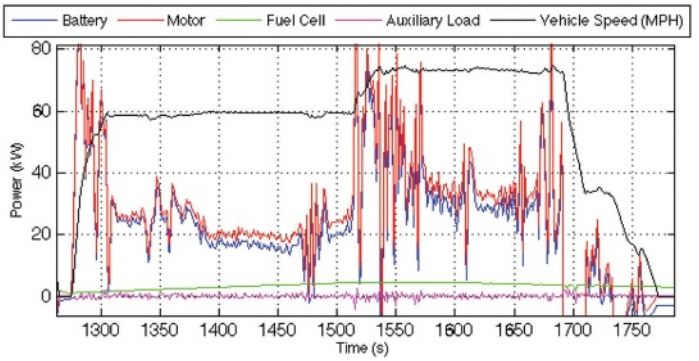
Using battery power alone, the range of the team's modified Malubu, which it calls H_2eV, would be limited to around 50 mi (30 km). To increase the driveable distance, the fuel-cell system provides the high-voltage bus with supplemental power. Three **Horizon** H5000 fuel cells are used in the vehicle, which produce a maximum power of 5 kW each, for a potential output of 15 kW.

The fuel cells are self-humidifying and self-cooling, and they use an ambient pressure cathode that requires minimal air handling. Air is pulled through the fuel-cell stack via several 24-V fans. This results in low balance-of-plant losses.

Another intriguing aspect of the fuel cells is that their highest efficiency operating point (~45%) corresponds closely to their highest output power operating point (~70 A at ~72V). This means that the fuel cells can be commanded to output a large amount of power into the battery, while still maintaining high hydrogen conversion efficiency.

A novel strategy is used to match the voltage of the fuel cells to that of the high-voltage (HV) bus. One of the fuel-cell stacks (fuel cell #1) is connected to a **Zahn** CH25090 dc/dc converter, and the output of the dc/dc converter is connected in series with the other two fuel-cell stacks (fuel cells #2 and #3). During vehicle operation, the fuel cells are able to maintain a near-constant voltage and output current because the dc/dc converter regulates its voltage to match the fuel-cell system voltage to the HV bus voltage. This configuration limits the fuel-cell system operation from 15 kW to 8-13 kW (depending on battery voltage), but can achieve high efficiency energy transfer as the dc/dc converter losses (80-85% efficiency) are only applied to fuel cell #1. Unlike some fuel-cell vehicles, this strategy does not require a custom, high-power, high voltage dc/dc converter, which greatly reduces vehicle build cost.

Gaseous hydrogen is stored on board the vehicle in Type III **Dynetek** storage cylinders. Three cylinders located in the trunk of the vehicle each store 1.65 kg (3.64 lb) of hydrogen at 5000 psi (300 bar). Hydrogen is delivered to the fuel cells through a custom hydrogen delivery system based on SAE J2579 best practices. The system uses two-stage regulation to go from 5000 psi at the tank to 7 psi (0.5 bar) at the fuel-cell inlet with the intermediate step at approximately 200 psi (10 bar). The hydrogen tanks are filled according to the SAE J2601 standard, including the capability to perform communication fills.



CSU's system was designed so that fluctuations observed in battery voltage are successfully isolated from the fuel-cell operation, as shown in this graph that reflects a portion of the drive cycle created for the EcoCAR2 competition. The battery power requirement is offset from the motor power by the fuel cells and auxiliary loads.

During the final EcoCAR2 competition, current of the fuel cell loading the dc/dc converter (fuel cell #1) was limited at 35 A within the controller to mitigate potential failures that may be observed under high load conditions. As seen in the graph above, the operation of the fuel cells as a group is quite constant throughout the drive cycle. The battery operation, however, is far from constant. The fluctuations observed in battery voltage are successfully isolated from the fuel-cell operation. It can also be observed that the battery power requirement is offset from the motor power by the fuel cells and auxiliary loads. ■

More detail on the CSU EcoCAR2 entry is available in SAE technical paper 2014-01-1925, titled "Detailed Analysis of a Fuel Cell Plug-in Hybrid Vehicle Demonstration," on which this article is based. Paper authors are Shawn Salisbury, Thomas Bradley, Jake Bucher, and Benjamin Geller, all of Colorado State University. Twenty undergraduates contributed to the research reflected in the paper: Devin Martinez, Marek Stejskal, Matthew Shannon, Alexander West, Chase Betzer, Mohammed Asheer, Michael Jurich, Joshua Engle, Clinton Knackstedt, Tom Cummings, Duc Cttu, Gabe Neymark, Garrett Kadillak, Brandon Pletcher, Sarah Bass, Mike Garcia, Jon Weeks, Emily Keats, Miles Rand, and Brad Nelson.

Adam Morely shot and edited Cal State – Fullerton's winning video.

FEATURE

CAL STATE FULLERTON FINDS WINNING FORMULA IN COMBINING ART AND ENGINEERING

Readers of the digital version can watch the top three videos by clicking on the icons below.

1st place: California State University – Fullerton
www.youtube.com/watch?v=F3KUDHZLFjs

Second place: VIT University
www.youtube.com/watch?v=wYfeWykDv1w

Third place: Oregon State University
www.youtube.com/watch?v=9gNIRB7vtcQ

Team wins Generation Auto video contest in a year marked by great improvement in its Formula SAE performance.

THE CHALLENGE: Create and submit a 1-2 minute video highlighting the diverse aspects of the automotive industry that make it an attractive or "cool" industry to work in.

The qualification: Participate in an **SAE International** Collegiate Design Series event.

Many teams qualified for the 2nd annual Generation Auto student video contest, but no team met the challenge better than **California State University - Fullerton**. It was announced as the first-place team during the 16th annual **OESA** Outlook Conference Nov. 11, and received a prize of $4000 for its efforts.

Finishing second in the contest organized by OESA and SAE International with the support of **Deloitte** was **VIT University** of India. That team received a prize of $3000. Taking home $1000 was the third-place team, **Oregon State University**.

The Cal State – Fullerton team placed 12th in the Formula SAE Lincoln event in 2014.

Momentum asked the Cal State Fullerton team to reflect on its efforts in Formula SAE and in the video contest. Passion turned out to be the theme connecting the two. FSAE team captain Carlos Gibson offered his thoughts about the team, while Adam Morely, who shot and edited the Generation Auto entry, spoke about the video.

CARLOS GIBSON ON THE FORMULA SAE TEAM

"What fascinated me the most about the Formula SAE team at Cal State Fullerton was the passion the students had. Three years ago, I walked into a room full of dedicated engineering students who were building a race car. At first, all I was looking for was an extracurricular activity related to my field of study. Three years later I am leading the entire team to what we hope will be the best year in CSUF's history.

Our school has successfully completed a Formula SAE vehicle for the past five consecutive years. Although the completion of the vehicle has been a success, we haven't had many successful years regarding how we place in competition. This past year (2014), our car placed 12th out of 76 competing schools in Lincoln, NE. This is the best our school has ever placed.

There isn't much to say about most other years, other than that we got a dose of schooling on how to strive for perfection. Being a relatively new team, we have spent most of our time trying to find the winning formula for racing. Last year's design served as a strong foundation for our team that we believe can yield a very successful car.

Our team is divided into four subteams: suspension, chassis, powertrain, and aerodynamics. We start our year off by designing the suspension. Once we have established the geometry points for the suspension, we proceed by designing the chassis. Simultaneously, the powertrain team designs an intake and exhaust that will give us a desirable power and torque curve. These three subteams are essential to compete.

Beyond the essentials, this year will be the first year our school implements an aerodynamics package. Although an aero package isn't necessary to compete, it is essential to win. By creating negative lift, we will be able to increase the normal force on the tires and provide more grip through turns. This will increase the vehicle's ability to accelerate laterally.

Once the vehicle has been designed, we move onto the manufacturing stage. We are proud to say that just about everything on the vehicle is manufactured on campus by us. This process allows students to understand the possibilities and limitations of many manufacturing processes.

After the car has been assembled, we are ready to drive! But it isn't all "fun and games" when we drive. The driving phase (or the "physical testing and data acquisi-

Time in the shop is an unavoidable part of bringing an FSAE car to fruition.

Team captain Carlos Gibson at work in the shop.

tion phase," as we like to call it) is very important for validating our design decisions. This year we are focusing on extracting as much empirical data from the car as possible. This is why we are implementing several data acquisition instruments on the car. We will be able to see where we actually stand with regards to our design goals by interpreting and analyzing the data.

Lastly, we will be ready to embark on our journey to Lincoln. An entire year's worth of work will come down to three days. All of the countless hours of work, sleepless nights, and cups of coffee will be reflected over a course of three days.

There are many factors that play an important role in the level of success of teams. Factors such as a large budget, a solid knowledge foundation, and a broad supply of resources help teams create the best Formula SAE vehicle possible. But there is one factor that in my opinion is the most important one: passion. And passion, our team has plenty of.

ADAM MORELY ON THE GENERATION AUTO CONTEST

Reflecting back on the time spent with the Formula SAE Team is something that brings a great deal of joy.

It was only my sophomore year when a friend of mine asked if I would like to come film in the shop at night. Immediately, I was so drawn to how cinematic the subjects were, with welding and cutting happening all around, I felt that I could practically point my camera in any direction and capture incredible shots. Even though the first few videos were just for fun, it allowed the team and I to develop a relationship that lead to more serious endeavors.

Over the past three years, I have unofficially been responsible for the team's media content that gets released, including crowdfunding videos, and most recently some award-winning videos for contests. This past November, with the video I shot and edited, the CSUF Formula SAE team took home first place in the OESA Generation Auto contest.

While this first-place victory is new, the contest itself is not. Last year, the team entered it and brought home third place. While that was nice, the celebration was short and we knew how much better first place would taste. So without hesitation we entered into this year's competition and did just that. It was a very rewarding victory and I believe it helped boost the morale of the entire team.

Besides the great publicity OESA was able to provide, I was also able to land a spot on the homepage of my University's website and have an article written in the local newspaper, the Orange County Register.

My time spent working alongside the Formula SAE team has not only allowed me to improve my video skills, but has opened doors that I couldn't be more thankful for. Through connections with the team, I have been able to bring home contract work with companies such as **HSM Works**/**Autodesk**. It's impressive to see how a friendly relationship with the team has turned into something beneficial for both parties. I have no doubt that the reason for our collaborative success is due to one common factor: passion. ■

SAE to have hand in CYBERAUTO CHALLENGE

SAE INTERNATIONAL IS PARTNERING WITH **BATTELLE** AND **DELPHI AUTOMOTIVE** for the 4th Annual Battelle CyberAuto Challenge to be held July 13-15 at Delphi Automotive headquarters in Troy, MI.

The aim of the challenge is twofold, said Anuja Sonalker, Lead Scientist and Program Manager at Battelle. The first is to "spread awareness about the vulnerabilities that automobiles today possess, and how trivial it is to leverage them in most cases; and spread awareness of the critical need for a new cross-disciplinary engineering field—the cyber-automotive discipline, which combines knowledge from the cybersecurity domain with automotive engineering to solve a critical talent gap the industry faces today."

Battelle developed the CyberAuto Challenge in 2012 as a way to champion science and technology in the automotive industry as a career choice for today's youth. Over the course of the five-day event, students are divided into teams with an equal ratio of working professionals from a variety of organizations, including automotive manufacturers; federal agencies such as the U.S. departments of Transportation, Homeland Security, and Defense; and research organizations. The teams participate in daily lecture and instruction in subjects such as secure system design, secure programming, embedded systems, IT law, and ethics. Then, each day, they apply their new knowledge to practical challenges on actual cars. Many of the sessions have time constraints to simulate real-world conditions.

"There is a value for all participants," said Sonalker. "Professionals can seek interns or employees from the student attendee; students can educate the professionals about emerging trends and upcoming waves such as crowd-sourcing and emerging studies. Knowledge seekers from different backgrounds can all work on hard, realistic problems and forge mentor or cooperative relationships."

There were a total of four teams in the 2014 CyberAuto Challenge. Each team comprised a mix of high-school and college students, OEM technical staff, Tier 1 supplier technical staff, STEM educators, and Battelle technical staff. Each team worked on an exclusive vehicle provided by car manufacturers. The teams created an outline of what they wanted to make the vehicles do that was extraordinary to the design of the vehicles and then executed methodically to get there. Since the event is not a competition, teams shared experiences and learned from each other.

By the end of the week, the number of students who believed they could see themselves become a part of the cybersecurity automotive engineering discipline rose by 200%.

Not all details of the 2015 event have been finalized, including call for participation. Students will have to be nominated to participate. For more information, email solutions@battelle.org or call 800.201.2011.

Go to http://articles.sae.org/13377/ to read an article about last year's Battelle CyberAuto Challenge.

Patrick Ponticel

Team members analyze vehicle data as part of the activities during last year's week-long Battelle CyberAuto Challenge.

Students learning to create automotive transceivers using breadboard kits.

Students at the CyberAuto Challenge determining sequence of events to execute.

FOCUS ON FEMALE ENGINEERS

Barb Samardzich, Ford of Europe COO, recently presented the Ford Prize for Women in STEM, in association with the Ford Professional Women's Network, to Holly Giles, now studying at Cambridge University. In an *Automotive Engineering* article about Samardzich and Ford of Europe at http://articles.sae.org/13721/, she said: "Ford employees in Europe recently took advantage of a 'Take your daughter and a friend to work' event. We showed them, from laboratory to test track, just what an engineer is and does. When I graduated in mechanical engineering in the 1980s, typically around 5% of engineers (graduating in any engineering discipline) were women; now it is about 17% in the U.S., even lower in some European countries. But it could be much higher. There are so many exciting opportunities and challenges ready and waiting for them!"

MOST POWERFUL PRODUCTION MINI SHOWS IN DETROIT

Power up by 10% and improved aerodynamics give the new-generation Mini John Cooper Works a 245-km/h top speed.

Aerodynamic improvements for the John Cooper Works include a model-specific rear apron and rear spoiler. Chromed tailpipes are centrally mounted and help provide the required aural signature.

WHEN THE FIRST BMC Mini was introduced in 1959, its power output was 25 kW (34 hp) from a very modest 848 cm^3 engine that could eventually take it to 100 km/h (62 mph) in about 26 s and on to a top speed of 120 km/h (75 mph)—on a good day.

At January's North American International Auto Show in Detroit, the most powerful production **Mini** ever was revealed. Its power output is 170 kW (228 hp) from a still relatively modest 2.0-L turbocharged engine that can take it to 100 km/h in 6.1 s and on to a top speed of 245 km/h (152 mph), more than doubling that of the original car.

The new Mini is the latest generation of the John Cooper Works (JCW) range leader. Compared to the outgoing 1.6-L model, the new 2.0-L presents a power hike up by 10%, and maximum torque, at 320 N·m (236 lb·ft) from 1250 to 4800 rpm, improved by a very impressive 23% to enhance driving flexibility. Acceleration from 80 to 120 km/h (50 to 75 mph) is down by 10%.

The car's engine, based on the Mini Cooper S unit, uses fully variable valve control and variable camshaft control. Improved aerodynamic efficiency has also contributed to the performance gains, and Mini has also focused on minimizing weight without losing the car's premium equipment.

Transmission options are a six-speed Steptronic or six-speed manual, the former giving the 6.1-s 0-100 km/h time, the latter increasing this slightly by 0.2 s.

Mini describes the latest JCW as drawing on the brand's motorsport expertise with a package of suspension, brake, aerodynamic, and interior modifications "to deliver race-car sensations without losing sight of Mini's premium position."

Or its emphasis on fuel consumption. The original Mini averaged between about 7.0 to 5.7 L/100 km. The JCW's combined NEDC consumption with the manual gearbox is 6.7 L/100 km with CO_2 emissions of 155 g/km. With Steptronic, economy improves by 20% to 5.7 L/100 km (coincidentally almost exactly the same as the original Mini's best), with CO_2 emissions down to 133 g/km. The original Mini weighed 585 kg (1290 lb), around half that of the JCW.

Both the suspension and the **ZF** Servotronic electromechanical power steering have been tuned to complement the JCW's extra power and torque. Newly developed four-piston **Brembo** brakes within 17-in light-alloy wheels are fitted; 18-in are optional. Dynamic Stability Control (DSC), Dynamic Traction Control (DTC), Electronic Differential Lock Control (EDLC), and Performance Control (PC) are standard, with Dynamic Damper Control an option.

Mini stresses the JCW's aerodynamic changes have been introduced "with a purpose rather than for purely aesthetic reasons." They include a new front apron with large engine air intakes, modified side sills, a model-specific rear apron, and a JCW spoiler.

The car has LED headlights with white turn indicators, wheel-arch surrounds, and unique radiator grille, side scuttles, and tailgate with JCW badging.

Compared to other Mini versions, the JCW gets exclusive to model bucket seats with integrated headrests in Dinamica/fabric and a multi-function steering wheel with shift paddles (in conjunction with Steptronic transmission), gear selector, instrument displays, stainless steel pedals, and footrest.

Bespoke JCW personalization options include a model-specific head-up display (HUD), Chili Red roof and door mirror covers, bonnet stripes, and exterior and interior John Cooper Works Pro design accessories in addition to the other options available for the entire Mini range. ■

By Stuart Birch, *Automotive Engineering* magazine

CATERPILLAR UPDATES ITS D7E DIESEL-ELECTRIC DOZER

Caterpillar's latest D7E dozers feature three new "productivity boosting" dozing features for optimized performance during grading work: Stable Blade Control, Traction Control, and Slope Indicate.

AFTER FIRST APPEARING ON JOBSITES IN 2009, **CATERPILLAR**'s latest D7E dozers feature three new "productivity boosting" dozing features for optimized performance during grading work.

According to Caterpillar, Stable Blade Control complements operator inputs and auto adjusts the blade for smoother, more precise grades; Traction Control senses track slip and makes instantaneous smart blade adjustments to improve load consistency and maintain fuller blade loads, resulting in greater productivity with less undercarriage wear; and Slope Indicate provides a constant visual readout of the machine's mainfall and cross slope for real-time grade and slope guidance without a dedicated grade control system.

What set the Cat D7E dozer apart from other dozers in 2009, and still in 2015, is its innovative diesel-electric powertrain, said to deliver up to 30% better fuel efficiency and 10% more production than its conventional D7R2 predecessor. Fuel savings, fewer mechanical parts to wear, reduced lubricant use, and increased production combine to lower owning and operating costs. The D7E meets **U.S. EPA** Tier 4 Final/EU Stage IV/Japan 2014 emissions standards.

Cat's emissions reduction technology is transparent, requiring no action from the operator and no stopping for system regeneration. Engineers designed the SCR system such that its diesel exhaust fluid (DEF) could be refilled at refueling time. Across a variety of applications, the D7E typically has used DEF at a rate of 2 to 2.5% of fuel consumption with optimized fluid efficiency, defined as the amount of work done per unit of fuel and DEF consumed. In less aggressive applications, Cat says many operators will find they can complete multiple shifts on a single tank of DEF.

The D7E engine powers an electrical generator that sends current through armored cables to a solid-state inverter, which supplies dc current to accessories. The propulsion module, featuring state-of-the-art ac electric motors, delivers well-modulated torque via axles to the final drives. Electrical drivetrain components are sealed and liquid cooled with both oil and water to work efficiently in a wide variety of conditions and in high ambient temperatures.

A load-sensing hydraulic system continually adjusts hydraulic power to maximize work tool efficiency. Dozer blade choices include universal, semi-universal, straight, and angle blades. There are also special application blades to meet the needs for processing materials such as wood chips, coal, and waste. Rear attachment options include a multi-shank ripper, winch, drawbar, and counterweight. Purpose-built waste-handler and stockpile configurations equip the D7E for optimum service in such industrial applications.

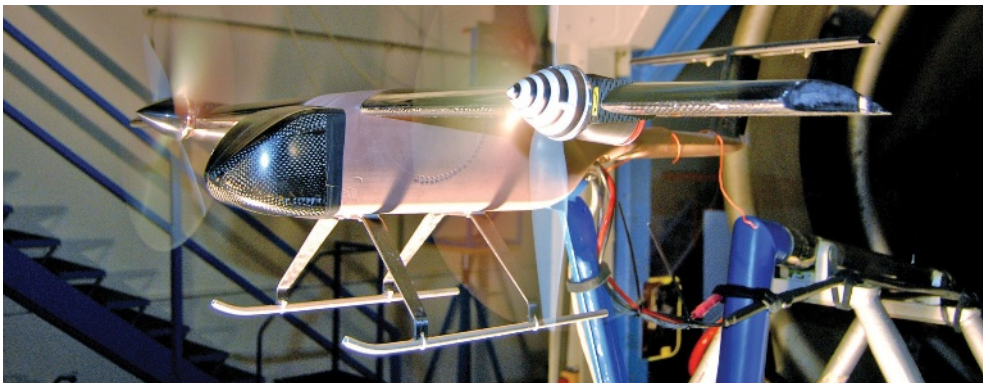
The cab uses a center-post design for improved all-around visibility, an in-dash monitor for displaying real-time machine data, and a heating/ventilation/air-conditioning system that is self-contained and electrically powered. A speed recall feature allows pre-setting forward/reverse travel speeds, and then resuming set speeds by the touch of a button.

A tilt cab allows easy access to modular drivetrain components, and routine service points and sight gauges are grouped on the left side of the machine. A ground-level service center houses the battery disconnect, hour meter, engine shutdown switch, and access lighting switches. An LED indicator in the service center, when illuminated, warns that powertrain and accessory systems are energized; when not illuminated, systems are safe to service.

In terms of other accessories that enable managers to make timely, fact-based decisions that can boost job site efficiency and productivity while lowering operating costs, Product Link helps fleet owners track location, hours, fuel consumption, idle time, and events by wirelessly reporting all via the online VisionLink user interface. Also, Cat's AccuGrade is a dealer-installed grade control system that provides real-time in-cab guidance and automated blade movements to assist operators in efficiently attaining accurate grades in fewer passes, improving productivity as much as 50% over traditional methods. ■

By Jean L. Broge, *SAE Off-Highway Engineering* magazine

COLLABORATIVE RESEARCH PROJECT LEADS TO POTENTIALLY SWARMING VTOL UAVS



The AVIGLE VTOL unmanned aerial vehicle, developed via collaboration by a variety of entities for a variety of applications, is shown in a wind channel test. (RWTH Aachen)

OVER A THREE-YEAR PERIOD, German aerospace engineers from industry and academia collaborated on the AVIGLE (Avionic Digital Service Platform) research project, described as a "widely applicable avionic service platform" with open interfaces. **Schübeler Composite** contributed to the project during design via its knowledge and experience in fluid-flow machines and lightweighting, while the aerodynamic shape of the AVIGLE drone was developed at the **RWTH Aachen University**.

The result of the collaboration is a UAV ready for use without infrastructure, and which addresses applications such as civil security, mobile communications, construction, GIS, and surveying, but also the entertainment market and the media. For takeoff and landing the wings are tilted 90° upward, so that the two propellers—normally responsible for propulsion—are turned into rotors for hovering. As such, the UAV does not need a runway and can be used in open terrain. Flying in a horizontal line in turn has the advantage that it is more energy efficient than a helicopter flight.

AVIGLE project engineers envision the UAVs acting as a swarm of flying robots, equipped with 3-D cameras that can take high-resolution images of a region from different perspectives. This data is submitted to an evaluation system via a high-performance communication network "where a 3-D virtual world is created in quasi real time." This model can support architects and city planners but also rescue personnel at civil protection organizations under situations where there are scarce resources for short-term cellular structure of dynamic wireless networks.

Schübeler supported the project in the development, design, and production of the flight platform particularly in regard to the construction of the airframes and associated strength and weight optimizations. This among other things resulted in a wind tunnel model that was used for design evaluation. The structure was optimized during the project for revised weight, strength, and efficiency of the components. For this purpose, new manufacturing methods—non-autoclave production technologies—for composite structures were tested and implemented.

A new mechanism for the pivoting wing was developed for the UAV, which is a tilt-wing model. Schübeler undertook the evaluation and deployment of the propeller blade designs (variable pitch propeller). The development of the adjustment mechanisms for wings and propellers were also implemented to realize the adaptation of the two flight modes: floating and horizontal flight. Schübeler was also responsible for selecting and providing the energy supply as well as the development, design, and tuning of the drive components.

Ultimately the team ended up with a lightweight chassis made of carbon fiber with lithium polymer batteries. A flight time of 60 minutes at a takeoff mass of 10 kg (20 lb) was achieved with a payload mass of 1.5 kg (3.3 lb). The speed of the high-wing aircraft is at most 40 m/s (130 ft/s), and it has a wingspan and fuselage length of about 2 m (7 ft).

Participating in the project allowed Schübeler to expand its knowledge in the field of flow simulation and lightweight construction via its extensive research into the technological issues that came to the surface during the project. Important aspects of the know-how gained were able to be incorporated into new products and the development of existing procedures and processes. Among other things, the technical competence of the tilt-wing will be transferred to other tilt-wing and tilt-rotor projects.

Knowledge built up on the new "vacuum infusion" non-autoclave production technology during the project is likely to be implemented in the company for the production of lightweight structures. In addition, the company will use the broadband usage of lightweight composite know-how as well as the application of CFD simulation methods at different prop projects.

In the interdisciplinary research consortium Schübeler Composite collaborated not just with RWTH Aachen but also the universities **TU Dortmund** and **Münster**, the research institutes **Fraunhofer IMS** and **IMST**, as well as the high-tech commercial companies **mimoOn** GmbH and **Aerowest** GmbH. The project was subsidized by the State of North Rhine-Westphalia and the European Regional Development Fund (ERDF). ■

By Jean L. Broge, *Aerospace Engineering* magazine

HELPING OVERLOADED ENGINEERS, ATTRACTING TALENT A GROWING CONCERN

Though hardware and software were front and center at the SAE 2014 Convergence event in Detroit, panels also explored broader issues facing the auto industry.

IBM's Bret Greenstein noted at the "Future of Technology Delivery" panel session at SAE 2014 Convergence that children look at engineers in a new light because of movie heroes like Batman and Iron Man. (Lisa Barclay/IBM)

PANELISTS FROM A RANGE OF INDUSTRIES provided ideas for optimizing the workforce during an SAE 2014 Convergence session on the "Future of Technology Delivery." Finding ways to help engineers be creative and efficient was a hot topic.

"Engineers are overloaded with information," said Bret Greenstein of **IBM** Corp. "Connectedness means that data volume will grow, creating a real challenge for analytics. Being able to design for feedback is a big challenge for engineers."

Connectivity and autonomy involve factors beyond the vehicle, making design challenges more complex. Engineers will have to explore more options given the vast number of variables.

"Every solution can create a new problem," said Sharafat Khan of **Deloitte Consulting**. "You have to consider what can possibly go wrong when you're designing anything."

That's going to require some changes in the way design teams work together. Collaboration is becoming more important. One way to foster more interactions between hardware, software, and manufacturing engineers is to move to an open-office format.

"We found the physical environment had a huge psychological effect on engineers," said Janaki Kumar of **SAP** America. "If you tear down the walls in an office, you remove the feeling that people have to ask whether they should collaborate. Designers can't take advantage of all aspects if they don't talk to other groups."

Finding enough talent to address the complexities of advanced designs is a big challenge. Panelists agreed that global design teams will be an important element in design programs.

"You expect people to be in different locations," said Stefan Jockusch of **Siemens PLM Software**. "Companies need an environment that lets them all work together."

Globalization brings a number of different challenges. Once the technical issues of virtual environments are resolved, managers need to focus on human factors. Engineers in different countries will have diverse ideas and ways of communicating.

"Language is an issue, but understanding cultural differences is a huge factor," Greenstein said. "Every country has its own rules. For example, how people communicate about honesty in the U.S. and China is totally different."

Whether companies are hiring people in their home country or abroad, they need to find new ways to attract and retain employees. Techniques for managing human resources are changing as Baby Boomers retire and Millennials become a greater percentage of the workforce.

"You have to provide incentive, and the working environment has to be cool," Khan said. "Automakers are learning

from Silicon Valley, doing things like letting engineers bring their dogs to work. Companies need to think about the culture they want to have."

Panelists noted that the quest to find talent has to include education, which begins in grade school. They agreed that companies and individual engineers need to help create interest in science, technology, engineering, and math.

"Getting kids excited about this is absolutely imperative," Khan said. "It's the key to getting a pipeline of skilled workers."

That effort even includes pointing out the link between engineering and popular culture. Greenstein noted that children look at engineers in a new light because of movie heroes like Batman and Iron Man. They are normal men who have well-engineered tools that make them superheroes, he said.

ADAPTING TO MILLENNIALS

As Baby Boomers retire, the Millennial generation is crucial to the engineering workforce.

Individuals born between 1946 and 1965 comprise 50% of today's workforce, but the exit door is spinning with the departure of Baby Boomers' knowledge and experience.

"The staggering number here is that statistics show that (Boomers) are retiring at a rate of 10,000 a day," said Jeremy Kearney, an organizer, moderator, and speaker for **SAE** 2014 Convergence's session on "Millennials: The New Generation of Employees."

Generation X, persons born between 1966 and 1980, represent 15% of today's workforce.

"As Boomers are retiring, there's just not enough Gen Xers to fill the gap that's happening right now," said Kearney, a **General Motors** design release engineer and a Millennial.

Millennials (also known as Gen Y) are persons born between 1980 and 1995. They account for 35% of today's job holders. By 2020, the Gen Y group is likely to comprise 75% of the workforce.

A lot is expected from Gen Y individuals. They need to have engineering knowledge and work experience to assume leadership roles at companies. But that's a tall task. Many automotive industry watchers claim it takes 10 to 15 years to gain the skills needed for a leadership role.

Like many of her Gen Y counterparts, Alisyn Malek multitasks. She is a founding member of **Corktown Studios**, a Detroit art gallery. She recently began working as an investment manager for **General Motors Ventures** LLC, following a stint as an engineering business manager for GM's electrification group.

From Malek's perspective, workforce experience needs to be fast-tracked.

"We need to figure out how to compress the time it takes to get competence. [We need to] make sure that we have the information available to supply the skills and the insights necessary because we just don't have 15 years to build up that workforce," said Malek, a co-organizer and speaker on Convergence's Millennial panel.

Millennials panelist Dave Whitman, who works in General Motors' purchasing department, said the rapid pace of innovation is skewing the jobs landscape.

"There are sections of our workforce picking up college degrees that weren't even in existence five years ago," Whitman said, adding, "There are technology advances happening at such a rapid pace that nobody in the field has 10-15 years of experience."

The reality is that professional-grade competence requires much more than textbook knowledge. "I know how to play baseball, but I'm not going to be playing for the Detroit Tigers," Whitman said.

"We need to figure out how to compress the time it takes to get competence," said Alisyn Malek of General Motors Ventures LLC.

Sara Schmitz, Corporate Recruiter for **Hella**'s U.S. facilities, said the supplier of lighting and electronics products is planning for the eventual retirement of experienced engineers. That plan includes putting student engineers into co-op jobs and internships that include ample time with veteran Hella trainers/mentors. "This is all being done to ramp up the bench strength, so when we have retirements at Hella we won't lose all that knowledge," Schmitz said in an interview with SAE Magazines.

Twenty-two college students, the majority pursuing an engineering degree, participated in paid Hella internships in the spring/summer of 2014. "That was an all-time high for Hella in the U.S. It really is important that we reach this (college) audience," said Schmitz.

Karissa King, a recruiter for **Experis Engineering** (a **Manpower** Group), said Gen Y engineers are in-demand. "The young engineers are very self-motivated, and they're tech-savvy," King said in an interview with SAE Magazines.

For young engineers with a resume that includes an internship, Formula SAE or other hands-on project participation, and one to two years of engineering work experience, the job picture is vibrant. "That's the point when they're starting to look (for other opportunities). They're being actively recruited by recruiters, so they understand they're desirable in the marketplace," King said.

Marc Issner, with **Chrysler** Group's Interior Project responsible for the **Jeep** Grand Cherokee, knows firsthand how social media can open doors. "A lot of us have profiles on **LinkedIn**, and you're getting targeted by companies that are looking for talent," said Issner, a Millennials panelist.

New opportunities can be very tempting, whether or not the pursued technical specialist is looking to switch jobs. Said Issner, "I think that pulls people and makes you really think, 'Am I really happy right now? Is this a better opportunity?'" ■

By Terry Costlow and Kami Buchholz, *Automotive Engineering* magazine

GEAR

COMPUTE STICK

The **Intel** Compute Stick, available in March 2015 via Intel authorized distributors, is a new pocket-sized computer delivering an entry compute experience by plugging directly into the HDMI input of a TV/monitor. Two versions will be launched initially. One will include 32 GB storage, 2GB memory, and a pre-installed Windows 8.1, 32-bit OS. The other will include 8 GB storage, 1GB memory, and a pre-installed **Linux** distribution. The Intel Compute Stick will support Wireless 802.11 b/g/n, a Micro SD card for expandable memory, mini-USB power supply, and Bluetooth 4.0 for keyboard and mouse. The Windows version is expected to retail for $149 and the Linux version for $99. Worldwide availability is expected.

BACKPACK FOR CHARGING

A solution for consumers worried about their mobile devices running out of power while on the go is **AMPL Labs**' SmartBackpack, which integrates smart electronics seamlessly into the fabric of the bag. It protects portable electronic devices with shock-absorbing dampers and a rain-resistant coating. Battery charge levels, internal temperature, and other parameters are communicated to the dedicated AMPL Mobile App. The charging system is comprised of seven USB connections, an internal 18.5 W·h battery that can recharge a smartphone 2-3 times, and supports up to three optional modular SmartBatteries. The SmartBatteries come in two sizes: TabletBoost (which supplies another 18.5 W·h and can charge a smartphone and tablet simultaneously) and LaptopBoost (which adds 55 W·h and can charge most laptops directly or through the optional SmartInverter module with an ac outlet, sold separately). The scratch-resistant molded nylon shell on the front of the bag houses an OLED display and touch controls for quick access to system vitals. The product will be available this summer starting at $299. Expansion SmartBatteries will be available at $59 for a TabletBoost, or $139 for a LaptopBoost (or $179 with the SmartInverter).

COMBINATION COOLER/ ENTERTAINMENT SYSTEM

With the Kube, **Thomas & Darden** combines elegant design, good sound quality, and insulation for beverage and food storage in a single package. With a Bluetooth range of 50 ft (15 m) and minimum distortion at the highest volumes, Kube delivers line-in-quality sound along with up to 20 h of performance on a single charge. It uses **Polk Audio** marine-certified speakers for rich audio performance from a few decibels up to 100. The unit is constructed of aluminum and durable coated polymer, with white stylized lattice speaker grills at each end and a 33-qt (31 L) interior cooler storage compartment in between. There are five backlit tactile buttons (power, Bluetooth pair, volume up, down, play/pause), and covered USB charging and power inputs on the back. LED lights automatically fade up to illuminate the storage compartment. Kube weighs 20 lb (10 kg) and is water-resistant. It will be available beginning this summer for a manufacturer's suggested retail price of $1,099.

MOBILE PRINTER

The **Polaroid** Zip mobile printer pairs wirelessly to any smartphone or tablet and, using a dedicated mobile app available for both iOS or **Android**, will allow users to instantly print color photos of 2 x 3 in (50 x 75 mm) size from virtually any image on their **Apple** or Android device. About the size of a smartphone, the Zip weighs just 186 g (6.56 oz). It measures 2.91 x 4.72 in (74.0 x 120 mm) and just less than 1 in (25 mm) thick. Despite having many features, the only physical control is a power button that has been seamlessly integrated into the unit's boldly simple design. The printer features a free app for iOS and Android and connects to mobile devices via Bluetooth 4.0 or NFC. The dedicated apps are full-featured and give users the ability to truly express their creativity by applying a wide range of creative filters, effects and controls.

SAE INTERNATIONAL

EXHIBIT. SPONSOR. ATTEND.

SAE 2015 WORLD CONGRESS & EXHIBITION

Leading Mobility Innovation

April 21-23, 2015
Cobo Center
Detroit, Michigan, USA

www.sae.org/congress

YOUNG PROFESSIONALS – DON'T MISS THESE ACTIVITIES CREATED JUST FOR YOU!

LEADER SHIP LESSONS Young Professionals Lunch Panel
As part of the initiative to promote YP activity at World Congress, IAV Automotive Engineering will host the "Leadership Lessons" Young Professional Luncheon to encourage an open forum discussion for YP s to engage accomplished industry professionals.

CAREER DEVELOPMENT SESSIONS
These leadership lessons are delivered through seminars, group discussions and paneldiscussions that will express and challenge conventional thoughts on leadership.

SPEED MENTORING – *"Executives Connecting with Future* Leaders"Located on the exhibit floor, this event is an opportunity for young professionals to engage with executives in an informal setting.

NIGHTLY NETWORKING
Each day will end with casual networking for young professionals, their peers, and industry leaders. This will be a great opportunity for young professionals to connect with other young professionals and industry leaders attending Congress in a casual environment.

sae.org/congress

Executive Leadership provided by:
HONDA
The Power of Dreams

Tier One Strategic Partner:
Continental

P150052

RECOGNIZE MOBILITY ENGINEERING STUDENTS & EDUCATORS

Nominate an outstanding student, young engineer, or educator for the following SAE Awards:

Henry O. Fuchs Student Award

February 28 deadline

This award recognizes a graduate or recently graduated student (i.e. post doctorate or new professor) that is working in the field of fatigue research and applications. Visit awards.sae.org/fuchs to learn more.

SAE/AEM Outstanding Young Engineer Award

May 1 deadline

This award recognizes an outstanding young engineer in the off-highway or powerplant industry. For more information, go to awards.sae.org/outstanding.

Max Bentele Award for Engine Technology Innovation

June 1 deadline

This award annually recognizes an SAE member whose work has furthered innovation in the manufacture, design and improvement of engine technology for ground, air or space vehicles. Learn more at awards.sae.org/bentele.

For the complete list of student awards, visit students.sae.org. PLUS, scholarship applications for incoming sophomores, juniors, seniors, and graduate students are due by February 15th! Go to students.sae.org/scholarships for more information, and submit an application today.

QUESTIONS ABOUT AWARDS OR SCHOLARSHIPS?

Contact:
awards@sae.org
scholarships@sae.org

SAE values and appreciates the time you spend completing a nomination. If you need any assistance, please contact the SAE Awards staff at awards@sae.org, or SAE Customer Service at +1.877.606.7323 (U.S. and Canada only) or +1.724.776.4970 (outside U.S. and Canada).

P150045