Camaro Z/28 taps F1 suppliers for maximum performance

New car technologies
What to look for on 2014 models
Supercapacitors aim to charge ahead
2 What’s Online
6 Editorial
   What’s next in innovation
7 Technology Report
   ENERGY: Supercapacitors aim to charge ahead
12 Global Vehicles
   Camaro Z/28 taps F1 suppliers for maximum performance
20 New technologies for 2014
   PRODUCT DEVELOPMENT FEATURE: OEM and supplier engineers are all about technical innovation. In this special feature, Automotive Engineering International highlights (in no particular order) some notable ones debuting on 2014 models.
35 Upcoming from the editors
35 Ad index
Robotic car body framing system
ABB’s robotic car body framing system, called GateFramer, controls all motion in the system through the company’s robust IRC5 robot controller. Up to six different car body variants can be framed on the same line by swapping gates that hold each car model’s tooling. More detail at http://articles.sae.org/12453.

Special-effect coating
BASF Basecoats’ XSpark, a new automotive OEM special-effect product, contains very fine glass particles that reflect light with greater precision, thus creating a pronounced sparkle. Targeted especially at premium car manufacturers and their customers, XSpark is an addition to BASF’s XColors product family. More detail at http://articles.sae.org/12480.

In-dummy data-acquisition system
MESSRING offers the new M=BUS in-dummy data-acquisition system for the WorldSID (Worldwide Harmonized Side Impact Dummy) 5th Small Female Dummy. It features up to 26 data loggers and 156 channels throughout the whole dummy, and users can connect up to 32 data-acquisition units with just one coaxial cable. More detail at http://articles.sae.org/12590.

Seating fabric and leather
With its new line of automotive fabric and leather concepts for customers worldwide, Lear Corp.’s seat surface material capabilities now extend to a full range of custom finishing techniques, including laser etching, embroidery, embossing, perforations, and polymer printing. The new collection features processes for fabric and leather designs that also include options for customization, durability, and protection. More detail at http://articles.sae.org/12578.
The large, space-inefficient cylindrical pressure tanks currently located in the Ram 2500 CNG’s cargo bed (shown) seriously reduce the truck’s utility. New tank technology under development could be a game-changer in light-duty CNG vehicles.

Chrysler exploring new CNG storage technology
The large cylindrical pressure tanks typically used for onboard CNG (compressed natural gas) storage are notorious for compromising passenger and cargo volume in light-duty vehicles. Chrysler is exploring the idea of using multiple smaller tanks to conquer the packaging challenge. Its patent-pending tank design features an all-new internal configuration that enables greater storage capacity and a non-cylindrical exterior form, while being capable of handling typical gas pressures up to 3600 psi (248 bar). More detail at http://articles.sae.org/12595.

Nissan and Mitsubishi expand collaboration
From new vehicles to new technologies and shared production capacity, Mitsubishi Motors Corp. and the Renault-Nissan Alliance will greatly broaden their current level of collaboration, the two Japanese automakers announced Nov. 5. Among the products planned is a new small car with an electric version to be sold globally; it will be based on a “kei car” platform co-developed by the two companies in a two-year-old joint venture called NMKV. More detail at http://articles.sae.org/12587.

Kia developing EV version of Soul
Kia will begin selling an all-electric vehicle based on the Soul in 2014, the company announced Nov. 11. Called the Soul EV and...
equipped with a 27-kW·h lithium-ion battery pack, it has a target range of 120 mi (193 km) and is geared for city commuters. Front-wheel-drive prototypes currently under development are powered by an 81-kW electric motor that generates 285 N·m. More detail at http://articles.sae.org/12592.

Valeo student contest deadline nears
Engineering students have until Feb. 14, 2014, to submit entries for a contest sponsored by Valeo and designed to bring out the best ideas to make cars more intelligent and intuitive by 2030. The winning team will receive a grant of €100,000, with the first and second runners-up each receiving €10,000. More detail at http://articles.sae.org/12599.

Dec. 5: EV/HEV Powertrain
“Optimization of the EV/HEV Powertrain: Robust, Efficient Electrical Machine Design” is a free, 60-min webcast with Brian K. Peaslee, Chief Engineer of Propulsion Systems at Magna Electronics, and Dr. Emad Dlala, Application Engineer at ANSYS Inc. The speakers will discuss EV/HEV powertrain architectures and the simulation-driven product design process, which can yield accurate efficiency maps and enables prediction of phenomena such as torque ripple. An audience Q&A is included. Sponsor: ANSYS. Registration: www.sae.org/webcasts.

Dec. 17: Aluminum Extrusions
“Designing with Aluminum Extrusions for Automotive Applications: Capitalizing on Extrusions’ Attributes on the Drive to 54.5” is a free, 60-min webcast that will focus on the attributes of extruded aluminum that make it a material of promise for automotive designers and engineers. Participants will receive an understanding of the extrusion process and material attributes, alloy selection, best practices in part design to optimize functional and production economics, and tolerancing. There is also an audience Q&A. Sponsor: Aluminum Extruders Council. Registration: www.sae.org/webcasts.
Congratulations Award Winners from the SPE® AUTOMOTIVE DIVISION

43 years of Recognizing the Plastics Innovation that Reduces Weight, Saves Money, Eliminates Finishing Steps, Adds Functionality, & Makes Vehicles More Stylish & Durable.

What’s next in innovation

Automakers rank at the top of lists on industry investments in R&D, driven by fierce marketplace competition. Innovation requires large investments. For instance, developing a new powertrain typically costs $1 billion over 5-8 years, according to the Alliance of Automobile Manufacturers. The AAM estimates that spending on R&D in the auto industry increased by 15% in 2011 for a total of $96.5 billion.

In this issue of Automotive Engineering International, the editors provide their take on some of the OEM and supplier technical innovations for the new model year. The highlighted innovations range from ZF’s industry-first nine-speed automatic transmission to the most powerful production four-cylinder engine in the Mercedes-Benz CLA45 AMG. Many of the innovations are occurring on the electrical/electronic front, from the Mercedes S-Class suspension that “sees” the road ahead, to the Chevrolet Spark EV that is the first to use SAE International’s J1772 fast-charging coupler, to Delphi and Volvo’s work to “fuse” radar and camera sensing, to the first use of 4G LTE connectivity in the Audi A3.

Connectivity was the theme of the slightly different take on innovation at the 2013 Los Angeles Auto Show’s Connected Car Expo (CCE) Fastpitch competition. Organizers of the event offered start-up app developers and other auto technology companies the opportunity to showcase their innovations.

A panel of innovation experts listened to pitch presentations and selected winners from eight finalists. The first-place winner was awarded a Splunk Start Program Enterprise License: 20 GB for 12-month term, including Splunk education, marketing, and support teams.

First place went to Estify, which aims to streamline the auto collision industry with the use of cloud-based services. The proposed system uses three platforms to simplify the collision repair process by importing estimate data into the current estimating platforms, combining multiple estimates in a split second, and electronically sending parts lists to many providers simultaneously.

Second-place Trucker Path is a logistical assistant app geared toward professional truck drivers and trucking companies. It provides weight station and truck stop detailed information, locations, reviews, directions, and pinpoint map locations.

Third-place RodeDog is a mobile app created by 11-year-old Victoria Walker, which helps prevent texting and driving by “barking” at users “like her mom” who attempt to unlock their mobile device on the road. The app also notifies the driver’s “pack” if smartphone usage occurs while traveling above a set speed. RodeDog also recently won the AT&T “It Can Wait” hackathon competition.

Clearly, innovation can come from anywhere in the world. We hope you enjoy reading about some of them in this magazine, and keep coming back to future issues to read about what’s next in automotive innovation.

Kevin Jost
Editorial Director
ENERGY

Supercapacitors aim to charge ahead

When it comes to electric-vehicle design, supercapacitors have always taken a back seat to batteries. A battery not only produces and stores energy but also delivers energy over a relatively long period of time, which translates into an extended EV driving range.

A supercapacitor, in contrast—which is essentially a latter-day Leyden jar—dispenses its energy over a much briefer period of time, making the technology suited for short power boosts.

Supercapacitors can be charged rapidly and thus can repeatedly release power in quick bursts of current so they are useful for regenerative braking and stop-start systems, according to Cosmin Laslau, an analyst at Lux Research, a high-tech business research and advisory firm. A few European and Japanese microhybrids employ supercapacitors so they can turn themselves off when their engines would normally be idling or so braking energy can be captured.

The largest application of the technology is in a fleet of some 10,000 hybrid diesel buses in China.

The current annual market for superconductors, which also includes wind turbine blade controls and specialized consumer electronics, is a modest $366 million, but it is expected to grow at 18% a year, he said. Lux Research estimates that by 2018 the global annual market for heavy-truck applications of supercapacitors will reach $323 million while the trade for passenger vehicles should hit $152 million, constituting the largest industry segment of a total predicted market of $836 million.

Lux recently published these numbers in a market forecast report titled “Power Play: Supercapacitor Innovation for Growth in Transportation and Electronics.”

Rapid power at hand

Unlike batteries, which create current using kinetically slow chemical reactions, supercapacitors store energy through the separation of highly mobile electrical charges on the surfaces of electrodes, which means they produce current rapidly.
Each “symmetric” supercap typically contains a pair of identical metal plates that are coated with activated carbon. Activated carbon is made more porous, thus greater surface area and charge-holding through either physical or chemical means.

The electrode pair is immersed in a liquid organic electrolyte that speeds the transport of charge. When fully charged, each carbon electrode has two layers of charge carriers coating its surface. This is why supercapacitors are sometimes referred to as double-layer capacitors (or alternatively, ultracapacitors). The cells can look like Red Bull cans or flexible pouches.

**Supercaps in cars**

One of the first auto industry applications of supercapacitors was by **Honda**. Its in-house-developed ultracapacitor was used in the 2002 version of the company’s FCX fuel-cell research car to provide power boosts for passing and hill climbing.

Production use in the auto industry began a few years ago when **PSA** began installing $40 pairs of supercap cells from **Maxwell Technologies** for the e-HDi systems in some **Citroën** and **Peugeot** microhybrids. Likewise, some **Mazda** microhybrids contain an i-ELOOP system with 10 **Nippon Chemi-con** cells (about $130) that adds brake-energy-recapture func-
tions to the stop-start operations.

Proponents say that supercapacitors can cost less in the long run because they can operate reliably much longer than batteries can. But batteries dominate the microhybrid energy-storage market because supercapacitors and the accompanying electronics—a dc-to-ac converter, a generator—can add a couple hundred dollars to a car’s price tag, not to mention take up scarce space and add weight, Laslau said.

Car makers are considering even more powerful supercapacitor units that could function as a mild hybrid or peak-load enhancer, he noted. “Several OEM engineers mentioned interest pursuing more aggressive applications that use from 30 to 50 supercapacitor cells to run mild hybrids. It could provide efficiency savings of 5 to 7%.”

**Diesel hybrid buses**

The biggest installation of supercapacitors that have been deployed thus far operate more than 10,000 hybrid diesel buses in China, he reported. Each contains a $15,000 pack of about 300 supercapacitors. The key adoption driver in this case was a government subsidy that fully financed the green power storage systems, which would otherwise double the $70,000 cost of a standard diesel bus.

Bus operators charge the supercapacitors to capture energy during braking and then discharge the cells to get going. In this case, supercapacitors can replace batteries entirely, whereas all-electric buses can use fewer batteries. The hybrid systems boost fuel efficiency by 25% to 30%, the analyst said, who added that “since the government subsidy expired, sales have plummeted.”

**Next-gen supercaps**

Global supercapacitor makers include Maxwell, Nippon Chemi-con, LS Ultracapacitor, Ioxus, Elton, Nesscap, Vina Tech, and Cap-XX.

Available supercap electrodes provide a specific capacitance (the main figure of
merit) of 100 F/g at a cost of $28/kg, but materials developers are coming up with potentially better performing options. One high-end chemically activated carbon is made from a coke feedstock by **Power Carbon Technology**, a joint venture of **GS Caltex** and **Nippon Oil**, and offers 135 F/g at $110/kg.

And new nanostructured carbons are starting to enter pilot production, said Laslau. One firm, **NanoCarbons**, is producing a chemically activated material that is based on rayon fiber (135 F/g), while another, **EnerG2**, is using a sol-gel process to make high-purity, stable carbon with “tunable porosity” that could reach 150 F/g, perhaps at $60/kg.

Another electrode possibility is “supermaterial” graphene—one atom-thick carbon. But Laslau urged caution: “Though graphene could provide better capacitance, it’s still in the early stages. There are stability issues to address, such as avoiding aggregation from vibration, and costs are sky high while supply is limited.” Two firms working in graphene supercaps are **XG Sciences** and **Angstron Materials**.

Today’s devices use either propylene (ethylene) carbonates or acetonitrile as electrolytes. Although the latter performs better, potential fire hazards have led to Japanese proscription, the analyst said, adding: “Ionic liquids keep coming up as potential alternatives, but they pose more questions than answers.”

Perhaps a better strategy, Laslau sug-
gested, would be to boost the voltage of the entire system from 2.7 V to 3.5 V. Higher voltage means better energy density, so fewer cells are needed. But it also can lead to breakdown of the electrolyte, and it requires high-purity carbon, which could be expensive. But a voltage upgrade could yield a 40% improvement in cell price/energy unit, he said. Both eSionic and Silatronix work in this area.

Laslau emphasized lastly that broader adoption of the supercaps also depends on cutting the costs of the balance of systems such as power electronics, since the cells do not solely drive the overall costs.

Steven Ashley

---

**OPTIMIZATION OF THE EV/HEV POWERTRAIN: ROBUST, EFFICIENT ELECTRICAL MACHINE DESIGN**

Thursday, December 5: 1 p.m. U.S. EST

**Don’t miss this FREE live, interactive 60-minute webcast!**

Major vehicle manufacturers around the world are developing increasing numbers of electric and hybrid vehicle (EV/HEV) powertrain architectures — to meet stringent fuel consumption regulations and customer demands for greener transportation. These architectures range from advanced hybrids to extended-range plug-in electric vehicles, and they are being developed to provide optimum performance over widely varying drive cycles. A key component of the vehicle architecture is the electrical machine.

This webcast will:

- Discuss how the simulation-driven product design process is required to arrive at the right, robust, efficient design the first time
- Uncover the involvement of electromagnetic design, thermal-cooling evaluation, mechanical stress analysis, and NVH (noise, vibration, and harshness) computation in the development process of an efficient electrical machine
- Explore the advantages of high-performance computing and parametric variables to perform extensive parametric optimization studies

**Expert Participants:**

- **Brian K. Peaslee**  
  BSEE, Chief Engineer of Propulsion Systems, Magna Electronics
- **Dr. Emad Dlala**  
  Application Engineer, ANSYS Inc.

*Webcast attendees are invited to interact with the experts during the program’s LIVE Q&A segment.*

Register now at [www.sae.org/webcasts](http://www.sae.org/webcasts)
Camaro Z/28 taps F1 suppliers for maximum performance

The prestige of Chevrolet’s Camaro Z/28 has ebbed and flowed over the years, from the zenith of the original racecar-for-the-street concept in 1970, to the flabby late-‘70s when the Z/28 was little more than a V8 Camaro with stickers, until it evolved in the ‘80s into the IROC-Z as the Z/28 merged with the replica of the International Race of Champions racecar.

By the time the fourth-generation Camaro went out of production, the hottest version used the SS name and was farmed out to SLP Engineering rather than being built in-house.

So when Chevrolet considered reviving the Z/28 name for the current fifth-generation Camaro, Chief Engineer Al Oppenheiser was insistent that the car be an authentic street-legal racecar. The supercharged Camaro that became the ZL1 was deemed unworthy because of its heft and load of comfort equipment.

A Z/28 should be stripped-down, with minimal conveniences and maximum precision and durability on the track. “We want this car to set the standard for what a sports-segment car can be,” said Oppenheiser. “The Z/28 is going to be the icing on the cake for the fifth-generation Camaro.”

The first order of business for the Z/28 was to delete anything not related to achieving faster lap times or not required by law to drive on American public roads. At 3837 lb, the Z/28 is 283 lb lighter than a ZL1.

The car possesses a single speaker for the door-ajar chime, but no sound system or air-conditioning (though A/C is an available option). Elimination of the power-adjusters for the Recaro front bucket seats sliced 8 lb from the car compared to the power Recaros used in the ZL1.

The next step was to bolt on the absolute highest-performing parts available, and in this respect the Camaro team truly set new standards. While the car itself is an impressive technical achievement, the bolt-on go-fast parts would, by themselves, make...
any car dramatically better on the track. “When you partner with these kind of suppliers, you are bound to have a car that is worthy of the Z/28 name,” said Oppenheiser. That list of parts suppliers includes Pirelli for its P Zero Trofeo R tires, Brembo for gigantic carbon-ceramic brakes, and Multimatic for its spool-valve shock absorbers. These companies also provide the same components to the four-times world championship Red Bull Formula One team.

Pirelli calls the Trofeo R the “ultimate DOT track tire,” and the astounding grip the Z/28 demonstrated during laps around General Motors’ Milford Proving Ground test track supported that assertion. The Z/28 wears 305/30-ZR19 tires at all four corners, giving the car the widest front tires in the industry, according to Mark Stielow, Performance Manager for the car.

A deflector ahead of the front tires reduces drag and lift. (Dan Carney)

Having that “square” tire arrangement, along with a specific new tire-carcass construction, has prolonged tire life on the track because the Z/28 doesn’t wear the outside shoulder of the tire as quickly, he explained.
The Trofeo R features an asymmetric tread pattern, with two wide central ribs and large rectangular blocks to withstand structural stresses under extreme braking and cornering. The latest edition of these tires have a 10% larger contact patch than earlier versions for even more grip than before.

Pirelli has kept additional details about the tire to itself. “Pirelli is pretty secretive about it,” Stielow noted. “We can tell a little about the construction by cutting them apart, but that’s about it.” The tire was developed for Porsche and is made in the same plant as Pirelli’s Formula One tires, he added.

Engineers selected 19-in Alcoa forged aluminum wheels rather than fashionably larger wheels to reduce unsprung weight and rotational inertia while providing enough room for the 15-in rotors. While the tires are uniform, the front wheels are slightly narrower, at 11 in, compared to 11.5 in in the rear. Together, the wheels and tires trim 48 lb compared to the larger ones on the ZL1.

Such is the force transmitted through these tires and wheels that the wheels’ beads are media-blasted to give the tires’ rubber a better grip to prevent the tire from sliding on the wheel, according to Steilow. Knurled beads proved to be insufficient for the requirements, which led to media-blasting them, he said.

Pankl titanium connecting rods, Mahle pistons, and a K&N cold air intake contribute to 505 hp and 481 lb-ft. (Dan Carney)
The Brembo carbon-ceramic brakes sliced another 22 lb and provide consistent, fade-resistant braking while storming around fast, unforgiving racetracks such as Germany’s Nurburgring. The front rotors measure 394 x 36 mm, and the rears are 390 x 32 mm.

They are designed to be durable, so they last through about 20 sets of pads. The rotors wear through loss of mass, rather than by getting thinner, so the minimum safe mass is inscribed on them. Owners will need to weigh rotors periodically to ensure they are still safe.

The front six-piston calipers are asymmetric for improved clamping force distribution, while the rear four-piston calipers are conventional. The pads feature increased surface area for improved pad life.

A key bit of brake-related software addresses the problem of pad knock-back. With rotors this large, their flexing can push the pads back from their rotor-skimming ideal position, giving the driver a bit of brake pedal travel on initial braking.

The Z/28’s Bosch ABS system periodically squeezes the pads back into their optimal position so the pedal is firm and responsive when the driver needs it, reported Stielow. “The brake feel and consistency from lap to lap is just incredible,” he said. In combination, these systems generate 1.08 g lateral acceleration and 1.5 g in braking deceleration.

The Z/28 is the first mass-produced car ever to carry Multimatic’s Dynamic Suspensions Spool Valve technology (the Aston Martin One-77 was the first road car to use them). But more should be coming soon. “We have high hopes the rest of the world is going to want this technology,” said Multimatic Vice President of Engineering Larry Holt.

Since it was pioneered in the Champ Car World Series in 2002, Multimatic’s spool valve technology has come to dominate Formula One and Le Mans prototypes and has become the spec damper for DTM, Formula 3, and the Ferrari 458 Challenge series.
Spool valves deliver the highest level of damper predictability, accuracy, and repeatability, reported Holt. That is why spool valves are used in most hydraulic applications for regulating the flow of hydraulic fluid.

But while the shape of their ports accurately determines the shocks’ force-velocity curve, those ports need to be accurate to within 2 microns of their design. Cutting such accurate ports originally took as long as 45 min. Now, laser cutters can do the job in as little as seven seconds, Holt said. Furthermore, the laser-cut ports have better internal surfaces, he added.

Spool valves are preferred to conventional shim-valve technology because any force-velocity curve can be designed in Multimatic’s SpecFinder software and created by the spool valve’s port design and the rate of the spring beneath the piston. The result is so predictable that racing teams using the company’s spool valve shocks don’t even use shock dynos to verify the results anymore, he said.

Conventional shocks use stacks of steel shims over a port which deflect in the flow of hydraulic fluid. Valving characteristics are changed by varying the thickness and diameter of the shims, which is less precise, and more significantly, less repeatable, than cutting spool-valve ports.

Shim stacks are subject to lift and flutter at high damper frequencies, problems that don’t exist for spool valves. Furthermore, spool valves are resistant to the effects of heat, making them consistent over the course of a race. “Transient response is
significantly better than conventional technology,” reported Holt.

Typically, carmakers demand shock suppliers deliver products with a margin of error of +/-10 % of the specified values, Holt reported. Formula One teams demand their shocks are within 0.5%. The shocks for the Z/28 are within 2%, he said.

Because carmakers lose money on the relatively high number of high-performance shocks that do not perform as specified, using Multimatic’s DSSV technology, which might cost more on a per-unit basis, could cost them less because of the reduced number of rejects and warranty claims, according to Holt.

The Camaro’s shocks are non-adjustable, with separate valving for compression and rebound. The large 45 mm diameter front strut design improves the rigidity of the damper’s attachment to the car and improves steering feel and vehicle response.

The rear is also 45 mm, and its aluminum construction cuts 2.6 lb from the car compared to the standard Camaro shocks.

To complement the more accurate shocks, the Z/28 is equipped with 85% stiffer front springs and 65% stiffer rears, rear lower trailing link bushings that are 25% stiffer, rear upper control arm bushings that are 400% stiffer, and front lower-arm bushings that are 50% stiffer. With body motion now better controlled by those components, stabilizer bars are actually smaller on the Z/28: 25 mm vs. 28 mm front, and 26 mm vs 27 mm rear.

The Z/28’s speed, demonstrated by a

Shock characteristics are determined by the spring rate, the piston flow, and the geometry of the ports. (Dan Carney)
documented 7:37.40 Nurburgring lap time that was achieved with rain on part of the course, also demands power. It comes from a naturally aspirated LS7 engine, which was chosen in part because it is 64 lb lighter than the ZL1’s LSA. Much of the weight savings comes from the elimination of the LSA’s supercharger, which was judged worthwhile in pursuit of improved front/rear balance.

Inside, the LS7 engine employs Pankl titanium connecting rods and Mahle pistons, and it flows air in through a K&N filter and out through tubular exhaust headers. The Z/28’s engine is rated at the same 505 hp as the LS7 in the Corvette, but at 481 lb·ft, it has an additional 10 lb·ft of torque because of improved airflow.

The Z/28 is the first Camaro to have a dry-sump oil system, which provides oil flow under the high lateral acceleration conditions seen on racetracks. Similarly, the car is equipped with oil coolers for the engine, transmission, and differential. Engine oil cooling is critical for an engine spinning to 7000 rpm, because at 165°C, the oil suffers excessive aeration, Stielow said. The cooler keeps the temperature at 150°C.

The transmission is a Tremec TR6060 close-ratio six-speed powering the car through a 3.91:1 ratio helical limited-slip differential from Zytek. By itself, the differential alone shaves 0.75 s off the car’s lap time at GM’s Milford track, according to Stielow.

While traditional limited-slip diffs are good for straight-line traction, the helical design is optimized for corner entry, where its low coupling lets ABS control all four wheels independently; for mid corner, where its zero preload improves steering precision; and for corner exit, where the rapid torque coupling increases traction for accelerating out of the corner.

Speed potential without appropriate aerodynamic development can spell trouble at the speeds cars see at the
Nurburgring, so the Z/28 was refined to improve downforce.

GM refined the Z/28’s ground effects using the rolling road Windshear, Inc. wind tunnel in Concord, NC. At 150 mph, airflow presses the Z/28 to the ground with 440 lb more force than the ZL1.

The blow-molded plastic splitter has steel reinforcing inserts and can support 250 lb of force. Abundant work went into optimizing the design of the hood vent, which incorporates four slats, each with its own specific shape to help move air from underhood.

Skirts on the rocker panels mostly help stabilize the car from cross winds at speed, while the fender flares ahead of the front tires reduce drag by diverting air around the spinning tires.

All of these race-spec parts contribute to a car built so robustly that GM is providing warranty coverage even for racetrack use. After verifying the car’s durability with 24-hour tests at racing speed, the company is confident it will hold up. “If we can’t break the car, our customers can’t break the car either,” said Oppenheiser.

Dan Carney

Designing with Aluminum Extrusions for Automotive Applications
Tuesday, December 17: 2 p.m. U.S. EST

Now Offering a FREE live, interactive 60-minute webcast just for you!

Aluminum components – and aluminum extrusion-based components in particular – are increasingly seen as key elements in designing vehicles that meet tomorrow’s demanding fuel economy targets, while still providing the comfort, safety, performance, and amenities that consumers demand. The webinar, “Designing with Aluminum Extrusions for Automotive Applications: Capitalizing on Extrusions’ Attributes on the Drive to 54.5,” will focus on the practicalities of extrusion design and its automotive applications.

Webcast attendees will:
• Explore the attributes of extruded aluminum that make it a material of promise for automotive designers and engineers
• Receive an understanding of the extrusion process and material attributes, alloy selection, best practices in part design to optimize functionality and production economics, and tolerancing
• Review several mini case studies along with economic justification

Webcast attendees are invited to interact with the experts during the program’s LIVE Q&A segment.

Industry Expert Participants:

Craig Werner
Chairman of the Aluminum Extruders Council’s AEC Academy and President of Werner Extrusion Solutions

Rob Nelson
Sales Manager, Almag Aluminum

Now Offering a FREE live, interactive 60-minute webcast just for you!

Aluminum components – and aluminum extrusion-based components in particular – are increasingly seen as key elements in designing vehicles that meet tomorrow’s demanding fuel economy targets, while still providing the comfort, safety, performance, and amenities that consumers demand. The webinar, “Designing with Aluminum Extrusions for Automotive Applications: Capitalizing on Extrusions’ Attributes on the Drive to 54.5,” will focus on the practicalities of extrusion design and its automotive applications.

Webcast attendees will:
• Explore the attributes of extruded aluminum that make it a material of promise for automotive designers and engineers
• Receive an understanding of the extrusion process and material attributes, alloy selection, best practices in part design to optimize functionality and production economics, and tolerancing
• Review several mini case studies along with economic justification

Webcast attendees are invited to interact with the experts during the program’s LIVE Q&A segment.

Industry Expert Participants:

Craig Werner
Chairman of the Aluminum Extruders Council’s AEC Academy and President of Werner Extrusion Solutions

Rob Nelson
Sales Manager, Almag Aluminum

Registration:
www.sae.org/webcasts

Now Offering a FREE live, interactive 60-minute webcast just for you!

Aluminum components – and aluminum extrusion-based components in particular – are increasingly seen as key elements in designing vehicles that meet tomorrow’s demanding fuel economy targets, while still providing the comfort, safety, performance, and amenities that consumers demand. The webinar, “Designing with Aluminum Extrusions for Automotive Applications: Capitalizing on Extrusions’ Attributes on the Drive to 54.5,” will focus on the practicalities of extrusion design and its automotive applications.

Webcast attendees will:
• Explore the attributes of extruded aluminum that make it a material of promise for automotive designers and engineers
• Receive an understanding of the extrusion process and material attributes, alloy selection, best practices in part design to optimize functionality and production economics, and tolerancing
• Review several mini case studies along with economic justification

Webcast attendees are invited to interact with the experts during the program’s LIVE Q&A segment.

Industry Expert Participants:

Craig Werner
Chairman of the Aluminum Extruders Council’s AEC Academy and President of Werner Extrusion Solutions

Rob Nelson
Sales Manager, Almag Aluminum

Registration:
www.sae.org/webcasts

Now Offering a FREE live, interactive 60-minute webcast just for you!

Aluminum components – and aluminum extrusion-based components in particular – are increasingly seen as key elements in designing vehicles that meet tomorrow’s demanding fuel economy targets, while still providing the comfort, safety, performance, and amenities that consumers demand. The webinar, “Designing with Aluminum Extrusions for Automotive Applications: Capitalizing on Extrusions’ Attributes on the Drive to 54.5,” will focus on the practicalities of extrusion design and its automotive applications.

Webcast attendees will:
• Explore the attributes of extruded aluminum that make it a material of promise for automotive designers and engineers
• Receive an understanding of the extrusion process and material attributes, alloy selection, best practices in part design to optimize functionality and production economics, and tolerancing
• Review several mini case studies along with economic justification

Webcast attendees are invited to interact with the experts during the program’s LIVE Q&A segment.

Industry Expert Participants:

Craig Werner
Chairman of the Aluminum Extruders Council’s AEC Academy and President of Werner Extrusion Solutions

Rob Nelson
Sales Manager, Almag Aluminum

Registration:
www.sae.org/webcasts
New technologies for 2014

OEM and supplier engineers are all about technical innovation. In this special feature, Automotive Engineering International highlights (in no particular order) some notable ones debuting on 2014 models.
Contents

Jeep debuts industry-first nine-speed automatic ..........22
S-Class suspension ‘sees’ road ahead ......................22
BMW’s i3 pushes carbon-fiber limits .........................22
CLA45 AMG gets most powerful four-cylinder ..........23
Mitsubishi twin-motor PHEV charges on-the-go ..........24
NASA insulation keeps Corvette cool .......................24
Z/28 carbon-ceramic brakes are a sporty-car first .......25
Double duty for new Cummins V8 turbo diesel ..........25
Audi, Hella team on A8 matrix LED headlights ..........26
Delphi and Volvo ‘fuse’ radar and camera sensing ..........26
Chevrolet Spark EV first to use J1772 fast-charging ......27
Rolls-Royce Wraith transmission predicts the future ......27
Audi A3 first car with LTE connectivity ...................28
Mercedes advances all-LED lighting .......................28
Aluminum all over Range Rover ............................29
Supercapacitor-type regen braking debuts on Mazda6 ....29
Acura uses one HVAC system to cover three zones ......30
Hyper-efficient VW XL1 enters limited production ......30
Toyota shines on ............................................31
Mercedes-Benz CLA is new low-Cd king ..................31
Driver assistance segment firsts for 2014 Mazda3 ........32
1st rear-axle disconnect for midsize SUV ................32
Shape-memory alloy controls rear hatch ..................33
Honda develops novel aluminum/steel hybrid door .......33
Nissan debuts fully recyclable TPO liftgate ...............34
**New technologies for 2014**

**S-Class suspension ‘sees’ road ahead**

*Mercedes-Benz*, using networked electronic systems (sensor fusion), introduced on its MY2014 S-Class a suspension system that can “see” the road surface ahead and make ultra-high-speed decisions on how to deal with it. Called Magic Body Control (MBC), the anticipatory system comes with “a world first” Road Surface Scan stereo camera and Mercedes’ established Active Body Control. The windshield-mounted camera monitors the road to a distance of 15 m (49 ft) in front of the car. Analyzing the resultant images and information about the car’s driving status, a control unit then calculates its optimum strategy. This means softening or stiffening damper reaction ahead of the event and increasing or reducing the load to each wheel via an active hydraulic system. MBC reacts in “fractions of a second” and operates up to speeds of 130 km/h (81 mph). See related article at [http://articles.sae.org/12330](http://articles.sae.org/12330).

---

**Jeep debuts industry-first nine-speed automatic**

The 2014 *Jeep* Cherokee is the first production vehicle to feature a standard nine-speed automatic transmission, a distinction it shares with *Land Rover*’s 2014 Range Rover Evoque. Developed by *ZF* (as the 9HP), *Chrysler* produces its 948TE version under license in Kokomo, IN. Offering a wide 9.81 ratio spread, a 4.71 first-gear ratio, and four overdrive ratios (in gears 6-9), the 948TE offers a gear ratio for virtually every load condition. It’s the first FWD-based automatic to use dog clutches to activate the 4-5 and 7-8 gear shifts. The dog-clutch shifting elements virtually eliminate the drag-torque losses inherent in multidisc friction clutches. See related article at [http://articles.sae.org/11884](http://articles.sae.org/11884).
BMW’s i3 pushes carbon-fiber limits

With its 2014 i3, BMW is busting through boundaries regarding carbon-fiber-reinforced plastic (CFRP). No other mass-production vehicle uses as much of the high-strength, low-weight material. In the i3 battery-electric vehicle (range-extended version also offered), it is used in the body structure. BMW has worked with various suppliers such as SGL Group to innovate not only in the composition and production of carbon fibers and CFRP parts, but also in how the parts are joined; for the i3 (and the coming i8 plug-in hybrid sports car), a special glue was developed, and parts are bonded in a unique, highly automated body shop. See related article (and video) at http://articles.sae.org/12529.

CLA45 AMG gets most powerful four-cylinder

Mercedes-Benz says the engine in its CLA45 AMG makes 355 hp (265 kW) and 332 lb·ft (450 N·m). The 2.0-L twin-scroll turbo I4 has a high power density of 178 hp/L (133 kW/L), thanks to the turbo providing up to 1.8 bar (26 psi) maximum boost pressure. The result is acceleration of the compact sedan to 60 mph (97 km/h) in 4.5 s and a top speed of 155 mph (249 km/h). The engine uses multiple injections and sparks to help it manage the high combustion pressures. Water-to-air intercooling also helps by reducing the air-charge temperature. The sand-cast aluminum cylinder block uses Mercedes’ Nanoslide cylinder-lining technology twin-wire arc process for spraying carbon and iron onto the bare aluminum bores to produce a hardened, low-friction, mirror-like surface. See related article at http://articles.sae.org/11972.
NASA insulation keeps Corvette cool

The term “aerogel” describes a gel composed of a microporous solid—typically silica, glass, or zeolites—in which the dispersed phase is a gas. NASA uses aerogels for thermal insulation in space suits and in the Mars Rover. Recently, the 2014 Chevrolet Corvette Stingray became the first production vehicle to use an aerogel as a lightweight thermal insulation, in this case a sprayed-on coating inside the car’s transmission tunnel. The aerogel, supplied by PaCor Inc. to Tier 1 interior vendors IAC and HP Pelzer, is unmatched in its performance but isn’t inexpensive, said Corvette Chief Engineer Tadge Juechter.

Mitsubishi twin-motor PHEV charges on-the-go

The Mitsubishi Outlander plug-in hybrid-electric vehicle (PHEV) uses a unique hybrid drivetrain combining a pair of 60-kW electric motors, a lithium-ion battery pack, and a gasoline internal-combustion engine. The GKN Multi-Mode eTransmission used as a front transaxle offers three different driving modes with two power sources: EV mode (front axle and rear axle driven only by electric motors, front motor attached to the eTransmission); Series Hybrid mode (combustion engine driving a generator to charge the battery while car is driven by front and rear electric motors); and Parallel Hybrid mode (combustion engine torque feeding through the eTransmission to the front wheels via a hydraulic clutch that remains disengaged in other modes).
Double duty for new Cummins V8 turbo diesel

**Cummins Engines** will start production in 2014 in Columbus, IN, on its new 5.0-L V8 Turbo Diesel for **Nissan**’s 2015 Titan. Pulling multiple duty, the engine will be tasked with not just a light-duty application, but, under the name ISV5.0, with commercial-vehicle applications such as delivery vehicles, school buses, and motor homes. The twin engines will look very much alike, with minor hardware changes, such as different turbochargers, to address both the different certification requirements and duty cycles. In two firsts for Cummins, the engines will use **Bosch** 2000-bar (29,000-psi) piezo injectors for up to seven precise injections for any combustion cycle, and will be built on a compacted graphite iron block that adds strength while dramatically reducing weight—by some accounts up to 50%.

---

**Z/28 carbon-ceramic brakes are a sporty-car first**

By specifying carbon-ceramic (C-C) brake rotors as standard equipment on the 2014 Camaro Z/28, **General Motors** engineers reduced unsprung mass by nearly 50% compared with the iron rotors used on the ZL-1 Camaro. Supplied by **Brembo**, the new C-C rotors also boost overall stopping power and reduce brake system operating temperatures. The ventilated rotors—the first C-C brake set in the sporty-car segment—measure 394 x 36 mm diameter (15.5 x 1.4 in) front and 390 x 32 mm (15.4 x 1.3 mm) rear. On the track-day-focused Z/28, they are paired with monobloc-type aluminum calipers—six-piston units front, and four-piston rear calipers.
Audi, Hella team on A8 matrix LED headlights

The Audi A8’s MatrixBeam LED headlight system runs permanently on high beam with the ability to dim down for multiple “targets,” providing long-range high-beam illumination that can straddle both an approaching vehicle and one traveling ahead, without dazzling the occupants of either. A multifunction camera placed behind the car’s rearview mirror provides control input. Each headlamp has 25 diodes divided into groups of five, each of which shares a common reflector, allowing the dim level to be varied. When entering a city, the combined 50 LEDs are dimmed. The system can handle up to eight “targets,” including the presence of pedestrians, who get three headlamp flashes to draw the driver’s attention to their presence and to warn the pedestrian. Cornering lights adjust the focal point of the light using targeted brightening and dimming in the direction of the bend. When linked to Audi’s MMI Navigation-plus technology, which provides predictive route data, the cornering lights activate momentarily before the steering wheel is turned. For more details, visit http://articles.sae.org/12579.

Delphi and Volvo ‘fuse’ radar and camera sensing

The term “sensor fusion” could have been created for Delphi’s RACam. The compact radar/camera module, designed to be mounted between the interior rearview mirror and the windshield, incorporates radar sensing, vision sensing, and data fusion to enable a range of active safety functions to help meet the new Euro NCAP five-star safety targets. RACam is scheduled to enter production in 3Q14; its first production application will be the 2015 Volvo XC90 that is based on Volvo’s new Scalable Product Architecture (SPA)—a modular platform intended to underpin a range of C- and D-segment sedans and crossovers.
Rolls-Royce Wraith transmission predicts the future

Rolls-Royce wants to attract a younger buyer for the Wraith, and to do so decided to offer a more dynamic driving experience. The all-new model is the company’s fastest car ever. The 12-cylinder power plant is mated to a transmission that, with the help of GPS, automatically puts the car into whatever gear is optimal for any given upcoming scenario—for example, a turn or a grade ahead. Rolls-Royce calls this first-in-the-luxury-segment technology Satellite Aided Transmission, and it was developed largely in-house. It will be offered on other Rolls-Royce models as well.

Chevrolet Spark EV first to use J1772 fast-charging

The 2014 Chevrolet Spark EV is the first model in the U.S. to be equipped for dc fast-charging according to SAE International’s J1772 standard, which also spells out the specifications for two levels of ac charging at slower rates. Fast-charging is offered as an option on what General Motors calls an urban mini-car, and it “fills” the car’s 21 kW·h lithium-ion battery to 80% capacity in just 20 min. When fully charged, the Spark EV has a combined city/highway range of 82 mi (132 km) and city/highway fuel economy of 119 mpge (e=equivalent), making it the most efficient U.S. retail EV on the market. See related article at http://articles.sae.org/12238.
Mercedes advances all-LED lighting

Almost 500 LEDs and not a single bulb light the road and the interior of the 2014 Mercedes-Benz S-Class, which the automaker claims is “the first vehicle in the world to do without a single lightbulb as standard.”

The LED story—depending on vehicle equipment level—includes headlights that use 56; taillights each with up to 35, with another four for the foglamp; and about 300 including ambient lighting for the interior. The result is a reduction in power consumption. For example, LED low-beam headlights take 34 W to produce the same light output as conventional types. Halogen needs 120 W and xenon needs 84 W.

High-performance single-chip LED diodes and newly developed projector modules (supplied by Automotive Lighting) in the headlamp unit allow deflected beams of light to be reflected back. See related article at http://articles.sae.org/12330.

Audi A3 first car with LTE connectivity

Audi says it is the first car maker to bring the fast 4G LTE data transfer standard to a car with full integration. It was first an option in Europe in the S3 Sportback and in all other model variants of the compact A3 last month. A SIM card with a data flat rate is inserted into the MMI Navigation-plus unit. When passengers connect their mobile devices to the WLAN hotspot integrated into the car, they can surf the Web independently of one another.

MMI Navigation-plus uses LTE to deliver the Audi connect services from navigation with Google Earth and Google Street View to Audi music stream web radio and online traffic information. Facebook and Twitter have been made vehicle-friendly with a text-to-speech function and a text function with prepared text modules. In addition, there are more than a dozen Audi connect services, including a text-to-speech function for e-mail and a dictation function for text messages—and the range of services is expanding rapidly.
Supercapacitor-type regen braking debuts on Mazda6

The first automotive 12-V regenerative braking system to use a supercapacitor makes its debut on the 2014 Mazda6. Called i-ELOOP for intelligent energy loop, tests have shown that the system delivers 10% better fuel economy in stop-and-go operation, while adding just 9.3 kg (20.5 lb) to a 12-V car. The cylindrical supercapacitor, which is of a type also called a “double-layer capacitor” or “ultracapacitor,” is mounted underhood on the driver’s side. It is 350 mm (13.8 in) tall, 120 mm (4.7 in) in diameter, and weighs just 6.0 kg (13.2 lb). The circuit requires a heavier wiring harness, which adds 1.5 kg (3.3 lb). See related article at http://articles.sae.org/11845.

Aluminum all over Range Rover

Land Rover’s 2013 Range Rover, the world’s first SUV with an all-aluminum structure, saves 408 lb (185 kg) compared to the preceding steel-bodied model. Novelis is the material supplier. High-strength AC300 is used in certain areas for crash resistance. The entire vehicle body side is pressed as a single aluminum panel—another automotive first, according to the company. Aluminum is also used in the final drive unit, in many suspension components, and in the front and rear subframes—the latter application being “quite novel in the SUV world.” Total vehicle weight reduction is up to 700 lb (318 kg) for the U.S. model. See related article at http://articles.sae.org/11341.
Acura uses one HVAC system to cover three zones

A single HVAC system invariably has been limited to smaller two-row vehicles—until the 2014 Acura MDX three-row crossover, which incorporates a novel approach to a three-zone layout. It uses a partitioned evaporator and heater core in a partitioned under-dash HVAC case that feeds an external multiple rear duct system, where a strategically located second blower motor maintains the auxiliary airflow. The integration concept originated at Honda R&D Americas, and Acura engineering approached potential suppliers with a structure and construction method Honda had patented. This led to a new HVAC supply relationship with Delphi, which developed the heat exchanger partitions and also is supplying its CVC seven-cylinder variable-displacement compressor for the MDX. See related article at http://articles.sae.org/12274.

Hyper-efficient VW XL1 enters limited production

The revolutionary carbon-fiber-reinforced polymer (CFRP) two-seat XL1 from Volkswagen enters very limited production with a diesel-electric plug-in powertrain and fuel consumption of 0.9 L/100 km. A 0.189 drag coefficient and small frontal area makes it the most aerodynamically efficient production car in the world. In pure-electric mode, the car needs less than 0.1 kW·h to cover 1 km (0.6 mi). Its 0.8-L two-cylinder diesel produces 35 kW (47 hp) and is augmented by a 20-kW electric motor. The CRFP-bodied XL1 has a curb mass of just 795 kg (1753 lb)—the monocoque contributing only 89 kg (196 lb). Other technical highlights are rearview cameras instead of mirrors, ZF motorsport-type dampers, low-rolling-resistance Michelin tires, side windows of lightweight polycarbonate Lexan by Sabic, and Visteon lighting. See related articles at http://articles.sae.org/11874.
Toyota shines on

Much of the motivation behind such a typically high-end feature as LED headlamps being standard on a compact car such as the Corolla was Toyota’s desire to excite customers. To make a front end that would grab attention with more rounded corners and yet a more aggressive, sculpted look, designers did away with “the thick structure” of conventional headlamps. The more-compact LED low-beam headlamps reduced corner mass, allowing for more tapering in the exterior and enabling engineers to “accentuate the Corolla’s rounded-corner, front-end design theme.” The reduced mass was at least partly the result of a lighter-weight PES resin lens being used instead of conventional glass due to the lower heat inherently generated by LED lights. See related article at http://articles.sae.org/12444.

Mercedes-Benz CLA is new low-Cd king

Mercedes-Benz has achieved a 0.22 Cd with the base version of its new CLA compact sedan, claiming it as the most aerodynamic high-volume (vs. Volkswagen’s low-volume XL1) production car on sale in the world. The 1.6-L CLA180 BlueEfficiency Edition incorporates narrower 195-mm tires on 15-in wheels with aerodynamic covers and lower ride height. Compared with the concept version, the production car has a slightly higher trunk lid, a change of offset between rear deck and shoulders, changes to the rear spoiler and the position of the wheels in their arches, adjustable radiator shutters, and rear lamp lens fins. A diffuser is fitted below the rear bumper; the car’s underbody is enclosed, including the middle section of the rear axle; and the muffler received aerodynamic attention. The result of the aerodynamic work is fuel consumption at 130 km/h (81 mph) by 0.5 L/100 km, which equates to approximately 13 g/km of CO₂. See related article at http://articles.sae.org/11931.

| Mercedes-Benz CLA-Class: the aerodynamics world champion (Wind) resistance is futile |
Driver assistance segment firsts for 2014 Mazda3

The redesigned Mazda3 features radar cruise control and smart city brake support—firsts for the non-luxury compact car segment, along with an emphasis on the human-machine interface (HMI) via a new infotainment system and head-up display. The car’s various active safety systems, collectively known as i-Activsense, use radar, laser, and a video camera. Mazda radar cruise control automatically adjusts vehicle speed from about 20-90 mph (32-145 km/h) to maintain a safe distance to the vehicle ahead based on readings from the 76-GHz radar. When traveling from about 2 to 19 mph (3 to 30 km/h), smart city brake support uses a near-IR laser to detect a vehicle up to 16 ft (4.9 m) ahead. The system can apply the brakes to help prevent or minimize a collision. Other class-leading i-Activsense safety technologies include lane-departure warning, high-beam control, and forward-obstruction warning. The HMI includes an infotainment system that features a 7-in instrument panel display and a floor console commander with tactile feedback for audio, navigation, and other functions. See related article at http://articles.sae.org/12410.

1st rear-axle disconnect for midsize SUV

Jeep’s 2014 Cherokee is based on a Fiat-Chrysler front-drive architecture, known as Compact U.S. Wide, rather than a traditional. That means to improve on-road fuel efficiency, the rear drive axle is disengaged when four-wheel-drive capability isn’t required. The Cherokee’s new rear-axle disconnect system, engineered by American Axle & Manufacturing (AAM), is a first for a midsize SUV. The compact system, which AAM calls EcoTrac, is featured on each of Jeep’s three Active Drive systems available on the Cherokee. A wet clutch in the rear drive module automatically senses input torque and seamlessly engages AWD when needed.
Shape-memory alloy controls rear hatch

Shape-memory alloys (SMA) are used increasingly in the medical and aerospace industries. Typically made of CuAlNi, NiTi, and CuZnAl alloys, these “smart” metals can change their shape, strength, and/or stiffness when activated by heat, stress, magnetic field, or electrical voltage. When deactivated, they return to their original shape. General Motors’ first production use is an SMA wire used to open and close a rear vent hatch in the 2014 Chevrolet Corvette. Activated by electric current, the wire (supplied by Dynalloy, Inc. to hatch Tier 1 Summit Polymers) replaces a motorized actuator and reduces mass by about 1.1 lb (.5 kg). See related article at http://articles.sae.org/11811.

Honda develops novel aluminum/steel hybrid door

Honda R&D Co. has developed an aluminum/steel sheet hybrid door—debuting on the 2014 Acura RLX—that it claims is more effective in reducing weight than an all-aluminum door. Because aluminum was used in the door skin, bimetallic corrosion at the connection between the aluminum and the steel sheets represented an issue. A high-ductility sealer was employed to help prevent water from infiltrating to the connection between the metals, and steel sheets with a zinc-aluminum-magnesium alloy coating—highly effective in controlling bimetallic corrosion—were employed in the door panels. Honda also developed a new 3-D lock seam process to hem the two different materials instead of using traditional spot welding. See related article at http://articles.sae.org/11800.

![Diagram of aluminum, high-ductility sealer, Zn-Al-Mg-coated steel sheet, and dust sealer]
Nissan debuts fully recyclable TPO liftgate

The liftgate of the 2014 Nissan Rogue employs materials that are fully olefinic (hence, fully recyclable at end of vehicle life) and features North America’s first TPO (thermoplastic polyolefin) outer panel. Supplied by Hitachi Automotive Systems, the full assembly is 30% lighter than comparable stamped steel systems. Due to parts integration, low scrap, and reuse of offal possible with injection-molded thermoplastics, raw-material costs on the outer panel were reduced 35% vs. sheet-molding compound (SMC). Use of a high-flow, high-stiffness, high-impact TPO formulation, supplied by LyondellBasell, reduced molding cycles vs. SMC and traditional TPO compounds for the painted Class A outer panel. Use of molded-in-color long-fiber thermoplastic polypropylene eliminated paint on the Class A inner panel. Advanced Composites Inc. also supplied materials, and Magna-Decostar was the processor.

FREE
2013 GLOBAL POWERTRAIN VIRTUAL SUMMIT
Thursday, December 12, 2013
8:00 a.m. - 5:00 p.m. U.S. EST
www.sae.org/events/globvirt/

Examining advancements in powertrain technology for the global ground mobility industry.

Includes Three LIVE Webcasts:
- Designing Off-Highway Drivetrains to Meet End-User Demands (9:30 a.m. - 10:30 a.m. U.S. EST)
- Vehicle Onboard Fuel Additive Systems: Exploring Their Role and Value (Noon - 1 p.m. U.S. EST)
- The Path to Improved Fuel Economy (2:30 p.m. - 3:30 p.m. U.S. EST)

Register NOW to access:
- Live Chat with Industry Experts
- Emerging technologies, trends and issues
- “Resource Download Center” - white papers, demos, podcasts, product information, and technical presentations
- A Virtual “Networking Lounge”
- A Virtual “ Exhibit Hall” with product information and knowledgeable professionals

Summit Host
Lubrizol

SAE International Contact:
Megan McCoy
E: mmccoy@sae.org
Digital Automotive Engineering International,® AEI,® December 3, 2013, Volume 4, Number 10. Digital AEI (ISSN 1939-7453) is published 10 times a year by SAE International,® 400 Commonwealth Dr., Warrendale, PA, 15096. SAE International is not responsible for the accuracy of information in the editorial, articles, and advertising sections of this publication. Readers should independently evaluate the accuracy of any statement in the editorial, articles, and advertising sections of this publication that are important to him/her and rely on his/her independent evaluation. For permission to use content in other media, contact copyright@sae.org. To purchase reprints, contact advertising@sae.org. Copyright © 2013 SAE International. The Automotive Engineering International and AEI titles and logos are registered in the U.S. Patent and Trademark Office, and feature articles are indexed and included in the SAE Digital Library. For additional information, free demos are available at http://saedigitallibrary.org

To contribute editorial content, contact the editors at aei@sae.org.
While today’s automotive industry continues to evolve, one thing remains constant – around every corner new possibilities exist; relationships evolve into partnerships… what once seemed innovative becomes the standard… the impossible becomes possible. By Creating New Possibilities at the SAE 2014 World Congress, together we will shape the future of the automotive industry.

**CREATE NEW POSSIBILITIES**

**April 8-10, 2014**

Cobo Center • Detroit, Michigan USA

*REGISTER TODAY!*

www.sae.org/congress

No matter what your industry calls it, it’s nothing short of groundbreaking.

INTEGRATED VEHICLE HEALTH MANAGEMENT STANDARDIZATION

SAE International is responsible for such internationally adopted aerospace documents as AS, AMS, AIR, and ARPs. In the ground vehicle industry, it plays the central role in developing essential North American standards and bringing them to the global standards table. Now, from the world’s largest, most respected consensus standards development organization, comes the first holistic, systematic approach to vehicle health management. An end-to-end capability that transforms system data into operational support information, Integrated Vehicle Health Management (IVHM) and related standards allow for the analysis and diagnosis of a vehicle and the understanding of how a failed structure or piece of equipment impacts the vehicle’s overall health. Use of IVHM has the ability to enhance vehicle safety and reliability as well as extend product life — with maintenance and fleet management benefits.

With its roots in aerospace, IVHM is already changing aircraft design and transforming organizations’ manufacturing and operations. And, its use is rapidly being implemented in the ground vehicle and marine craft industries.

As SAE International continues to develop a body of standards to enable IVHM technology development, it also is building a collection of resources to further this technology and the economic advantages it can bring to the mobility industry.

Listen to free podcast, view IVHM resources, sign up for complimentary SAE technology focused e-newsletter at sae.org/news/ivhm/

Ground breaking mobility standards solutions since 1905.

sae.org • USA, +1.724.776.4841 • Europe, +44 (0) 207 0341250

---

Tech Tools

- 2013 Global Powertrain Virtual Summit Dec. 12, 2013, Global Online Event
- NEW! Catalytic NOx Control Technologies for Diesel and GDI Engines Webinar
- NEW Book! Fuel/Engine Interactions
- Renewable Fuels Technical Paper Subscription
- Seeking participants for the following Standards Committees: SAE Chassis Controls Standards Development Committee; SAE Active Safety Systems Standards Committee for three new working groups: Definitions & Terms, CIB/AEB, and Sensor Fusion and SAE Driver Vision Standards Development Committee