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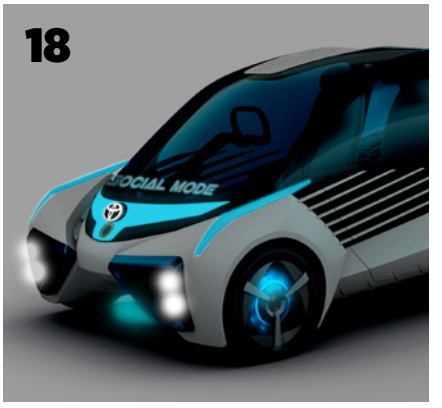

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Melexis Expands Lateral Sensing to Latch/Switch

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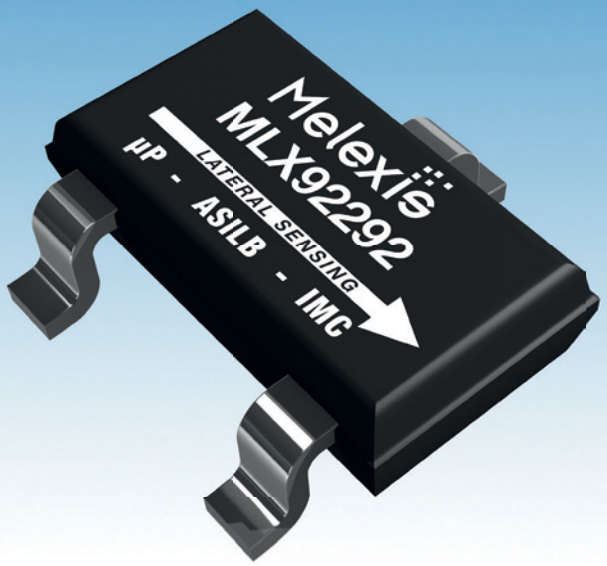

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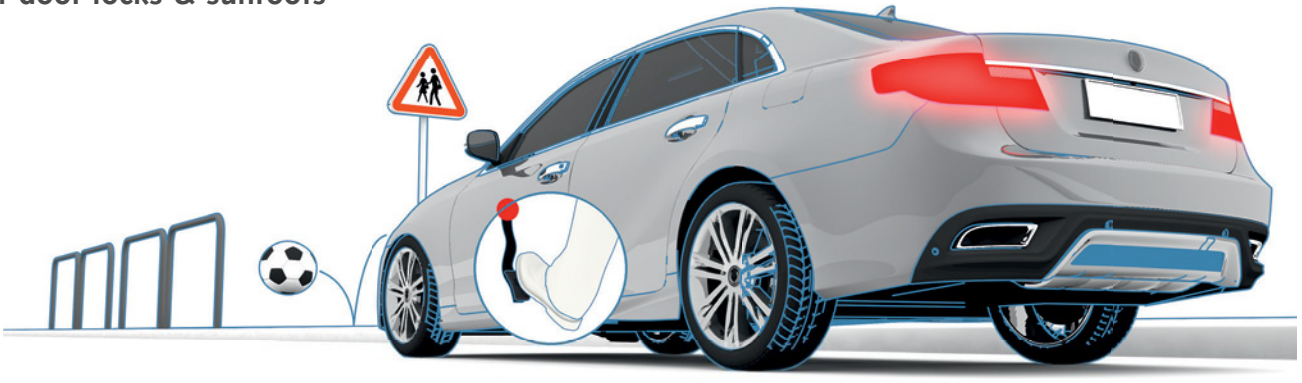

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For more information:
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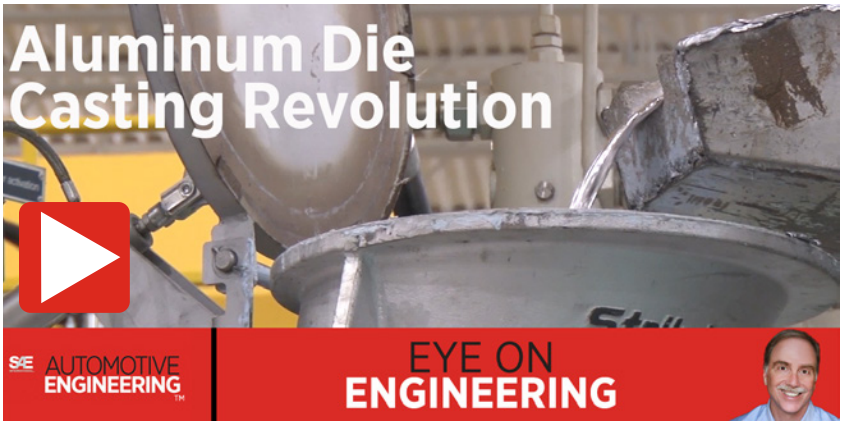
VIDEO LINKS

SAE Eye on Engineering: Aluminum die casting revolution

There's a revolution going on within the bones of new cars and trucks—new body structures that are much lighter and stronger for better fuel economy, safety, and handling. In this episode of SAE Eye on Engineering, Senior Editor Lindsay Brooke looks at the heroes of the revolution: aluminum die castings. It can be viewed at https://youtu.be/8noRIHS0wmY. SAE Eye on Engineering airs in audio-only form Monday mornings on WJR 760 AM Detroit's Paul W. Smith Show. Access archived episodes at www.sae.org/magazines/podcasts.



FROM OTHER INDUSTRIES

DEFENSE

Oshkosh's $30B Humvee replacement makes soldier protection a top priority

First there was the Jeep. Then came the Humvee. Now, the Joint Light Tactical Vehicle (JLTV) will soon enter production as the 21st century mobility machine for the **U.S. Army** and **Marine Corps**. The services plan to purchase nearly 55,000 JLTVs (all but 5500 going to the Army) in a contract estimated to be worth $30 billion through 2040. The impressively engineered and robust vehicle will initially replace about one-third of the aging HMMWVs (Humvees) in service. Defense-industry analysts say it could ultimately replace the entire fleet of more than 140,000 Humvees by 2040, depending

Oshkosh JLTV in Close Combat Weapons Carrier (CCWC) spec with 3500-lb payload capability and .50-cal. roof mount.

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on how many of those older trucks will be "recapped" (completely refurbished) as part of a long-term plan.

JLTV low-rate production begins 1Q16 at **Oshkosh Defense**, which beat out arch-rivals **Lockheed Martin** (teamed with **BAE Systems**) and **AM General**, maker of the Humvee, for the first run of 16,901 units worth $6.7 billion over three years. Full-scale production is slated to begin in 2018. The program involves more than 300 suppliers across 31 states.

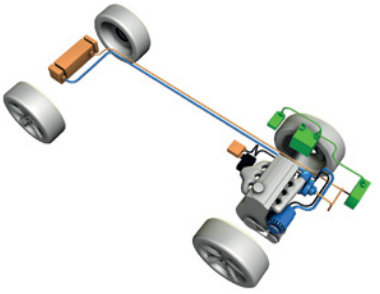
"In terms of ground vehicles this is by far the largest program for the U.S. military. Basically this is the Humvee replacement," observed Nelson Fisk, **IHS**'s principal U.S.-based military vehicles analyst. Fisk described Oshkosh's initial JLTV production contract as "a very big deal" for the company—"the most new vehicles in terms of both numbers and money," he noted.

Read more at http://articles.sae.org/14350/.

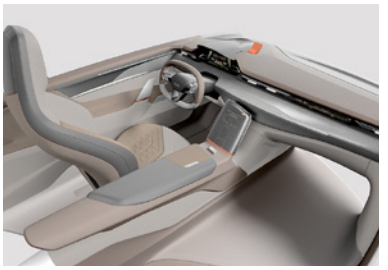
Most-viewed articles

The following are the top 5 most-viewed automotive-related articles of the month as of early November. Additional articles across all transportation sectors can be read at http://articles.sae.org/.

1 Tenneco unveils emission-control solutions for Euro 6c
http://articles.sae.org/14374/



2 Delphi says 48-V mild-hybrid systems could offer 15% CO_2 reductions
http://articles.sae.org/14376/



3 Johnson Controls, Faurecia envision interiors for autonomous driving
http://articles.sae.org/14371/

4 VW emissions scandal will impact future engine controls, testing
http://articles.sae.org/14384/

5 Visteon's new CEO targets connected-car leadership
http://articles.sae.org/14407/

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MOTION AND MOBILITY

EDITORIAL

Taking the ZEV lead

California has quickly become the largest market for zero emission vehicles (ZEVs), steered by the state's increasingly stringent mandates. As of January 2015, new analysis from **Frost & Sullivan** (https://www.frost.com/ne7e) finds that California accounted for 40% of the ZEV population in the U.S. The next set of requirements, taking effect from 2017 to 2025, are expected to see the state's ZEV sales rise from about 60,000 units in 2014 to 1.4 million units by 2025.

The lion's share of ZEVs in California and globally have been energized by battery packs. Just a few models have taken the lion share of the market, headlined by the likes of the **Tesla** Model S at the high end and the **Nissan** Leaf at the entry level.

However, many industry experts have looked to fuel-cell technology as having greater potential as the energy source for future ZEVs. In this issue, we feature how the technology is progressing in the "Fuel cell futures no longer a dream" feature.

The major challenge facing the fuel-cell industry is the scale-up of the technology. From very low volumes, the march to mass production is proceeding. At the 2015 Tokyo Motor Show, **Toyota** showed the FCV-Plus and **Lexus** LF-FC Lexus LS flagship concepts with fuel-cell drivetrains. Toyota's Mirai production fuel-cell vehicle is now reaching California customers, joining **Hyundai** with its fuel-cell-powered Tucson crossover.

Also at Tokyo, fuel-cell market leader **Honda** introduced its second-generation Clarity fuel-cell car that it will begin leasing to Japanese customers in March 2016. That car follows the first FCX Clarity launched in 2011. Honda now has a development partnership with **General Motors** focused on a Generation-3 fuel cell for 2020. Although Honda has lead in fuel-cell vehicle customer deliveries, GM—which built its first FCV in the 1960s—remains the industry leader in fuel-cell know-how as measured by the number of patents filed each year.

Engineers have conquered most significant fuel-cell technical issues. For instance, the Clarity's fuel cell fits entirely under its hood. Cost reduction is expected to be overcome with greater production volumes and further technical development.

The remaining non-vehicle challenges with fuel-cell and battery ZEVs are infrastructure development and consumer acceptance, and California is setting the example. Its directives are intended to be holistic, staking out plans for raising consumer awareness, building infrastructure, and offering special consumer benefits such as lane and parking access.

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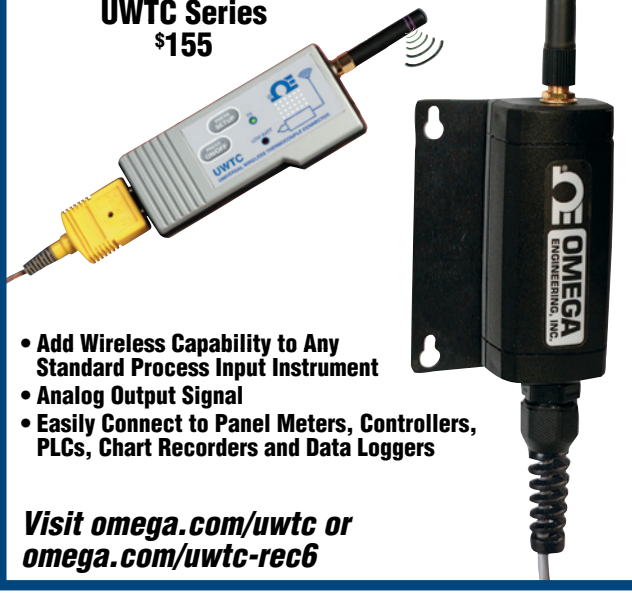

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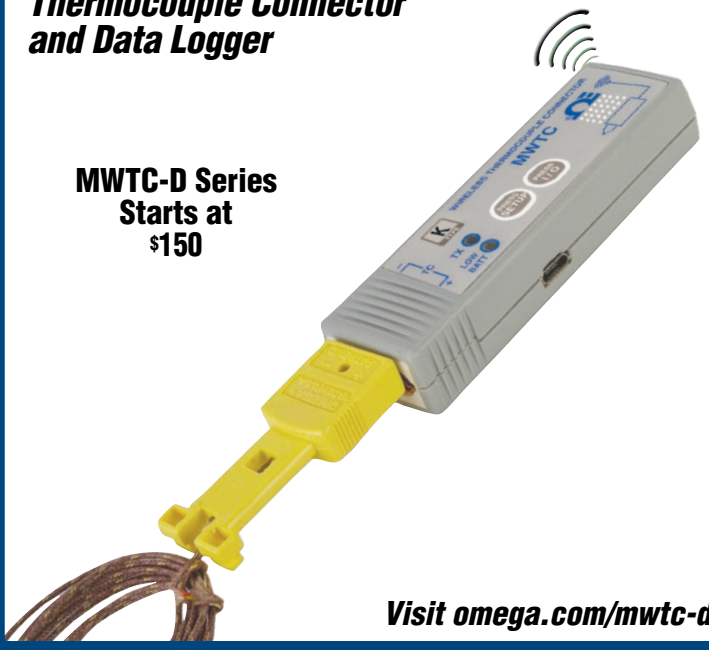

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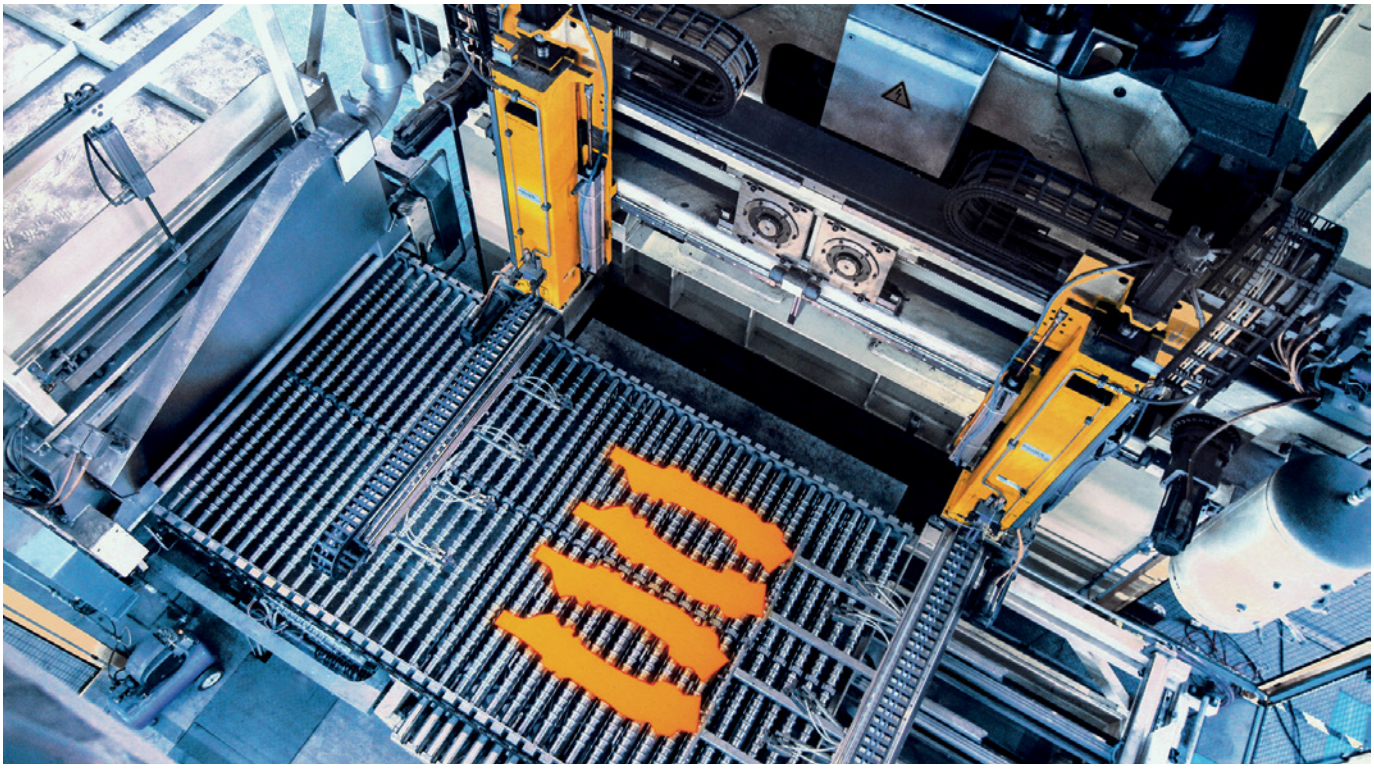
MANUFACTURING | BODY

Hot-stamping process from Schuler employs flexible 'pressure controlled hardening'



With its PCH (pressure controlled hardening) technology, Schuler has succeeded in halving cooling times for parts. (All images: Schuler)

In the press hardening method, parts are heated to 930°C (1706°F) and then simultaneously cooled and hardened in the subsequent forming process, which gives the parts their extremely high rigidity. At its Waghäusel, Germany site, **Schuler** recently presented its new PCHflex technology, which has been under development for about two years and is a further development of the company's "pressure controlled hardening" process.

The new process allows flexible and economical production of hot stamped parts with high output performance and consistently high quality, according to Schuler Managing Director Dr. Martin Habert. It also allows maximum process reliability and availability. "More performance pays off," he said. "In this way, costs and energy consumption per part are reduced."

PCHflex uses what Schuler claims are the fastest hydraulic presses with Dynamic Force Control and RingValve technology. With four parts per stroke (4-out mode), up to four million parts per year can be

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The new PCHflex technology also has the benefit that conventional press hardening dies can be used on these lines.

produced on one line.

By controlling pressure during hardening, the necessary press force can be distributed evenly over the part. The flexible bed cushion ensures—within the part and distributed over several parts—a uniformly high contact pressure, resulting in faster cooling, according to Jens Aspacher, Sales Manager Hot Forming at Schuler. "This ensures a reliable and optimized metallurgical transformation process," he stated. The cooling time is claimed to be half that of conventional methods, while productivity and part quality are increased.

"The material properties are the same [as with other hot-stamping processes], but the martensitic transformation becomes more reliable within the part, which leads to higher content of martensite and higher part quality," Aspacher added.

What makes the PCHflex technology unique, according to Aspacher, is that automotive manufacturers and suppliers are more independent of die and material fluctuations for process reasons; different manufacturing tolerances and sheet thicknesses can be compensated for more easily. "This reduces scrap as well as downtime and idle losses that would otherwise occur due to the reworking

of dies, for instance," he shared.

An additional benefit of the new PCHflex technology is that existing conventional press hardening dies can be used on these lines, he noted. And conversely, dies designed for PCHflex technology can be used on conventional lines.

A U.S. car manufacturer has placed an order with Schuler for four production lines to manufacture lightweight parts using PCHflex technology. Options have been agreed upon for four further lines. The supplier expects PCHflex to be in operation by the beginning of 2017.

"As a systems supplier, Schuler will not only be providing hydraulic presses and automation equipment, but also the roller hearth ovens and dies," explained Habert. "Our employees will also be helping launch production in the first few months."

Is the pressure-controlled process suitable for applications on on- and off-highway heavy-duty vehicles? "Absolutely," said Aspacher. "Commercial-vehicle manufacturers are also affected by the need to reduce CO_2 emissions, which is why they, too, have to make use of lightweight parts with extremely high rigidity. And hot stamping is the most economical way to produce lightweight parts."

Paired parts such as left and right of the rocker, A-, B- and C-pillars, or the roof frame are typical applications for the process. "Now, there are more and more roof bows or connector plates under the back seat, for example. More or less all structural parts which do not need to absorb energy in crash situations [are possible]," Aspacher said. "Outer skin parts are not possible because of the rough surface."

"Commercial-vehicle manufacturers are also affected by the need to reduce CO_2 emissions, which is why they, too, have to make use of lightweight parts with extremely high rigidity. And hot stamping is the most economical way to produce lightweight parts," said Schuler's Jens Aspacher.

The press-hardening equipment supplier expects demand for such technology to grow in the coming years due to requirements for passenger protection and emissions reduction. In response, the company is planning to open a new Hot Stamping TechCenter at the Group's main site in Göppingen, Germany, in early 2016. The technical center will serve both as a demonstration center as well as a location for training and research on press hardening.

Ryan Gehm

FUEL CELL FUTURES no longer a dream

Fuel cell technology is catching up with the hype as fuel cell vehicles become reality.

by Dan Carney

Honda PEM-type fuel cell as used in the Clarity FCV. For this compact new power unit, Honda's original wave flow-channel separators were further advanced and the number of cells was reduced by 30%. Its cells measure only 1-mm each, reducing their total thickness by 20%.

The knock on fusion power is that "it is the energy source of the future, and it always will be." It has seemed like the same criticism could be levied against fuel cell vehicles, as their seemingly magical ability to turn stored hydrogen and atmospheric oxygen into motive power for personal transportation—with only water as a by-product emission—has remained tantalizingly out of reach for decades.

Indeed, some environmentalists charged that the George W. Bush administration's support for automotive fuel cells was a cynical play to perpetuate fossil fuel consumption, because, they insisted, fuel cells weren't a realistic automotive power source.

But the truth is, as manufacturers begin to dribble out hand-built, lease-only, limited-market fuel cell cars to meet California's zero-emission requirements, the technical obstacles to fuel cells have been overcome. What remains is some challenging crossing of 't's and dotting of 'i's, because exorbitant costs and challenges like freezing temperatures have been left in fuel cells' rearview mirror.

"We are looking at fuel cell vehicle production to exceed tens of thousands by 2020," predicts Morry Markowitz, President of the **Fuel Cell and Hydrogen Energy Association**. "Some of

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FUEL CELL FUTURES
no longer a dream

Honda's 2016 Clarity Fuel Cell production vehicle will launch in the Japanese market in March 2016, followed by the U.S. and Europe.

the leading manufacturers have spent billions of dollars and products are now reaching showrooms," he said. "That speaks volumes to the commitment these companies have and the future of this technology."

"The major challenge we're facing is the scale-up, both for the infrastructure and for the mass production of vehicles," stated Bryan Pivovar, Fuel Cell Group Manager for the **National Renewable Energy Lab** (NREL). While breakthroughs in basic science used to stand in the way of practical fuel cell vehicles, those obstacles have been overcome, he said. "Now, we're to the point where we're pretty close and incremental advances might be sufficient."

The march toward production is proceeding with a certainty unseen previously. At the 2015 Tokyo Motor Show, **Honda** introduced its next-generation Clarity Fuel Cell car that it will begin leasing to Japanese customers in March 2016. In his introductory remarks at the show, Honda President and CEO Takahiro Hachigo acknowledged that the road to production has been a long one.

"Approximately 13 years ago, in December 2002, Honda opened the door to the future by becoming the world's first automaker to put the ultimate clean car, a fuel cell vehicle, into practical use," Hachigo said. "Since then, Honda has been advancing and improving the performance of its fuel cell vehicles, including success in making it possible to drive a fuel cell vehicle in areas with cold climates, which was thought to be difficult."

Toyota showed the far-out FCV Plus concept and the **Lexus** LF-FC. The FCV Plus is an ambitious, eye-catching concept with in-wheel electric motors, while

the LF-FC is a design study hinting at the next iteration of the Lexus LS flagship sedan, but shown with a potentially optional fuel cell drivetrain.

Hyundai offers a fuel cell-powered version of its Tucson crossover SUV, with a mileage counter on the company's Web site showing more than 750,000 miles of fuel cell travel so far in its vehicles.

BMW said at Tokyo that its first fuel cell vehicle would likely be a larger-sized sedan which would go on the market after 2020, when its hydrogen development partnership with Toyota (launched in 2013) concludes. In the partnership BMW is developing a process to compress hydrogen at ultra-low temperatures to increase its storage volume, using a fuel cell stack developed by Toyota. BMW officials claim that their FCV will have greater range than the 435 mi (700 km) claimed by Toyota for its Mirai.

The Mirai, now reaching a few California customers, is a dedicated model with its own unique styling to underscore its alternative powertrain. The nascent fuel cell market will have to determine whether customers prefer

GM's hydrogen fuel cell lab in Pontiac, MI, builds and tests the next generation of fuel cell technology—from single cells to full vehicle sized fuel-cell systems.

specific fuel cell models or if they are happier with fuel cell versions of existing popular vehicles. NREL's Pivovar thinks Toyota is on the right track with a dedicated FCV.

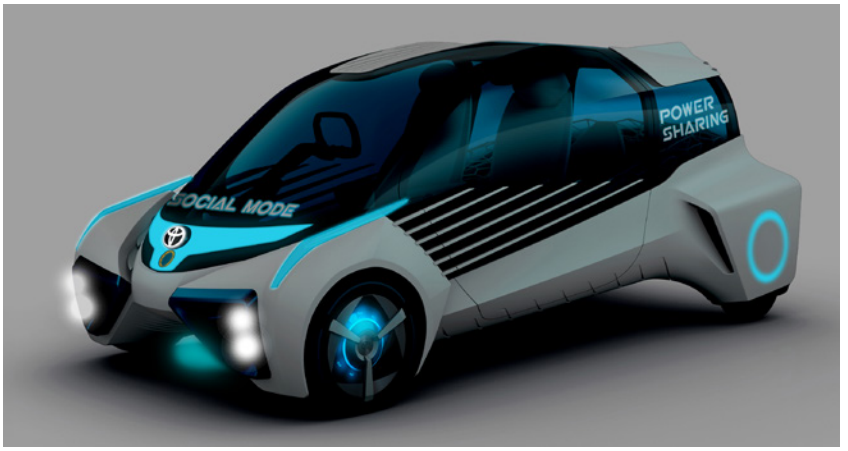
"I think it is the correct approach and it has worked for them before," he said, noting the popularity of Prius's success as a pioneer in the hybrid-electric market.

Japan is investing heavily in fuel cell technology and hydrogen infrastructure as part of a national policy to foster a "hydrogen society" where the zero-emission fuel would power homes and vehicles.

Partnering for success

Honda's development partnership with **General Motors** lets the two companies create a fuel-cell product arc, starting with the **Chevrolet** Equinox FCVs of 2008, continuing through the Generation-1 2011 Honda FCX Clarity, the new Generation-2 2016 Clarity FCV and onward to vehicles using a jointly developed fuel cell

FUEL CELL FUTURES
no longer a dream



The unconventional Toyota FCV Plus concept car uses electricity from its fuel cell to power in-wheel motors.

system by 2020. The companies label this their "Generation-3" fuel cell.

The fuel cell in the Clarity FCV is 33% smaller and makes 60% more power than that in the FCX Clarity. A key milestone is that the entire system now fits under the car's hood like a conventional powerplant, leaving space in the rear seat for three passengers, so the new car carries five people instead of the old car's four.

Though Honda is the company that has been putting fuel cell vehicles in customers' hands, GM remains the industry leader in fuel cell know-how, as measured by the number of patents filed each year and the critical technologies it commands, according to Pivovar. GM built its first FCV in the 1960s.

Toyota, however, has been catching up, so GM's partnership with Honda is a good match. That's because freezing a fuel cell specification for production means that resources are no longer used to improve, refine, and reduce the cost of the fuel cell system and instead get focused on the practical matter of building the cars, according to Charlie Freese, GM's Executive Director of Fuel Cell Activities.

With this partnership, Honda can take care of building Clarity FCVs and learning production lessons, while GM engineers toil on the Gen 3 fuel cell the companies will use in their 2020 products.

"By teaming up with Honda, Honda was already locked in on a production program they are rolling out," said Freese. "They are able to remain focused on that while we remain focused on this next-generation technology."

GM's development of proton-exchange membrane (PEM) fuel cells took on a new dimension in 2011, when the automaker began working with **U.S. Navy** researchers to develop a fuel-cell power unit for an unmanned undersea vehicle—essentially a robotic mini-submarine. The UUV is powered by an automotive fuel cell stack similar to those used in GM's fleet of 118 Equinox FCV test vehicles. When submerged the UUV's fuel cell "breathes" through a sophisticated closed-loop oxygen storage system (see http://articles.sae.org/13909/).

Today's fuel cells have already conquered the most significant issues. The Clarity's fuel cell fits

entirely under the car's hood, so spending additional resources to shrink the size of the next iteration wouldn't provide any discernible benefit.

Similarly, the amount of platinum used has already been successfully reduced to nearly the benchmark level of that used in the catalytic converters for internal combustion engines. GM's Equinox fuel cells used 80 g (2.8 oz) of platinum and the 2011 Clarity FCV used 30 g (1.05 oz). Catalytic converters typically use 10 g (0.35 oz), according to Pivovar.

The Lexus LF-FC is a sneak preview of styling themes of the upcoming LS, but an available fuel cell powertrain would be a coupe in that segment if it materializes.

Catalysts can work with less than that, but for the sake of longevity and to provide a margin of safety, manufacturers tend to err on the side of caution by using an extra

FUEL CELL FUTURES
no longer a dream

Hyundai opted for the conventional route with its fuel cell vehicle, a modified version of its popular Tuscon SUV.

couple grams in their catalysts, he said.

So with the new Clarity FCV using less than 12 g (0.42 oz), according to the company, the precious metals battle is also nearly won.

Next stop: mass production

That means that Freese's GM team is focused on designing to reduce the cost of manufacturing in volume. One thing they can do is to simplify the cars' systems. The Clarity Fuel Cell has a pair of cylindrical hydrogen tanks because the ideal design, a sphere, would intrude unacceptably on passenger space.

Using a pair of cylinders in place of a single sphere lets the tanks fit under the car's floor, but it requires more complex and costly assembly and adds valves and lines that contribute additional cost.

A better solution would be a new tank that doesn't have the packaging compromises of a cylinder or sphere, and holds enough hydrogen in a single tank to provide the requisite 300-400 mi (480-640 km) driving range. The industry's engineers are scrambling to solve this technical challenge.

"Conventional vehicles have a plastic tank molded to any shape available," Freese told *Automotive Engineering*. "That would be the thing you'd aspire to get closest to."

Toyota had been working with pressure-tank specialists **Quantum Technologies** on a new high-pressure hydrogen storage solution, but the automaker brought development back in-house, said a source involved with the program.

A big challenge to cost reduction is that production volumes will be low by industry standards, even with both Honda and GM selling cars, because the market for the cars will still be immature in 2020. But even with relatively low-unit production, it is possible for some components to enjoy high enough volumes to exploit economies of scale because many of them are used in each car.

With 330 layers of carbon paper for gas diffusion in the cell, it creates the opportunity for 3.3 million of those layers in a production year of 10,000 cars, Freese pointed out.

Another area where there is the potential to benefit from

production scale is in the production of components that, while they are unique to fuel cell vehicles, are similar to those used in high-volume internal combustion vehicles. For example, the compressors used in fuel cells are similar to turbochargers, and so they may be able to benefit from the higher production volumes of turbos, Freese said.

"There is a lot of knowledge that can be brought over," he said. "It is the same thing on injectors. There are unique requirements, but it is not unlike other injectors that inject gaseous fuels like CNG. So they are not entirely foreign to the rest of the industry."

The supply base that can provide these components is another area Freese points to as a benefit of GM's joint effort with Honda.

"In some cases there are not a lot of suppliers out there who can do the things we need," he explained. "We were working with some of the same suppliers but some were different. So we not only get exposure to other ideas, we also got exposure to other supply base players."

As automakers find the path from today's low-volume, hand-built production to more affordable mass-produced fuel cell vehicles, the cars will be able to attract customers and manufacturers can stop losing money on them.

"Everybody loses money on the way through just to get us to a better place," Pivovar reflected. "From a technological perspective, it is clear: fuel cell vehicles are here."

Maybe fusion is next. ■

2016 HOT TECHNOLOGIES

Our annual review of significant, innovative, and just plain cool technology applications for the new model year.

by the *Automotive Engineering* Staff

Lightweight mixed-material body structures. Hand-gesture controls of onboard systems. The return of water injection as an anti-detonation measure in high-compression spark-ignition engines. These and other innovative technologies are the tip of the industry's spear for making new vehicles more efficient, safer, and customer pleasing. The following highlights, culled from our editors' field reporting, represent just some of the work being done by **SAE** members and their colleagues across the globe as they move mobility forward in 2016.

Monopost seating in the 1st electric SUV

Tesla Motors' new Model X, the first battery-electric SUV, brings a slew of surprise-and-delight features along with its claimed 257-mi (414-km) range on a single charge and 5000-lb (2268-kg) towing capability. But residing under the X's swoopy "falcon wing" doors and enormous panoramic windshield are a feature with less sizzle but perhaps far more practicality: a cleverly designed second-row seat set mounted on monopost pedestals.

"It is a single column...just such a clean design," noted Tesla CEO Elon Musk about the cleverly engineered pedestal mounting system in an online video shot when the Model X concept was unveiled in 2012. He observed that the design eliminates traditional "rails and all sorts of crud in your way."

Besides its modernist aesthetic, the

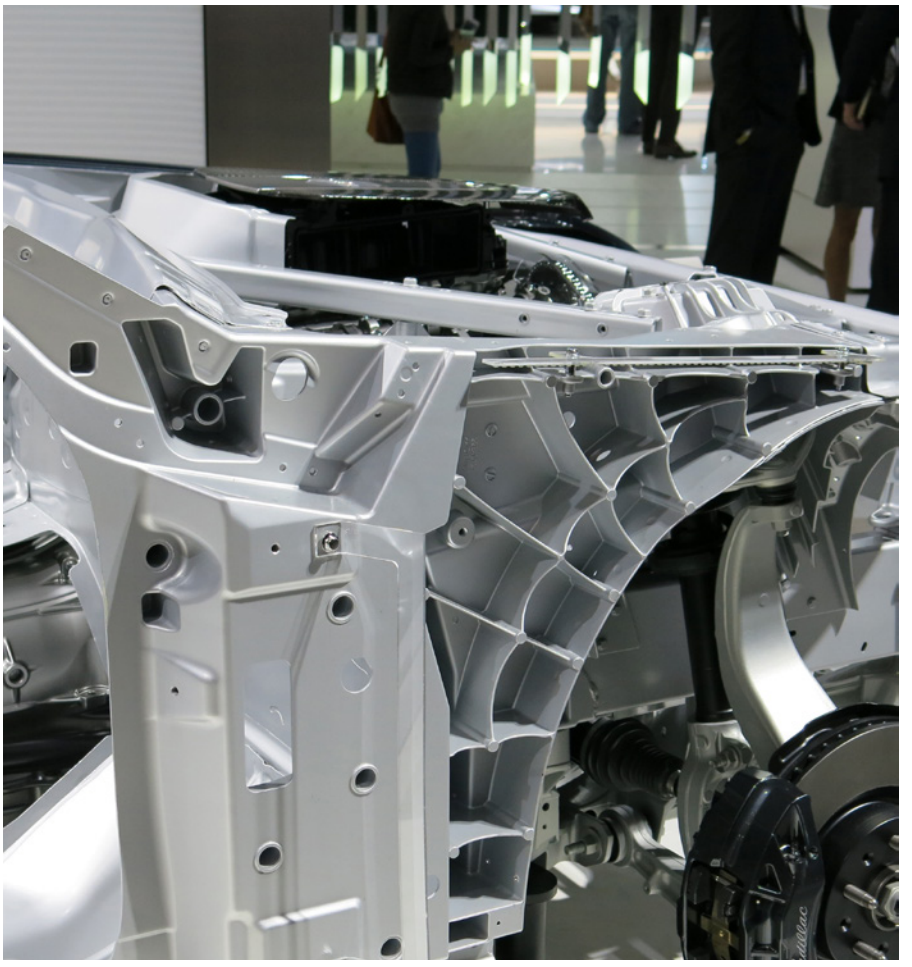
Tesla engineers focused on easy access to the Model X's cabin through the "falcon" doors, and a comfortable (and flexible) seating experience inside. Note pedestal mounts under 2nd row seats.

monopost design with either bench or 6-seat arrangement is optimal for occupants with both large feet and the need for under-seat stowage, as is done on airliners. Each seatbelt is integrated into the highly sculpted seat, which aids third-row ingress/egress. The second row seats articulate individually and slide longitudinally as well as tilt forward. While Tesla's prototype second-row seats were fully folding, the production vehicle's seats don't have that functionality.

And they haven't been easy to manufacture. In last month's conference call to media and investors Musk admitted that Tesla has "substantially in-sourced" the Model X seats, despite having the company's seat supplier (Australia's **Futuris Group**) located in a new plant close to Tesla's Fremont, CA, factory. The slower-than-planned learning curve has caused Tesla to limit Q4 deliveries of Model X until the seat-build issues are resolved.

Magna helps make 'light' of GM's new Omega platform

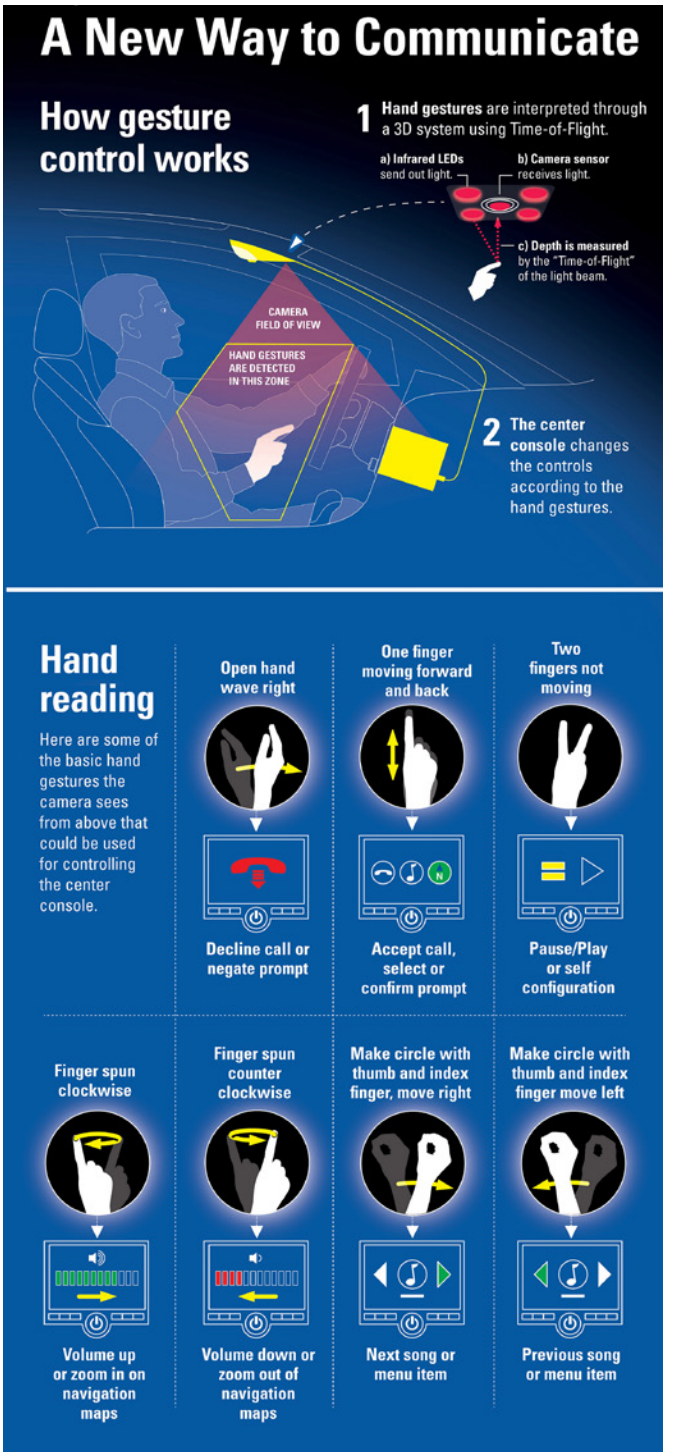
Cadillac's all-new 2016 CT6 full-size sedan is about 200 lb (91-kg) lighter than the **BMW** 5-Series while packing the interior volume of the short-wheelbase 7-Series, thanks to an aggressive mix of lightweight materials, forming technologies, and new joining methods. The claimed 3700-lb (1678-kg) CT6 recently entered U.S. production riding on **GM**'s new lightweight Omega vehicle architecture. Key to the vehicle's stout and svelte structure are 13 exquisitely designed and manufactured high-pressure die castings (HPDC) that join the various aluminum extrusions and high-strength steel stampings that make up the body-in-white. Made by **Magna**'s **Cosma Castings** facility in Battle Creek, MI, the HPDC components include two of the industry's largest and most geometrically complex AL body structure castings: the CT6's center tunnel and front body hinge pillar. The cast-AL hinge pillar does the job of 35 parts in a traditional hinge-pillar application, according to Cadillac Executive Chief Engineer Dave Leone, while enabling a stiffer body shell and reducing the bill of material by 20%. See more about the CT6: http://articles.sae.org/14020/ and http://articles.sae.org/13986/.



The CT6's extensively webbed body hinge pillar is a beautiful example of Cosma's AL casting work; too bad it gets covered up by exterior panels! (Lindsay Brooke)

Delphi gesture controls for new BMW 7

"Proximity sensing, voice recognition, re-configurable instrument clusters and placing buttons on the steering wheel are all attempts at tailoring the cockpit experience," noted Pietro Ottavis, Vice President, **Delphi** Infotainment & Driver Interface. "Now we've added one more dimension. You can make hand gestures in mid-air and your car will respond." Entering production on the 2016 **BMW** 7-Series, Delphi's "touchless" 3D infotainment system controls use simple midair finger movement to control functions such as the audio system's playlist and volume. Tap your index finger on an imaginary surface, as if you were touching a phone button and you can accept a phone call or hang up. Draw an imaginary circle in the air; clockwise to raise the volume and counter-clockwise to lower it. Any finger gesture in a field above the center console is detected by an infrared camera integrated in the overhead console—above the iDrive controller in the case of the BMW. Delphi is steadily developing the gesture-control technology to include facial recognition aimed at reducing driver distraction and increasing functionality.



Delphi's "sign language" in the new 7-Series is just the beginning of gesture control technology in vehicles.

JATCO advances the CVT art in 2016 Maxima

Nissan and JATCO continue to improve their CVT technology as evidenced by the 2016 CVT-7.

Nissan's Xtronic continuously-variable transmissions are widely regarded as the CVT to beat, according to competitor engineers who have benchmarked them. For 2016 the **JATCO**-engineered CVT-7 (the 7 denotes the replication of seven stepped ratios) gains significant design changes for improved functionality, NVH reduction, and efficiency, making the all-new '16 Maxima one of the most lively, fun-to-drive performance sedans in its segment. The 2016 CVT-7 has a wider (6.3) ratio spread, up from 5.4 on the previous unit, that allows for stronger acceleration from a standing start. It also benefits from a claimed 40% reduction in internal friction due to a new lubrication system and low-friction chain. The unit's so called 'D-step' shift logic goes to step-shift mode under high throttle inputs (enabling rapid "gear shifts") and features an all new "adaptive" shift logic that now includes high-*g* cornering inputs from a new chassis-mounted *g*-sensor. When the Xtronic is in Sport mode the algorithm holds engine rpm when it detects a high-*g* cornering load, enabling the driver to execute smooth, seamless re-acceleration at the corner exit. But wait, there's more: Active "engine brake" controls adjust the amount of engine compression braking to be applied by varying the CVT gear ratio. The system estimates the desired vehicle path based on vehicle speed and steering input. A target speed appropriate for the estimated trajectory is determined from these measurements. Engine braking is then smoothly and automatically applied when the actual vehicle speed is higher than the target speed.

BMW launches new water-injection system on M4 GTS

While water injection adds complexity and cost, BMW intends to spread it to high-volume applications in order to meet the more stringent future emissions regulations.

Last used on a production road car by **Saab** (the 99 Turbo), water injection (WI) returns to limited production on the 2016 BMW M4 GTS. The system is claimed by BMW to help boost power by 16% (to 493 hp/368 kW, at 6250 rpm) over the standard M4. WI is a method of improving a combustion engine's resistance to "knock." It uses the charge-cooling effects of water (typically mixed with methanol as an anti-freeze agent) injected into the intake ports and then introduced into the combustion chamber. It also enables reduction of fuel consumption at high loads and low rpm (up to 4% improvement on the NEDC cycle); reduction or avoidance of fuel enrichment and lower exhaust-gas temperatures at high loads and high rpm, and improved torque: Peak torque in the 3.0-L M TwinPower Turbo inline six is increased 10% to 442 lb·ft (599 N·m), over a wide 4000 to 5500 rpm rev range. BMW stealthily proved out the Bosch WI system on its special M4 used as a MotoGP track-safety car. In the M4 GTS, an underfloor compartment in the car's trunk houses a 1.3-gal (4.9-L) water tank, pump, sensors, and valves. The pump delivers a fine spray mixture at 145-psi (10-bar) into the intake manifold plenum chamber, where it evaporates. The phase change that occurs significantly lowers the intake air temperature by 80°F (44°C), with the prospect of lowering CO_2 emissions in the new Worldwide Harmonized Light Vehicles Test Procedure (WLTP), scheduled to replace Europe's current NEDC tests in 2017. Read more about this system: http://articles.sae.org/14176/.

First-in-class matrix lighting for Opel-Vauxhall Astra

ZKW supplies the LED matrix headlamps for the new Astra.

The all-new 2016 **Opel-Vauxhall** Astra is entering premium-market territory, particularly in the high-specification versions, by offering the option of IntelliLux LED matrix headlights—a system until now firmly associated with premium brand **Audi** and supplier **Hella**. Opel-Vauxhall's supplier is the Austrian company **ZKW**. Each headlight comprises eight LED segments, the system automatically and constantly adapting the length and distribution of the main beam. IntelliLux works in concert with a front-mounted camera that identifies oncoming vehicles and switches off relevant LED segments to prevent dazzle. As the vehicle exits an urban area, high beam lighting is automatically selected and remains on. Studies by the **Technical University of Darmstadt** and the European LightSightSafety Initiative have confirmed the potential for increased safety offered by the system. We sampled its impressive efficacy during a night drive in the U.K.

2016 Civic structure employs in-die soft zones

The 2016 **Honda** Civic employs selectively-tempered "soft zone" technology in the B-pillars and rear frame rails, allowing zones within a single frame piece to have more ductile properties than the surrounding ultra-high-strength hot-stamped steel. The technology minimizes parts count and saves 15.6 lb (7 kg) compared to the previous-generation Civic. "Our method of application for this [in the rear frame rail] is a world's first," according to Ryan Miller, the program's Performance Development Leader. "Full-band soft zones [such as in the B-pillar] have been done before on a few other cars, but what we've done that's unique is we've created partial soft zones; this is much more difficult to do." Honda co-developed this application with supplier **Gestamp**. The soft zones gave engineers the ability to completely control the frame crush mode and prevent cracking of the frame at the same time, Miller told *Automotive Engineering*. The process involves heating the sheet steel to 930°C (1706°F) before simultaneously stamping and cooling key areas of the part. A laser cutting trimming process then completes the component. Read more about this technology at http://articles.sae.org/14449/. For more on the 2016 Civic, visit http://articles.sae.org/14351/.

An in-die soft zone on the 2016 Civic's rear frame rail varies from about 590-MPa advanced high-strength steel (pink) to 1500-MPa press-hardened steel (deep purple). The yellow depicts the transition zone between the two grades. (Ryan Gehm)

Alcoa and Ford debut new Micromill alloys on 2016 F-150

Ford's bold lightweighting play for its aluminum-intensive F-Series trucks further evolves in 2016, through a new supply stream from aluminum giant **Alcoa**. The F-150 will add three parts—a tailgate inner, cargo box crossmember, and tailgate reinforcements—as part of a mid-cycle running change starting 4Q15. The components, in 5000- and 6000-series material, are the first automotive parts made using new Micromill alloy technology from Alcoa's dedicated San Antonio plant. Ford is the first OEM to use the advanced automotive aluminum commercially. According to Alcoa CEO Klaus Kleinfeld, the new "suite" of Micromill alloys are 40% more formable than incumbent AL material. The technology "gives us capability to go to thinner gauges without compromising dent resistance, and offers about a 30% weight-save versus high-strength steels for a given application," said Pete Friedman, Global Manager of Structures and Stamping, Ford Research & Advanced Engineering. He told *Automotive Engineering* that door inners and fenders are the next target for the new process, which can reduce assembly costs by 4-8% versus ingot-based aluminum. Ford will transition additional AL truck parts to the Micromill materials next year. Kleinfeld claimed that Micromill is the fastest, most productive aluminum casting and rolling system in the world. It combines multiple processing technologies into a streamlined production system. While a traditional rolling mill takes around 20 days to turn molten metal into coil, the Micromill does it in just 20 minutes, he said. Ford plans to more than double its use on a range of vehicle components and future platforms through 2017.

Prototype F-150 hood inner produced using the new Micromill material. (Lindsay Brooke)

Toyota's standard GoPro mount

Toyota and GoPro engineers collaborated on the quick-release GoPro camera mount in the 2016 Tacoma (shown).

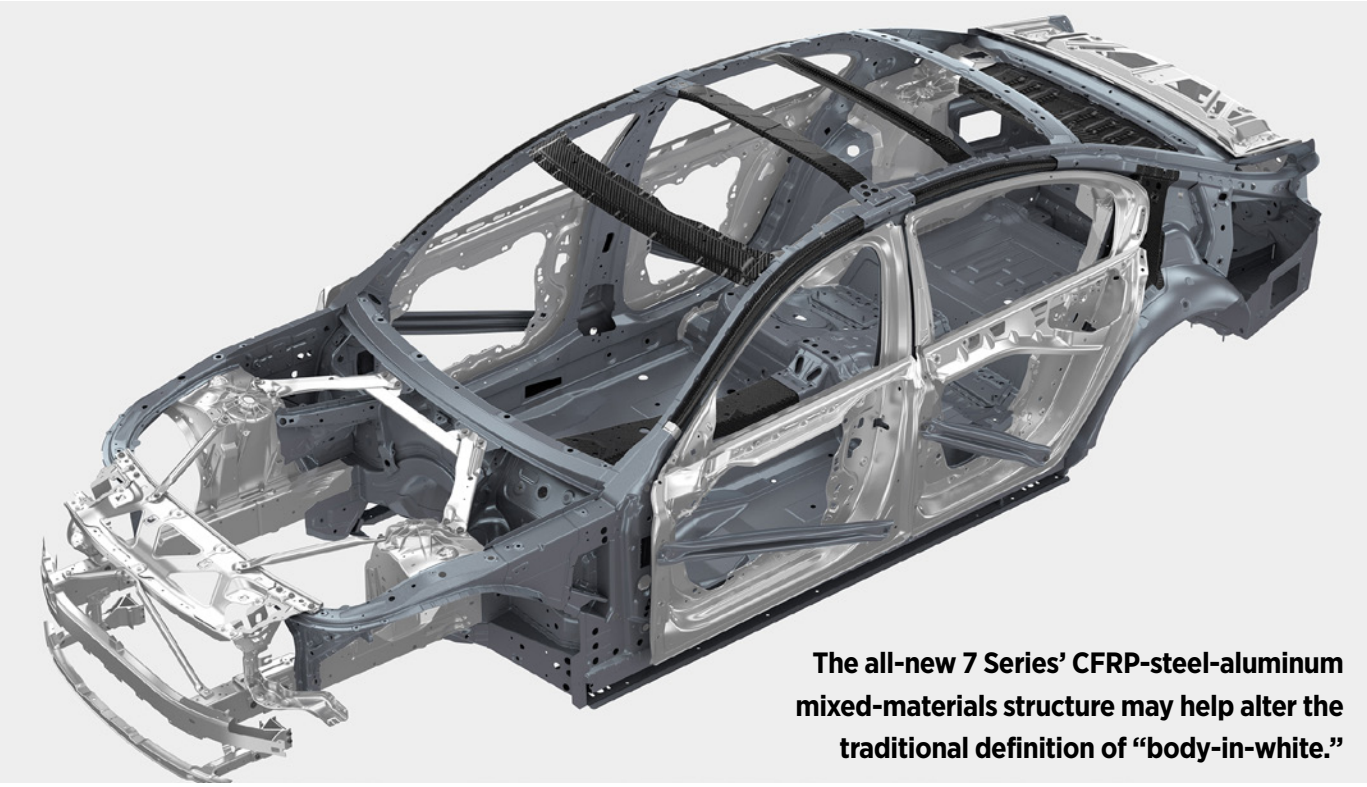
Running down an extensive list of segment firsts for the 2016 **Toyota** Tacoma, Chief Engineer Mike Sweers corrected himself when mentioning the standard **GoPro** video camera mount: "This is actually an industry first," he stressed. "Our customers are active and we've noticed their use of GoPro, so we teamed up with GoPro to add a standard QR [quick release] mount to all Tacoma windshields. It allows our owners to capture their adventures." According to Sweers, the close collaboration with GoPro engineers in San Francisco is another auto industry first. "We worked with their video team and mounts engineering team, and shared information and data back and forth to find the best location that meets all regulations, which they're not familiar with, but also how to get the best camera angle for our customers—simple things like getting a perspective of the vehicle." Read more about the 2016 Tacoma at http://articles.sae.org/14334/.

Jaguar brings RFID wearable to F-Pace option party

New technology abounds inside the **Jaguar** F-Pace, where there is a 10.2-in touchscreen infotainment display and a 12.3-in instrument panel that are powered by an Intel quad-core processor with a 60-GB solid-state hard drive. All of the system's components are connected via gigabit Ethernet networking, making the F-Pace one of the very first vehicles to employ this technology. An innovative new system called Active Key is a **Flextronics**-supplied rubber wristband RFID system that the driver wears like a **Fitbit** activity monitor. With it, the driver can lock keys and valuables in the car and unlock it by pressing the Active Key to the letter "J" in the F-Pace's rear Jaguar badge. A Delphi onboard system communicates with the passive Active Key, so there is no battery in the wristband to discharge.

Active Key rubber wristband is a batteryless and (to some) stylish link for the Jag owner.

Carbon Core for multi-material BMW 7 Series



The all-new 7 Series' CFRP-steel-aluminum mixed-materials structure may help alter the traditional definition of "body-in-white."

The all-new **BMW** 7 Series employs a multi-material body structure that cuts vehicle weight by as much as 130 kg (286 lb). Called Carbon Core, and derived from BMW's i3 and i8 development, the composite construction features a combination of CFRP (carbon fiber reinforced plastic), ultra-high-tensile steel, and aluminum. The body design also increases the strength and rigidity of the passenger cell, engineers claim. The joining technologies for the dissimilar materials were crucial in making the 7 Series structure possible, with structural adhesives being a key enabling technology. By using a hybrid construction of CFRP with ultra-high-tensile steels for structural elements, such as those in the vicinity of the B-pillars, the design of the sheet-metal components were adapted to save weight. The CFRP roof frame, for example, is built for the first time as a core-free, closed structural element, resulting in greater strength and reduced weight. This enhances the torsional stiffness of the passenger cell and lowers the vehicle's center of gravity, so that both safety and driving dynamics benefit, according to BMW engineers.

Ultracaps spark Cadillac 2016 stop-start

Maxwell's new 2.85-V, 3400-farad ultracapacitor cell in cylindrical 60-mm "K2" form factor is designed for automotive stop-start applications.

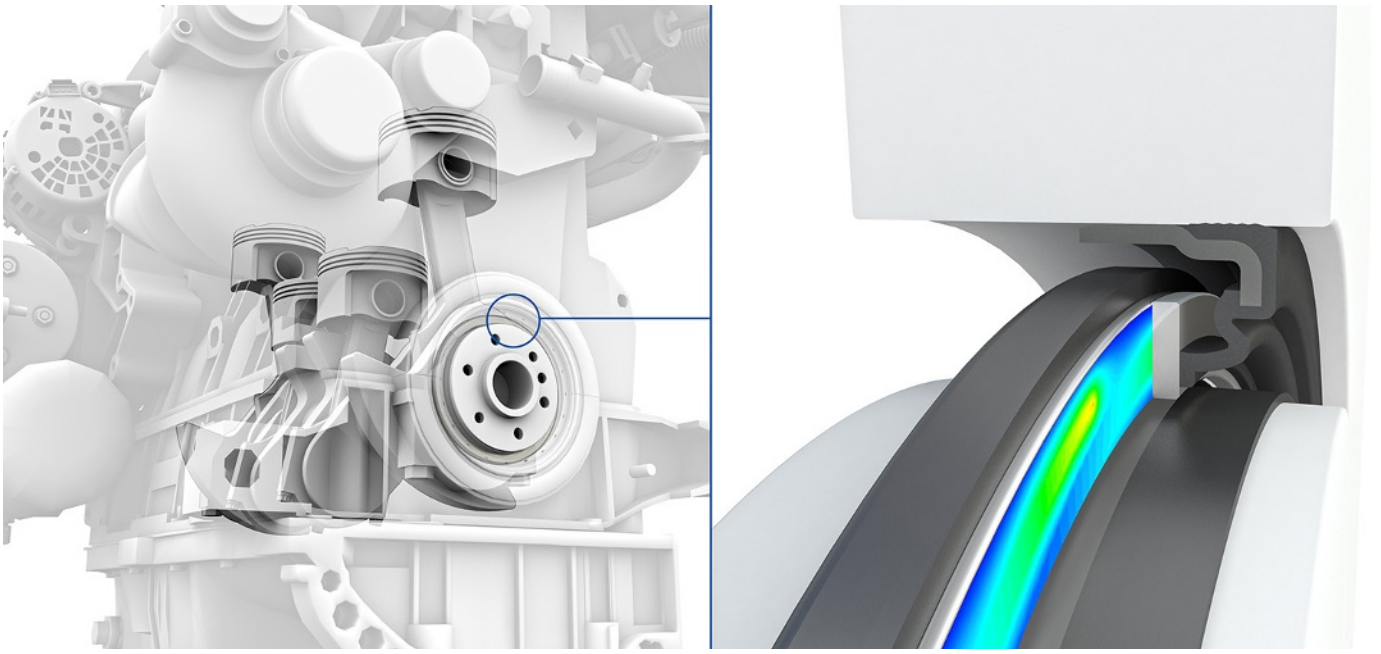
General Motors is making stop-start a standard feature on many 2016 Cadillac models. The system uses **Continental Automotive**'s voltage stabilization system, which employs **Maxwell Technologies**' ultracapacitors. The ultracap helps maintain current to keep radios and air conditioners running when the starter is cranking. It also lessens engine vibration to smooth out restarts while reducing repeated cycling that can shorten battery life. And it helps GM meet requirements in cold environments. These components have equivalent series resistance (ESR) capabilities that give them better winter performance. "In cold temperatures, the battery ESR is increasing and therefore, cranking power for the starter is below what is required for a reliable restart," said Jens Keiser, Senior Product Marketing Manager at Maxwell. "The ESR of ultracapacitors is stable until -40 degrees Celsius." Regardless of the temperature, voltage levels often fall to around 4-6 V when the engine is started. That can impact systems that have higher voltage and current requirements such as infotainment, where some components don't have the low 3.3 or 1.8 V levels of many digital devices.

Hyundai's dual-member damper housing

Hyundai engineers claim the 2016 Tucson employs a "world's first" dual-reinforcing panel rear wheelhouse design, which optimizes panels that are prone to vibration, resulting in a 109% increase in rigidity, reduced road noise levels, and ride and handling improvements. Traditional designs employ only one reinforcement. "In terms of the rear suspension towers, it's to make the attachments stiff enough to where we increase the envelope of tunability of the shock absorbers," said Chahe Apelian, Senior Manager of Vehicle Evaluation – Chassis & NVH, Hyundai America Technical Center. "Once the body becomes stiff to the point where it deflects very little, all the energy from the road is absorbed by the shock absorber and that's a tunable variable." Apelian pointed out the spring seat on the underside of the body-in-white wheel well, comprised of 100 kg/mm^2 (980 MPa) high-strength steel and hot-stamped steel; "on the other side, we sandwich it with another piece of hot-stamped steel, so it's all bracketed in and takes all the forces right here." Though the overall solution is heavier than the previous single reinforcement, Apelian noted that "all of the other solutions would be higher weight...to achieve this much stiffness and this much ride improvement." Read more at http://articles.sae.org/14287/.

The new Tucson features a claimed industry-first integrated dual-member rear wheelhouse design using advanced high-strength steel (orange = 100 kg/mm^2, or 980 MPa; red = hot-stamped steel). Also shown is the hydraulic rebound bump stop. (Ryan Gehm)

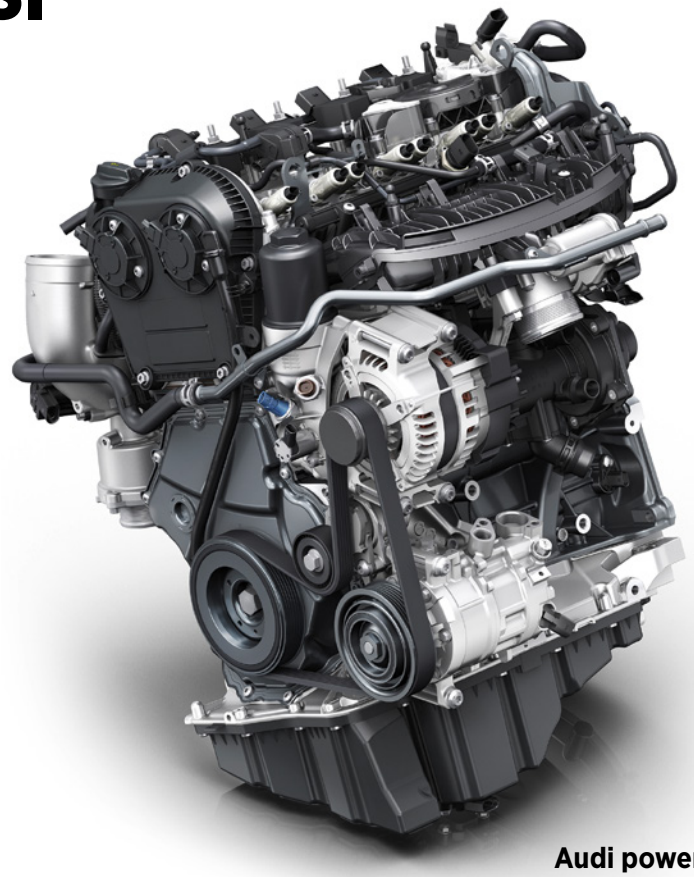
Levitex frictionless crankshaft seals for 2017 engine program



Split-image graphic showing Levitex seal location on engine and detail of its design. The frictionless seals initially will be produced in Europe although the company plans a future product expansion into North America.

Freudenberg-NOK Sealing Technologies has announced its first major order for its new generation of automotive seals. The frictionless Levitex seals, a subject of a long R&D process, will go into an engine for a global platform in 2017. The new seals function with a cushion of air, reducing both fuel consumption and CO_2 emissions—by as much as 1 g/km driven, the company claims. A Levitex seal consists of two rings, one of which is firmly attached to the crankshaft and the other to the crankcase. One of the rings has grooves that are just a few micrometers deep. When the crankshaft rotates, the air is dragged against the sealing dam that encloses the grooves. The grooves taper to a closed tip and thus represent a cul-de-sac for the enclosed air. This produces a cushion of air that separates one sealing surface from the other, making possible a nearly frictionless seal for the shaft. Until now, gas-lubricated mechanical face seals were exclusively used in major industrial facilities, according to Freudenberg-NOK. The supplier's new patented design and its associated production process allow the idea to be carried over to combustion engines, where space is limited.

Audi evolves the Miller cycle in its new 2.0-L TFSI



Audi powertrain engineers have evolved Ralph Miller's namesake combustion cycle with the new 2.0-L turbo gas engine.

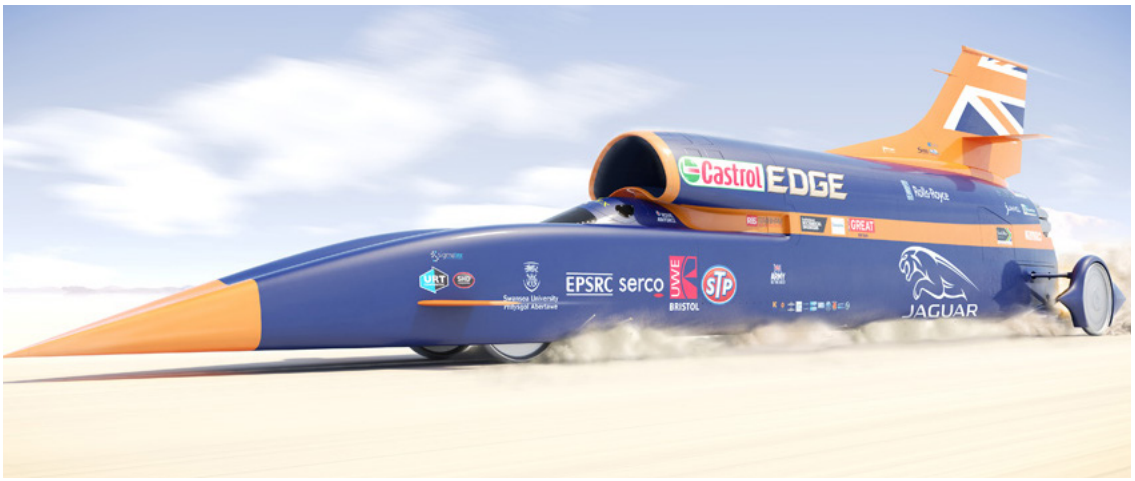
The 2016 A4 is **Audi**'s first model to receive a new 2.0-L engine that takes gasoline spark-ignition technology a step further toward diesel-levels of fuel consumption and torque capability. It does so via technology that is described as being "comparable to the Miller cycle" and is noteworthy for using a turbocharger rather than supercharger as is typical for Miller-cycle engines. The 140-kW (188-hp) direct fuel injection (TFSI) engine enjoys the consumption benefits [less than 5.0 L/100 km on the NEDC test cycle] of a downsized engine in partial load operation, while at high speeds it has the advantages of a large displacement engine, said Dr. Stefan Knirsch, Head of Engine Development. Knirsch and his team further developed the Miller cycle, originally patented by American engineer Ralph Miller in 1957, "in crucial ways." Focusing on the inlet side of the engine, intake timing is greatly reduced by adopting a 140° crank angle compared to typical 190-200° timing. The engine gets a higher boost pressure on the inlet side to provide what Audi describes as "optimal cylinder charges" despite shorter intake timing. To help achieve performance targets, in part-load range there is an additional injection upstream from the intake valve. This yields an efficient mixture formation that is already complemented by the direct injection in the chamber as well as in the intake manifold. Max torque is claimed to be 320 N·m (236 lb·ft), available from 1450 rpm to 4400 rpm.

A polyamide chassis 'first'

Strut mount developed by ContiTech Vibration Control uses fiberglass-reinforced BASF Ultramid polyamide as the primary structural constituent.

In collaboration with General Motors, **ContiTech Vibration Control** has developed a strut mount for the all-new 2016 Cadillac CT6 in which fiberglass-reinforced **BASF** Ultramid polyamide is used as the primary structural component, reducing weight by 25% compared to a traditional aluminum design. The supplier claims it is the first strut mount for passenger-car chassis made of this material, which is used in both the front and rear axle, employing different versions for each. The new two-section, three-path bearing from ContiTech comprises both fiberglass-reinforced polyamide and aluminum components. The new design can withstand shock loading as high as 75 kN (16,860 lbf), the equivalent to driving a car along a badly potholed road. The strut mount, which is the interface between the spring strut and body working to provide optimum tire contact to the road, also ensures that only minimal counter-torque acts on the shock absorber. A highly insulating rubber element enhances ride comfort. "Key to success was the early integration of our customer in the development process, which meant that we were involved in system design right from the outset," said Stefan Wohler, a developer at ContiTech.

Engineering a 1000-mph car



The Bloodhound Project is accelerating toward its 1000-mph World Land Speed Record attempt.

Engineering a car designed for a 0-1000 mph (1610 km/h) time of 55 seconds is one of the world's most unlikely, most daunting, and most exciting challenges. That is the task of Mark Chapman, Chief Engineer of the U.K. supersonic **Bloodhound Project** and his team, now on course to attempt a new World Land Speed Record that at Mach 1.4 blends automotive and aerospace engineering technologies to achieve a spectacular target never before considered outside the realms of space fiction.

It is eight years since Chapman took a telephone call and made the life-changing decision to join the small, highly specialist project to build on the supersonic success of Thrust SSC, which achieved 763.035 mph (1227.986 km/h) in 2007. It has taken four years longer than planned as the design evolved and hurdles overcome, but now runway test programs are in place starting in the U.K. in March 2016 that will take the Bloodhound car initially to a relatively modest 200 mph (322 km/h) before culminating in scheduled 800-mph (1287-km/h) record-breaking runs in South Africa in October 2016. The 1000-mph record attempt will be in 2017.

An afterburning 90-kN (20,230-lbf) **Eurojet** EJ200 jet engine as used for the Eurofighter Typhoon, and triple **Nammo** rockets—total rocket thrust 120 kN (26,980 lbf)—will blast the Bloodhound toward the record. Then airbrakes are deployed, with braking parachutes (a transonic drogue type used in the 1960s and '70s and manufactured based on that design by **SES**, as a back-up safety system as speed drops below 650 mph (1046 km/h). Rotary wheel brakes will be applied from about 160 mph (257 km/h).

Interviewed by *Automotive Engineering* in London, where the Bloodhound was unveiled to the public, Chapman spoke of the most professionally satisfying achievement of the project to date; it wasn't some esoteric area of

Mark Chapman, Chief Engineer of the Bloodhound Project: "There is no precedent for this car."

complex aerodynamics, powertrain, or materials technology: "It was how we solve problems. There isn't any precedent for this car. Unlike **Formula One**, which is also pushing technology boundaries, you can't just look across a pit lane and say, 'That's how **Mercedes** or **Red Bull** has done it; let's do something similar.' This is completely different to anything anyone has done before; it's thinking on your feet and solving it totally yourself."

The project is seeing the integration of many technologies, said Chapman: "We are developing a vehicle that is part jet fighter, part spacecraft, and part racecar."

One difficulty for the project has been finding specialists with the extraordinary breadth of experience required: "But we did so—and have seen them blossom in an environment where we don't know the right answer! Our design team has just five members (we peaked at 15), with a further 15 responsible for building the car."

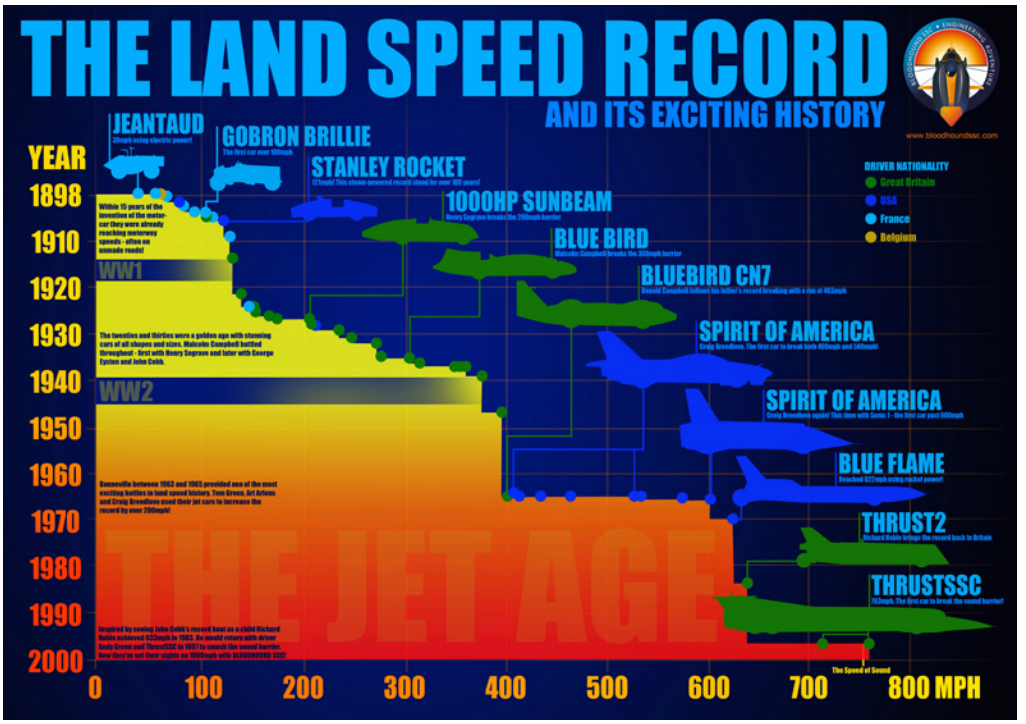
Chapman's background has been in the aerospace industry, beginning with a British Aerospace (now **BAE Systems**) apprenticeship in 1987, later gaining a degree in aeronautical engineering.

Aerodynamics challenge

Of all the many hurdles to overcome with Bloodhound, Chapman cited aerodynamics as the most challenging: "Getting the car to stay on the ground but also getting it to go in a straight line. At Mach 1.4 we don't generate a significant downforce. We want the car to sit completely neutral—just at 1 *g*. Too much downforce and it would break through the crust of the desert."

Achieving this has been a major part of the Bloodhound project: "Fully fueled, the car weighs about 7.75 tons. There is some variation in positive or negative downforce, ranging from about 1 to 2 tons."

For its 2016 high-speed tests in South



How the speed has built as the records have been achieved.

Africa, Bloodhound will use only the EJ200 engine and one rocket. These will provide sufficient power to reach 800 mph (1287 km/h).

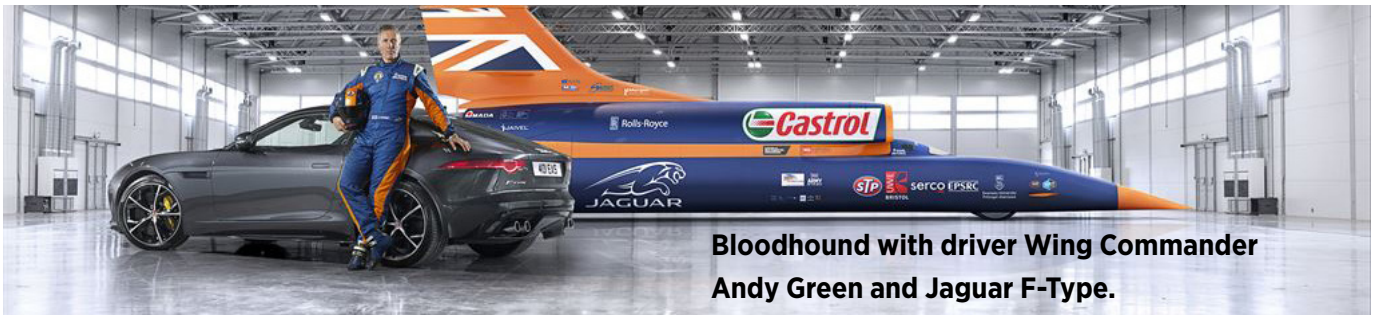
"The air intake we have at present is optimized for Mach 1.1. So—and this is one thing we need to test—we think we are on the edge of being able to use reheat from stationary; at present we can't use full 'burner until about 80 mph. We have a design for the auxiliary doors on the side of the intake to let in extra air. The AV-8B Harrier had a similar design. So if we need to increase our acceleration for the record run—what limits our speed is not power but length of desert—we could do so.

"To pump the oxidizer for the rockets we have a **Jaguar** AJ133 5.0-L supercharged V8 auxiliary power unit (APU). Jaguar uses the engine for its F-Type R sports car. We also have an all-wheel-drive F-Type R as the medical rapid response vehicle, plus two Jaguar XJRs with the same V8 engine as rapid response fire vehicles—effectively a pair of 200-mph fire engines!"

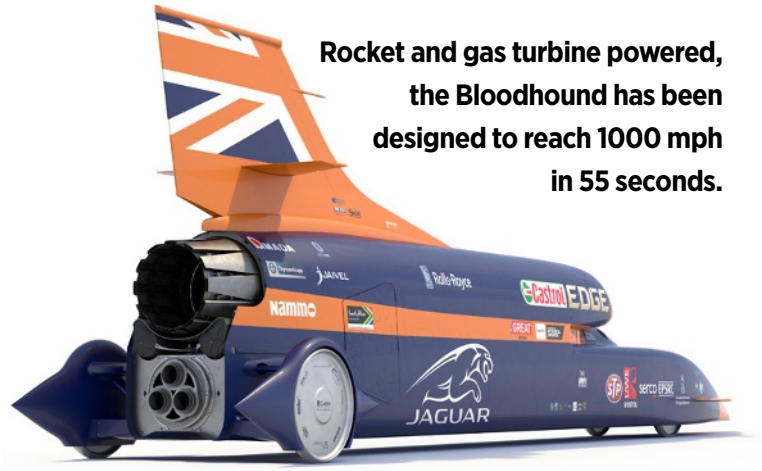
Bloodhound uses a mix of materials; the front third of the car is a carbon-fiber monocoque to provide a very strong tub. It takes all frontal loads. Aft of the cockpit area is a metallic structure comprising the titanium stressed skin that sits on top of aluminum ribs.

"Chassis frequency and stiffness are almost more important than the strength of the car," said Chapman. "We are trying very carefully to keep frequencies at an order of magnitude between the wheel hop frequency of 3 Hz and desired chassis frequency of 30 Hz."

Overall length of the car is almost 14 m (46 ft) and wheelbase about 8 m (26 ft);



Bloodhound with driver Wing Commander Andy Green and Jaguar F-Type.



Rocket and gas turbine powered, the Bloodhound has been designed to reach 1000 mph in 55 seconds.

"we are looking for deflections of only a few mm," he said.

For its 200-mph tests on a runway, the car will use rubber-tired (recertified by **Dunlop**) wheels from a **BAC Lightning** fighter of the 1960s and '70s (not to be confused with the World War II **Lockheed** P-38 nor the latest **Lockheed Martin** F-35 Lightning II). This editor first achieved 1000 mph in a RAF Lightning in the 1970s—but at 35,000 ft.

The tires, very narrow and running at high pressure 200 psi, are good for about 250 mph (400 km/h). "No one has ever produced tires that go much above 400 mph," explained Chapman. "So when we run on the desert we are on solid aluminum wheels. **Otto Fuchs** (the company developed the classic forged aluminum wheel for the **Porsche** 911 in 1964—the Fuchsfelge—and currently wheels for many other models) did a special forging for us, and Scottish company **Castle Precision Engineering**, who make turbine discs for **Rolls-Royce**, machined them.

"For braking during the sub-200 mph tests, on rubber tires, Bloodhound will have an **AP Racing** carbon-carbon system on all four wheels; on the desert, for higher speed tests, we only have brakes on the front. They use steel rotors because if you spin a carbon disc at 10,500 rpm they will explode!"

Fighter pilot's cockpit

The Bloodhound's cockpit layout was designed around the requirements of its driver, the current World Land Speed Record holder, **Royal Air Force** fighter pilot, Wing Commander Andy Green. It includes three screens providing various engine data, an F1-style steering wheel with systems' operating buttons, a foot throttle for the jet engine, and a brake pedal.

"It combines a bit of F1 and aerospace. Ergonomics such as emergency levers for fuel cut-off of the EJ200, and others that manually release the parachutes, are laid out in a similar

way to those of an aircraft," stated Chapman.

An electric rack and pinion system steers the car's front wheels. Bloodhound's turning circle is 250 m (820 ft).

For the record attempt, Green will strap into the cockpit, start the EJ200, and get its temperatures and pressures up to required levels before "taxi-ing" at low speed to line up for the record run. Then it's brakes off, jet engine throttle to maximum dry power accelerating Bloodhound to 80 mph (129 km/h) before selecting maximum afterburner (this sequence is subject to change with the possibility of maximum 'burner from brake release) to pass 300 mph (483 km/h).

Green pulls back triggers on the steering wheel to activate the rocket light-up sequence. The Jaguar engine APU will start: "We use that to pump a small amount—about 10% flow rate—of hydrogen peroxide (H2O2) to the catalyst pack; this pre-heats the pack. Peroxide decomposes to steam and oxygen across a nickel silver catalyst. If we delivered 50 kg of peroxide per second it would quench the pack and it would never get hot enough; the catalyst must get sufficiently hot (around 600°C) at just the right time, at which point the full flow rate of peroxide can be delivered after a second or so."

The rockets ignite at about 350 mph (563 km/h). They burn at full power for 20 seconds, to hurl Bloodhound through Mach 1 and on to the 1000-mph target and through a speed trap under FIA control, as Green immediately

Supercharged Jaguar XJR converted to rapid response fire engine for the Bloodhound Project.

cuts the rockets and throttles-back the EJ200, the car's drag providing immediate 3 *g* deceleration. The airbrakes are deployed 5 mi (8 km) from the "trap," and the vehicle stops.

But there is far more to do before the record can be achieved.

The car must make two runs in opposite directions. Effectively about 50 min is available to back-up crews to refuel, carry all checks, and turn it around.

Said Chapman: "This requires a choreography of checking rocket, jet, and gasoline engine fuels and cooling systems; it is almost as big a challenge as getting to 1000 mph!"

Then it will be "just" a matter of reaching at least 1000 mph again—the car's theoretical Vmax is 1050 mph (1690 km/h)—and entry into the record books.

Stuart Birch

New Astra is Opel-Vauxhall's 'no excuses' car

Hurrying to catch its design and engineering rivals: GM Europe's new Astra.

General Motors' European duo, **Opel** and **Vauxhall**, have created a convincingly fresh design and engineering challenge to **Volkswagen**'s ubiquitous Golf and **Ford**'s Focus.

It's no mean feat. Although recent Astra models have been steadily gaining commercial and critical credibility, they generally haven't managed to attain the overall respect achieved by their archrivals.

But an all-new lightweight vehicle architecture and enhanced chassis and engine capability complemented by impressive added technologies and an interior that provides a surprisingly up-market ambience combine to give the new car added status.

Vauxhall's UK Ellesmere Port manufacturing facility is the lead plant for the new model (the other is Opel's Gliwice, Poland factory; design and engineering of the car is centered at Opel Germany) producing both Opel and Vauxhall badged cars in hatchback and wagon (Sports Tourer) configurations.

Depending on the version and its trim level, the latest generation Astra is up to 200 kg (440 lb) lighter than its predecessor. Body-in-white weight is down by about 20% to 280 kg (617 lb).

The new chassis is also lighter by 50 kg (110 lb) despite the fact that it uses no aluminum. Instead, Opel-Vauxhall incorporates high-strength (HS) and ultra-high-strength (HSS) low-weight steels and compact subframes as cost-effective solutions.

This has brought other pluses, said Horst Bormann, Opel-Vauxhall's Director of Vehicle Performance: "For example, if we reduce bodyshell and suspension weight we can have smaller brakes and that reduces weight further. We can also have smaller wheels and

Ellesmere Port in UK is the lead plant for Vauxhall/Opel Astra production.

smaller tires—again weight saving."

To compensate for the aesthetic effects of wheel and tire changes, Design Director Mark Adams gave the Astra a lower, sleeker look, with a falling roof line to the distinctive C-pillar, which helps to enhance the car's individuality, providing "down road graphics" that can visually separate it from other vehicles in its class. Said Adams: "Basically we have done everything from scratch; the old car was too heavy and we needed to address that, so we fixed the whole package. This is a 'no excuses' car now."

Styling was inspired by Opel-Vauxhall's 2013 Monza concept.

Adams and his team, working closely with aerodynamicists, have managed to give the Astra a good if not exceptional Cd figure for its class of 0.285. Tweaks that have helped toward this include the placing of exterior mirrors on stalks, with benefits also coming from the C-pillar shaping.

Stefan Fesser, Plant Director at Ellesmere Port, where £140 million has been invested over the past 18 months, said the manufacturing process now includes laser brazing: "Opel has not used this before; we can work with HSS and no longer require spot welding of the roof, saving roof rails and bringing a huge weight reduction."

The Astra hatchback is slightly smaller externally than the outgoing model, by 5 cm (2.0 in) overall and 2.5 cm (1.0 in) in height, but despite a wheelbase shorter by 2 cm (0.8 in), interior space has increased thanks to the car's new architecture. Unlike the previous platform/architecture, which had to be shared with other distinctly different models such as the Zafira, the new car is using a dedicated solution just for the Astra range. The wagon (Sports Tourer) is expected to be joined by further variants.

At launch, the powertrain line-up for the new Astra range includes diesel units ranging from 74 to 148 kW (99 to 198 hp). Particularly interesting is the diesel 1.6-L CDTi 81-kW (109-hp) ecoFLEX, with stated 82-g/km CO_2

GM Europe's weight saving campaign for the new Astra led to a 20% lighter body-in-white.

emissions and combined fuel consumption of a remarkable 3.1 L/100 km.

A three-cylinder 1.0-L turbocharged gasoline engine is also offered, with 77 kW (103 hp) and maximum torque of 170 N·m (125 lb·ft) delivered at a very low (for a gasoline unit) 1800 rpm. CO_2 emissions are stated at a best—for the ecoFLEX version with an Easytronic transmission, stop-start, and low rolling resistance tires—of 96 g/km (99 g/km with the standard five-speed manual), with combined fuel consumption of 4.2 L/100 km. The best zero to 97 km/h (60 mph) time is 10.5 s.

The company is slated to introduce 17 new engines by 2018.

Although Opel-Vauxhall does not pretend that the Astra is entering premium-market territory, its interior does have a perception of "premiumness" about it, particularly in the high-specification versions. Adams' description of it blending "sculptural dynamic shapes, premium materials, and an absolute focus on quality of execution and craftsmanship" may be a shade too lyrical, but it does indicate the essence of the cabin.

Another interesting aspect of the car's rather cheeky up-market technology message is the option of IntelliLux LED matrix headlights, a system until now firmly associated with the premium sector via **Audi** and supplier **Hella**. Opel-Vauxhall's supplier is the Austrian company **ZKW**. Each headlight comprises eight LED segments, the system automatically and constantly adapting the length and distribution of the main beam. IntelliLux works in concert with a front-mounted camera that identifies oncoming vehicles and switches off relevant LED segments to prevent dazzle.

As the vehicle exits an urban area, high beam lighting is automatically selected and remains on. Studies by the **Technical University of Darmstadt**, Germany, and the **European LightSightSafety Initiative** have confirmed the potential for increased safety offered by the system. This editor sampled its impressive efficacy during a night drive in the UK.

Horst Bormann has overseen the new Opel-Vauxhall Astra's enhanced dynamics.

High-tech LED matrix headlights are on the new Astra's options list.

The Astra's technology repertoire also includes torque vectoring and electronic drag torque control to avoid wheel slip caused by high engine drag torque, helping to maintain vehicle steerability.

Suspension is fairly conventional with MacPherson struts front (decoupled to separate the paths of spring and damper settings) and a Watt's linkage at the rear. Opel-Vauxhall claims to be the first in the world to combine a torsion beam axle with the Watt's link—and patented it to prove the point. It has been further developed for the new Astra.

Chassis specialist Bormann regards it as providing the dynamic advantages of an independent multi-link setup without the penalties, such as added mass, complexity, and packaging. He added: "We have a new rigidly mounted suspension subframe, which is important. The old car had a much heavier subframe mounted with four bushings. We did a lot of structure test analysis and transfer path analysis and found the rigid mounting to be much more efficient with regard to mass, stiffness, and bending characteristics."

Torsional rigidity of the body structure is 19,600 N·m (14,400 lb·ft) per degree, a 400 N·m (295 lb·ft) per degree improvement over that of the previous Astra.

Front/rear weight distribution of the hatchback is 60/40 with the battery in the trunk.

The new car is the first Astra to feature OnStar, described by the company as "the ground-breaking connectivity technology now available across Europe." OnStar includes high-speed 4G LTE mobile network, emergency response notification, and stolen vehicle recovery alert.

Astra is described by Opel-Vauxhall as being one of the first vehicles from a mainstream manufacturer to get **Apple** CarPlay and **Google** Android Auto, available through a new version of the IntelliLink infotainment system.

It all adds up to a potentially big step forward for GM Europe.

Stuart Birch

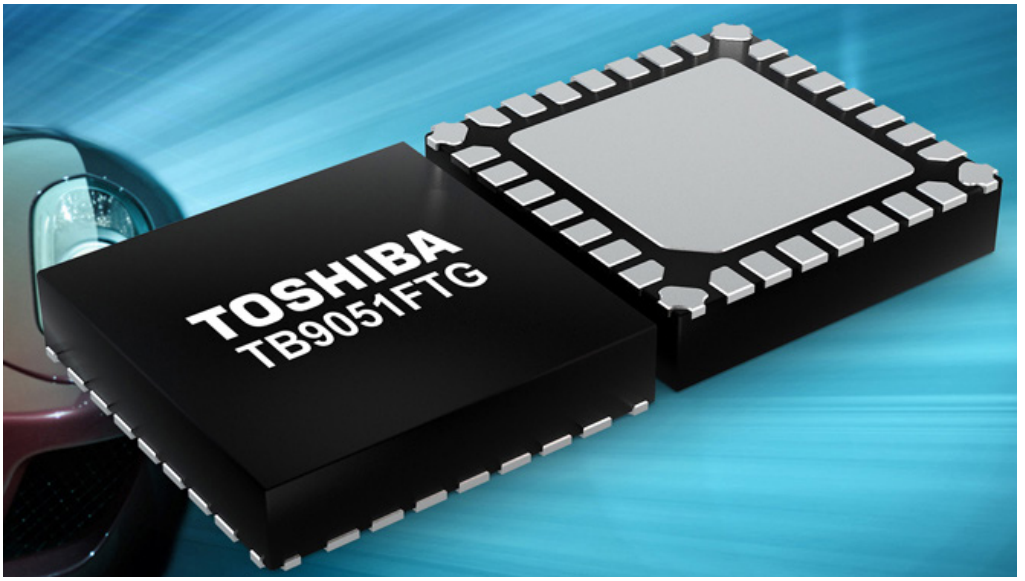
SPOTLIGHT: ENGINE COMPONENTS

Piston ring coating for high-output GTDI

Mahle claims to deliver improved top piston rings using a new thermal spray coating for gasoline turbocharged direct injected engines. Under development since 2011 at Mahle's thermal spray development labs in Muskegon and St. Johns, MI, the new process initially was designed for high-output GTDI engines currently in production by two U.S. domestic automakers. The new coating also was developed to help meet requirements for new production engines planned for 2018-2020, which call for less cylinder-bore friction and the use of lower-viscosity oils and alternative fuels. According to Mahle, the coating provides the performance of a more costly premium inlaid top ring. Referred to as MSC312, the new coating improves upon the scuff-and-wear capabilities of the supplier's MSC385 coating because of its chromium nitride (CrN) composition, applied through a high-velocity oxygen fuel (HVOF) method. Tested against the MSC385 (chrome carbide HVOF) currently used in several North American production engines, MSC312 improves wear by up to 25%, the company claims. The thickness of the new coating can be adjusted to meet engine durability requirements. CrN coatings, which are common in the piston-ring industry when applied by physical vapor deposition, provide excellent wear resistance and low friction between piston ring and cylinder wall, and also resist scuffing at the ring-to-wall interface. Mahle claims that its new coating is the first thermally applied piston ring coating to use CrN in its formulation; the addition of molybdenum-chrome provides enhancements to pure CrN. In downsized GTDI engines, conventional top-ring plasma rings are not sufficiently robust to survive high levels of pre-ignition activity associated with low-speed, high-boost conditions, according to Mahle.

SPOTLIGHT: ENGINE COMPONENTS

Motor driver IC for engines

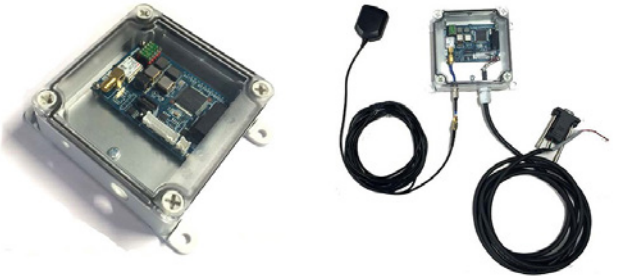


Toshiba America Electronic Components, Inc. has released a small-sized motor driver IC for brushed dc motors used in vehicle engine applications such as electronic throttles and valve controls. The new TB9051FTG, housed in a flat 6- x 6-mm (0.24- x 0.24-in) P-QFN28 package, employs double-diffused MOSFET (DMOS FET) transistors as driver circuits. These devices do not require base current biasing, so they have virtually no input current, which lets them process high current density per device area with low on-resistance. The new motor driver ICs have the flexibility to enable control of a range of automotive electronics—not only engine applications, which are the primary target, but also other onboard systems such as wing mirrors and trunk locks, operating at up to 5 A. The TB9051FTG features a single, H-bridge channel and on-resistance of 0.34 ohm (H-side + L-side, max). Its two power supplies, VBAT and VCC, operate at 4.5 to 28 V and 4.5 to 5.5 V, respectively. Control functions include motor-related (forward, reverse, brake), as well as PWM control, current limit control, H-side current monitor, diagnosis output, and power-on-reset circuit. Built-in detection circuits include over current, over heat, and low/high voltage. Sample shipments started in September 2015, with mass production scheduled to start in October 2016.

Thermal shields

Interface Performance Materials has introduced two new thermal shields in the Select-a-Shield thermal product family—THH-1010 and TFP-3065—the first innovations in a series scheduled to be released through 2016. Suitable for use in the lawn and garden, power sports, automotive, and trucking industries, both thermal shielding products feature an inorganic fiber insulating core (0.65-mm thick for TFP-3065 and 1.0-mm thick for THH-1010) and a thin embossed foil facing to create a lightweight, durable shield that is directly applied to protect sensitive elements from a high-temperature source. TFP-3065 comes with a low surface energy pressure-sensitive adhesive (PSA) backing for plastic surface applications, while THH-1010 comes with high-temperature acrylic PSA for metal and painted surfaces. Both THH-1010 and TFP-3065 are also available without a PSA backing for mechanical fastening applications. Uses include fuel tanks, plastic body panels, acoustic parts, enclosure panels, and any surface that needs to be protected from heat sources, such as engine exhaust components. Both products can be placed within 15 mm (0.6 in) of a 560°C (1040°F) heat source. Available in rolls, sheets, and finished die-cut parts.

Inertial measurement unit



Tamagawa Seiki has launched a series of automotive and industrial-grade inertial measurement units (IMUs) for affordable high-performance applications. Model AU7595 features high accuracy and GPS for measuring position, direction, and attitude of vehicles or any mobile application. The AU7595 is equipped with three-axis, high-precision, piezoelectric MEMS gyros and stable accelerometer sensors for high resolution, precision, and low-noise requirements. The multi GNSS receiver is compatible with QZSS and GLONASS and includes digital interfaces (CAN or Serial IF). Model TAG247 version of AU7595 is housed in a protective case and comes with cables. Model AU7554 is a compact—35-mm (1.4-in) square—and low-price unit with an optional GPS receiver. The AU7554 outputs triaxial angular velocity, acceleration, and angles supported by stable thermal behavior and repeatability. I/O interfaces include CAN, RS232C, and USB. Model TAG250 version of AU7554 has options including GPS receiver substrate, wireless communication substrate (Bluetooth), and battery pack. **AdvanTech International** is the exclusive marketing partner of Tamagawa Seiki in the U.S. and Canada.

Quick connector for fuel and urea systems

Norma Group has developed a new plastic quick connector for use on fuel and NOx-reducing diesel urea systems in passenger, commercial, and off-highway vehicles. Produced at a Norma Americas plant in St. Clair, MI, the NormaQuick SSL quick connector is easy to assemble to fluid lines without the use of special tools. The new quick connector features a secondary latch that ensures service personnel can make a secure connection and also allows for quick disconnection. The connectors produce a significant "click" sound when installed correctly. If the NormaQuick SSL quick connector needs to be disassembled for maintenance and service, a technician can disconnect it by pressing the latch on the same side it was engaged. The quick connector is designed for use on both plastic and metal fittings designed to meet **SAE** J2044 specifications. Made of recyclable materials, the connector features extremely low fluid permeability, according to Norma. It comes standard in 0° and 90° versions; special versions are available upon request.

Fiber laser system

Prima Power has introduced the Laserdyne 430 Versa 3D fiber laser system with third-generation BeamDirector, designed for the typical laser processing needs of tool rooms, model shops, and R&D centers of manufacturers. The system is suitable for laser cutting, welding, drilling, texturing, and marking of a wide range of materials. The 430 Versa provides a cost-effective path into volume production by making possible the full benefits of fiber laser processing with an "effectively priced" workstation, the company claims. The 430 Versa is equipped with an air-cooled 3000-W peak power fiber laser and the proprietary BeamDirector, which provides two axes of laser beam motion without part movement. Laserdyne S94P control with standard hardware and software features include Automatic Focus Control for capacitive part sensing, and as an option, the patented Optical Focus Control for sensing of non-conductive surfaces. The 430 Versa has a range of standard focusing lens assemblies including right angle assemblies for processing inside cylinders that have diameters as small as 60 mm (2.4 in) and welding assemblies that shield the weld metal to prevent contamination and protect the focusing lens from spatter.

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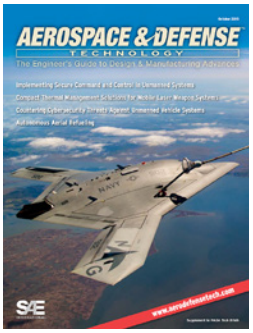

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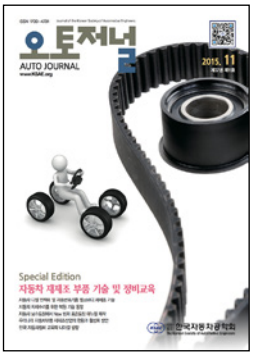

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