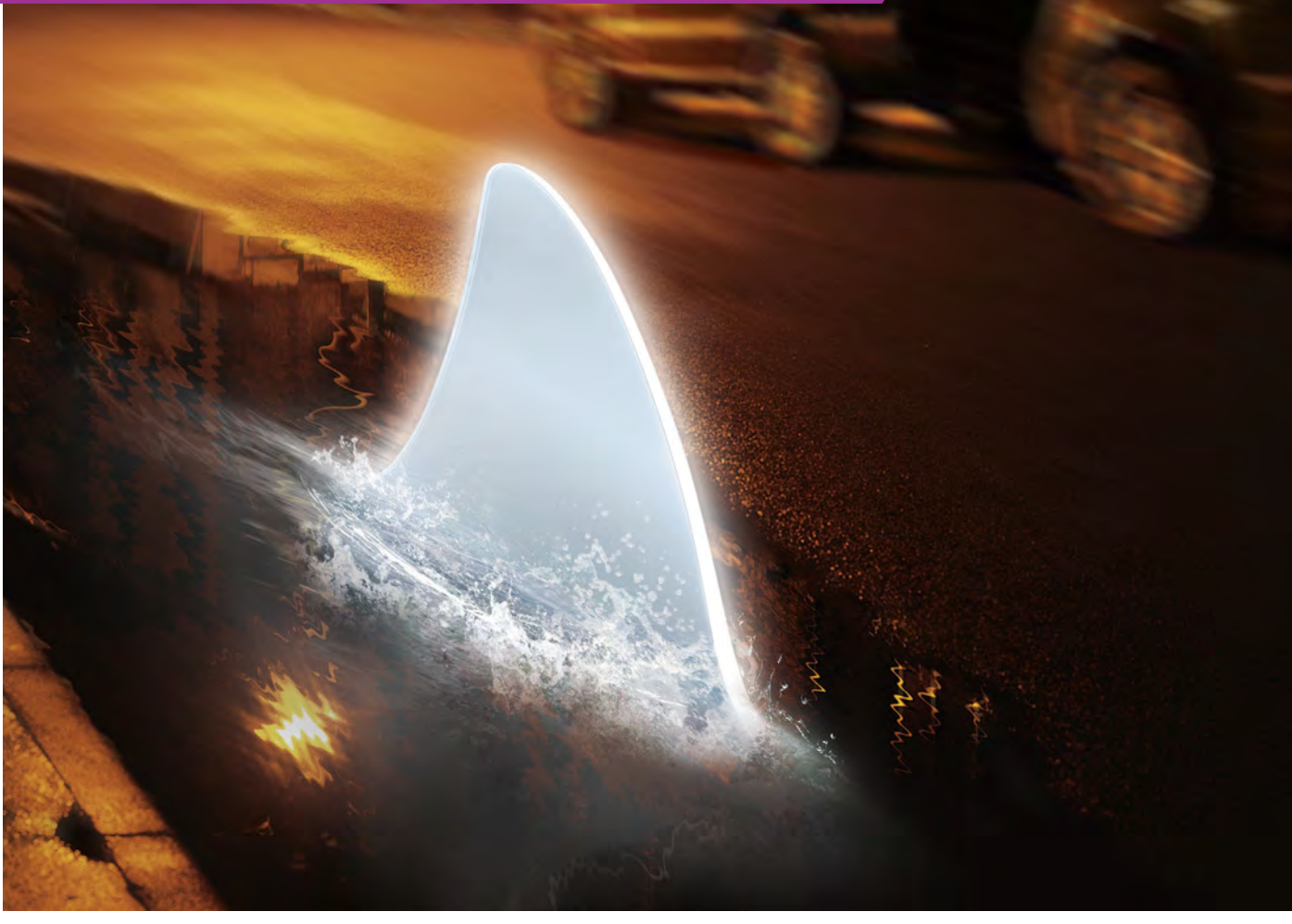
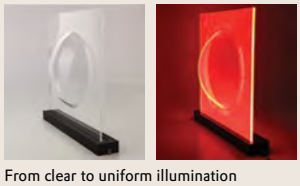
# It's so cool, it's scary.

## New ACRYLITE® LED for automotive applications.





From clear to uniform illumination with ACRYLITE® LED.

ACRYLITE®

Sleek and thrilling to behold, ACRYLITE® LED brings a new dimension to automotive lighting design. Using LED edge lighting, ACRYLITE® LED transforms from crystal clear to *uniform illumination* in any color—no more unsightly LED "hot spots." The design possibilities will take your breath away.

**Evonik Cyro LLC**
www.acrylite-polymers.com

See for yourself with an in-person demo!
**Call 1-800-225-0172**

**Evonik. Power to create.**

EVONIK INDUSTRIES

SAE INTERNATIONAL®

# AUTOMOTIVE ENGINEERING®


## McLaren faces the electrified future

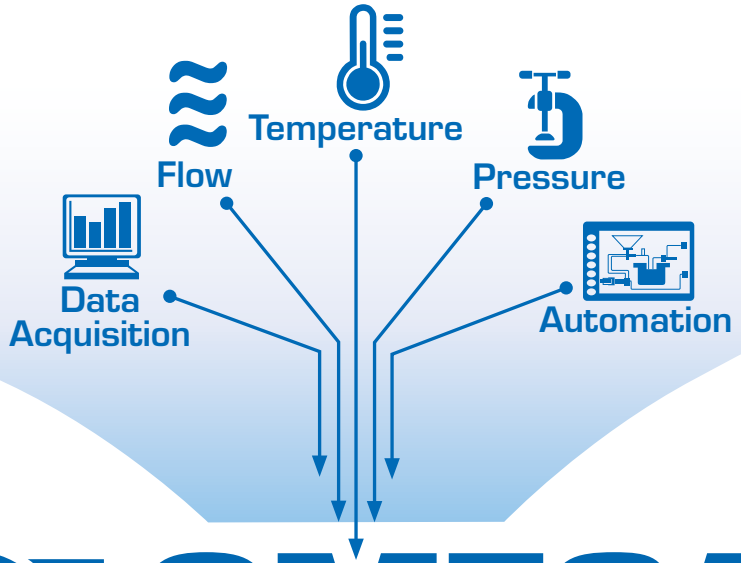
Britain's supercar ace has what Silicon Valley wants—but it's staying independent with a £1B product investment

## Toyota's top safety engineer talks vehicle autonomy

## Mercedes reprises the inline six—with 48V

December 2016 | autoengineering.sae.org

# Your One-Stop Source for Process Measurement and Control




OMEGA®

## 100,000 Products
## Customized Solutions
## Expert Technical Support
## Easy Online Ordering
## Fast Delivery

### OMEGA's Solutions for the Automotive Industry

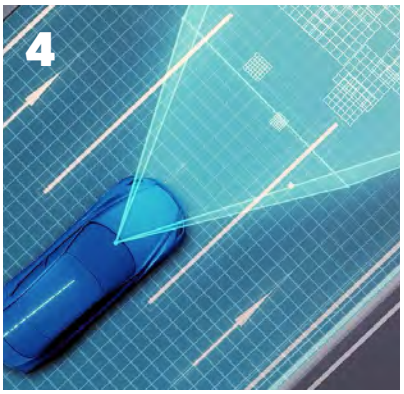

**omega.com**

**1-888-826-6342**

# CONTENTS

VOLUME 3 ISSUE 3









**Follow us on social media**

@SAEAutoMag @saeaei SAE Magazines

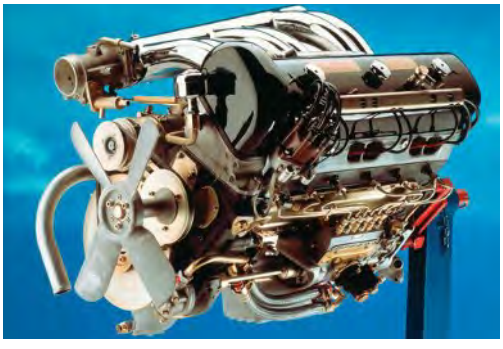
# EDITORIAL

## What's old (and revered) is new again

Apart from top brass and various other engineering true believers at **Mercedes-Benz**, maybe nobody was more delighted than me when it was confirmed a couple of years ago that Mercedes was introducing a new architecture for inline 6-cylinder engines, a powerplant layout that long served as a cornerstone for the brand's reputation for consummate powertrain performance and refinement.

The inline six became synonymous with Mercedes in its "modern" era that started roughly in the 1950s and appeared in some form or other for the next half-century (including the seminal 3.0-L **Bosch** direct-injected M198 for the 300 SL gullwing). The company cut ties with its last I-6 in 1998.

In October, Mercedes made known the basic details of the new inline 6-cylinder family, the foundation of which is a modular 500-cc cylinder—not to mention the incorporation of new-age electrification features; *Automotive Engineering* European correspondent Stuart Birch delivers the initial rundown at: http://articles.sae.org/15093/.



**The grandaddy of Mercedes inline-sixes: the direct-injected (in 1954!) M198 that powered the 300SL.**

I've certainly missed the I-6. As many know, inline sixes gradually became a vehicle-development liability as front-wheel drive (FWD) vehicle architectures began to dominate and, more directly, as global frontal-crash regulations tightened. Inline sixes typically were too long to be effectively packaged in transverse-engine FWD platforms (although it was accomplished)—and the straight six's physical length similarly made it difficult to fit one even in a platform designed for longitudinal engine placement, because the unyielding engine didn't permit enough energy-absorbing crumple zone in frontal impacts.

Only **BMW**—which over the years became more famous for the straight six than even Mercedes—somehow kept the faith. When inline sixes started to bite the dust all over the globe, I repeatedly asked senior engineers, designers and executives how BMW could somehow get on the right side of crash physics when everyone else claimed it couldn't be done. The usual answer, I'll paraphrase, tended to be: "Perhaps it's because we make the

inline six-cylinder a priority."

It surely must have been difficult for those concerned with engine superiority to turn their backs on the I-6 layout's inherent balance and outstanding torque characteristics. Then there are the considerable design and manufacturing advantages compared with a V-6, as Ron Kociba, former **General Motors** chief engineer of the "zig-when-everyone-else-is-zagging" early 2000s Vortec 4200 I-6, always explained. It's ironic those benefits are being revisited as cost advantages compared with a V-6, given that one justification Mercedes and others cited for moving to vee-arranged 6-cylinder engines was modular compatibility with V-8s. My, how the world has changed: now the critical cost-sharing modularity metric is with inline 4-cylinder engines, not V-8s.

The German luxury-car makers didn't have an exclusive on the I-6 secret—**Toyota**, for one, authored some magnificent inline sixes, including my personal craving, the ballistic twin-turbocharged 2JZ-GTE 3.0-L used in the last-generation Supra. But for Mercedes and BMW, there's no doubt the format is indelibly tied to those brands.

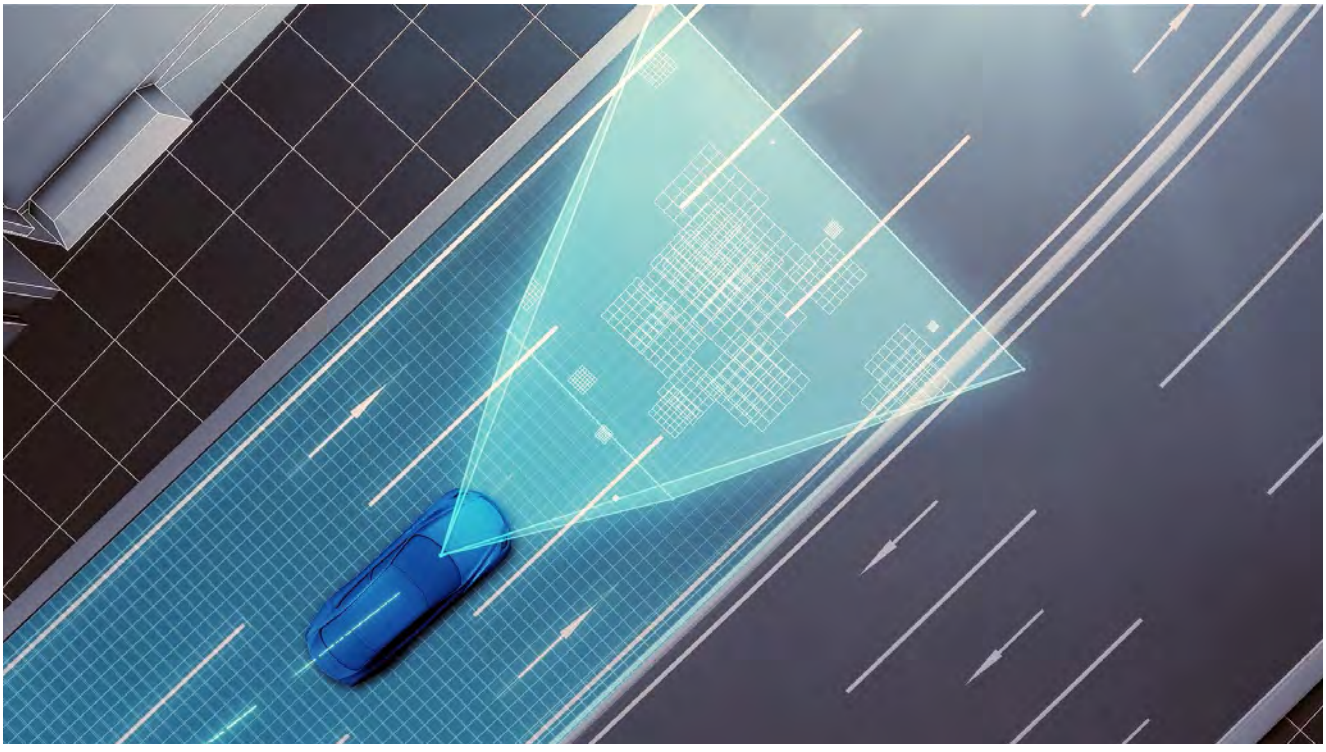
What makes it all the better for straight-six disciples: as with the M198 from the 1950s, Mercedes is launching its new-generation I-6s with the era's most bleeding-edge technology: integration with a 48-volt electrical system that facilitates several nifty efficiency and performance game-changes, included an electrically-accelerated turbocharger as the last word in eradication of turbo "lag."

What's old really is new again. In Mercedes' revival of the inline-six, "old" may equate to vintage attributes, but these new engines promise to be anything but vintage. What a world.

Bill Visnic
Editorial
Director

AUTONOMOUS TECHNOLOGY

# Toyota sticking with measured, 'Teammate' approach to autonomous development



**Toyota believes advanced, on-the-fly route-mapping capability will be a factor in dramatically reducing accident rates.**

One might expect Japan's largest automaker to be "all-in" on promoting autonomous-driving technology, but **Toyota** to now has rather conspicuously avoided self-driving hype. Instead, said Kiyotaka Ise, the company's chief safety technology officer and President of its Advanced R&D and Engineering Company, Toyota is being "more cautious than others" because it sees the chief promise of autonomy to be enhanced safety rather than enhanced convenience.

Definitely a little tamer than cars driving themselves across the country.

"Our stress with autonomous is safety first, a safer traffic environment," insisted Ise in a recent interview with *Automotive Engineering*.

Instead of focusing on the gee-whiz potential of SAE Level 4-5 fully-autonomous driving, Ise said Toyota is concentrating on the driver-assist possibilities of Levels 2-3: the potential to drastically reduce or even

Intelligent Transport Systems

Electromagnetic Interference

Safety & Driver Aids

Wireless Connectivity

In-Vehicle Networks

# Automotive Test Solutions

The complexities of the automotive ecosystem continue to increase with technology being added to support new communications and safety applications. From R&D to production, Anritsu offers a comprehensive range of proven high-performance test solutions for the modern car. Including; wireless connectivity, safety and driver aids, in-vehicle networks, intelligent transport systems and electromagnetic interference.

**To learn more download our Understanding Connected Car Guide at:**
www.goanritsu.com/12SAE

1-800-ANRITSU
www.anritsu.com/en-US/test-measurement


Anritsu
envision : ensure

eliminate accidents altogether—while still providing the driver with the opportunity to enjoy piloting the vehicle under conditions of choice. The autonomous vehicle works with the driver in a "mobility teammate" collaboration, a strategic concept Toyota revealed in 2015.

Ise won't commit to a timeframe, but he admitted Toyota's goal is no less than "accident-free society." But it's clear he means sooner than later.

## SAE Level 3 Teammate

Although many automakers and Tier 1 suppliers say it's most logical to direct development resources to achieving high-level autonomy, skipping the system-to-driver "handoff" complications of Level 2-3 systems, Ise said Toyota's mid-level autonomy focus makes the most sense to more quickly produce safer roads. That's the endgame to which the company has been directing more than 20 years of autonomous-technology research from three primary corporate R&D channels: the **Toyota Research Institute**, the **Collaborative Safety Research Center** and **Toyota Connected** (formed in early 2016 to be Toyota's "big data" hub).

Toyota's efforts are focused on integration


**Toyota's "Highway Teammate" system autonomously handles all driving functions—including lane changes—leaving the driver to control the vehicle in non-highway situations or when deliberately seeking driving pleasure.**

# UPCOMING WEBINARS

## A NEW PARADIGM IN TURBULENCE MODELING FOR AERODYNAMIC SIMULATION

Available On-Demand until November 30, 2017

Whether for cars, trucks, aircraft, or wind turbines, aerodynamics is a critical aspect of improving energy efficiency. Aerodynamic simulation, therefore, requires accurate flow solvers, comprehensive turbulence models, and precise geometry handling. In this 60-minute Webinar, a world-renowned turbulence modeling expert examines Stress-Blended Eddy Simulation (SBES) – a new paradigm in hybrid RANS-LES modeling.

Sponsored by: ANSYS®

Hosted by: SAE INTERNATIONAL®

**For additional details and to register visit: www.sae.org/webcasts**

---

## PREDICTING AND ELIMINATING SQUEAK & RATTLE NOISE IN VEHICLE INTERIORS WITH PSA PEUGEOT CITROËN

Tuesday, December 13, 2016 at 10 a.m. U.S. EST

For car makers, squeak and rattle phenomena represent a significant problem as many customers will interpret the noise as a general lack of quality in the product. To combat these issues, PSA Peugeot Citroën Group partnered with Altair ProductDesign to explore the use of simulation technologies and numerical optimization methods at an early stage of development. This 60-minute Webinar discusses the project and its progress.

Sponsored by: Altair

Hosted by: SAE INTERNATIONAL®

**For additional details and to register visit: www.sae.org/webcasts**

---

## FROM THE EDITORS OF SAE – SENSOR FUSION FOR AUTONOMOUS VEHICLES

Wednesday, December 14, 2016 at Noon U.S. EST

Enhanced vehicle systems rely on vision and camera systems, sensor technology, and software to automate driving tasks. Future systems will leverage more advanced sensing, car data networks, vehicle-to-vehicle and vehicle-to-infrastructure systems, and wireless network connectivity to automate most of the driving experience. In this 60-minute webinar, three experts will offer insight on this important topic.

Sponsored by: Anritsu dSPACE SYNOPSYS®

Hosted by: SAE INTERNATIONAL®

**For additional details and to register visit: www.sae.org/webcasts**


**Toyota is studying the best methods for alerting and advising the driver when it's time for the crucial "handoff" between autonomous driving and manual control, imparting the information through an instrument-panel information display.**

of sophisticated onboard active-safety features and systems, vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication and automated-driving technology. The company has pledged, for example, to have its "Safety Sense" active-safety technology suite (pre-collision alert/avoidance, pedestrian detection, lane-departure assist, automatic headlight high-beam control and adaptive cruise control) standard for nearly every vehicle in the Toyota and Lexus model lines by 2017. Combine the onboard technology, Ise said, with V2I communication and go after a big-time reduction in intersection accidents, for instance, which account for a quarter of all vehicle fatalities in the U.S.

Toyota sees the approach extending into two distinct paths for its Mobility Teammate philosophy, a "Highway Teammate" and an "Urban Teammate." The highway teammate is targeted at taking over the mundane and riskier aspects of highway driving; flip a switch when preparing to enter an Interstate, say, and the system automatically merges the vehicle, accelerates and brakes and changes lanes. Leaving the highway, the driver resumes control for the presumably more-engaging (or more complex, depending on one's perspective) aspects of the trip. Highway Teammate is targeted for introduction in Japan sometime around 2020.

The Urban Teammate tackles automated driving in more-congested

environments, where active-safety systems such as pedestrian detection and avoidance come into play.

According to Toyota's description of the Teammate strategy, "This approach acknowledges the utility of automated-driving technologies while maintaining the fun experience of driving itself."

## Automatic maps and AI

As technology advances, Toyota sees artificial intelligence assuming a larger role, using LIDAR and camera vision to generate, on-the-fly, ultra-precise maps for the vehicle, but also for others in the vicinity or scheduled to use that road.

Meantime, Toyota safety executives are not unaware of the development hurdles surrounding the driver handoff required for engaging and disengaging with Level 2-3 autonomous systems. They're studying the most effective methods to alert and inform the driver and hope to standardize that interface.

Ise also acknowledges that different world regions will adopt autonomy at a different pace. In Japan, he said, the Urban Teammate concept is more critical than in the U.S., where more suburbanized driving, lengthy highway travel and more crashes with big trucks might suggest quicker adoption of Level 4-5 autonomy.

**Bill Visnic**

POWERTRAINS/PROPULSION

# Straight-sixes are back (with electrification) at Mercedes-Benz

**The M256 is Mercedes' new inline 6-cylinder engine. If that's not a big-enough deal, it also incorporates 48V technology.**

**Mercedes-Benz** is not generally given to hyperbole to detail its technology, so when company engineers describe a program as "the biggest strategic engine initiative" in the automaker's long history, it is worth taking notice. And electrification is very much to the fore.

The company's latest propulsion blitz opened with the new 4-cylinder 2.0-L diesel now used in the E-Class. It will continue in 2017 with the appearance of a new gasoline 4.0-L V8 biturbo for the S-Class, new 6-cylinder units in gasoline and diesel forms with 48V technology, and a 2.0-L 4-cylinder gasoline which also uses 48V to power auxiliaries. The sixes are inline, not "vee"-arranged, because Mercedes' engineers reckon in combination with 48V electric systems, the return to the hallowed inline-six layout delivers meaningful packaging advantages.

The V8 has capacity reduced by about 0.7-L from the outgoing V8 and gets cylinder deactivation, becoming a "four-pot" unit under light loads while cruising. With a claimed output of over 350 kW (469 hp) with about 700 N·m (516 lb·ft) peak torque, the engine has received attention from Mercedes' **AMG** tuning specialists.

Some premium car makers are fixated on reduction of cylinder count—for

example Volvo, with its aim of being accepted by the market as a premium producer, reckoning four cylinders is the maximum for all its models—to achieve required fuel-consumption and emissions targets. Mercedes, though, while on many models already demonstrating what can be achieved with four cylinders, is not being seduced by the prospect of drastic displacement reduction. Instead, it is using the latest complementary technology to meet the unremitting demands for cleaner, more-frugal engines while maintaining the level of performance and refinement expected of its powertrains in their higher-level models.

As well as 48V, those complementary technologies include an integrated starter generator (ISG) and electric auxiliary turbocharger compressor (eZV) to assist the exhaust-driven compressor.

To help continue maximum-efficiency systems cohesion, Mercedes opened a new powertrain integration center (AIZ) at its Sindelfingen, Germany assembly complex.

## All-new I6 replaces V6

Prof. Dr. Thomas Weber, responsible for group research for **Daimler AG** and Mercedes cars' development, says of the strategic power unit initiative: "Our high-tech engines need to be (and are) designed with a view to all current and future requirements. A key success factor is the extensive electrification of the powertrain."

Of the new engines, it is the 3.0-L inline sixes that are the real attention-grabbers. The gasoline version (M256) produces a claimed 300 kW (402 hp) and delivers maximum

torque of "more than" 500 N·m (369 lb·ft)—the qualifying words, which the company uses extensively in its initial talk about the new engine architectures, shows either a caution about claims or a plan to surprise later. Mercedes has chosen 500 cc per cylinder as the optimum swept volume, the same as that for the new 4-cylinder diesel.

The gasoline inline 6-cylinder (the S-Class gets that too, next year) uses a 48V system and forced air via an eZV and has an ISG to look after hybrid aspects, including energy recovery.

Mercedes' first V6, the M112, was introduced in 1998 as a response to new frontal-crash requirements, replacing the company's classic gasoline I6 family. For the move back to inline cylinders for 2017, Mercedes engineers cite performance akin to an 8-cylinder, which should make next year's S-Class something very special. It also brings design opportunities, such as eliminating the need for a front-end accessory belt drive, that help reduce overall length.

Near-engine exhaust aftertreatment for low heat loss helps reduce emissions. The 48V system delivers the high-power demands of the water pump and air-conditioning compressor and the ISG. With this setup, emissions are down some 15% against the outgoing V6, engineers claim.

## 48V with new I4

The diesel version (OM656) of the new I6 family incorporates the Camtronic variable valve timing, with steel stepped-bowl pistons and 2-stage turbocharging.

The stepped-bowl piston has a positive

**Destined for the 2017 S-Class, Mercedes' new M176 gasoline 4.0-L V8 biturbo.**

effect on the combustion process, engineers explain, in terms of thermal loading of critical areas of the pistons and the introduction of soot into the engine oil. Efficiency is increased by the higher burn rate in comparison with the previous "omega" combustion bowl. The characteristic feature of the specifically configured combination of bowl shape, air movement and injector is its very efficient utilization of air, which allows operation with high air surplus. This means that particulate emissions can be reduced to an especially low level, engineers said.

The engine's block is aluminum and what is described as "improved" Nanoslide coating is used to line the cylinders. The engine also uses near-engine exhaust treatment. A Camtronic switchable exhaust camshaft is integrated.

Output is over 230 kW (308 hp) to make it the most powerful passenger-car diesel in Mercedes-Benz history, according to the company. Maximum torque is over 650 N·m (479 lb·ft).

Topping the muscle chart for the new engine group is the M176 gasoline V8 4.0-L, claimed to deliver a hefty 350 kW (469 hp) and 700 N·m (516 lb·ft) from 2000 rpm.

Cylinder shut-off via Camtronic at part-load effectively creates a V4. For added efficiency, the engine's two turbochargers

**Mercedes' OM656 6-cylinder diesel has stepped-bowl combustion chamber and 2-stage turbocharging.**

are placed between the cylinder banks.

Less glamorous than the sixes and V8 but very significant for Mercedes' higher-volume models is the new gasoline 2.0-L 4-cylinder (M264). Also known as the Toptype, it follows downsizing/rightsizing philosophy by offering a specific output of 100 kW (134 hp) per liter. It is technology-dense with a twin-scroll turbocharger, belt-driven 48V starter-generator and 48V water pump. Energy recovery capability is claimed to be some 12.5 kW (17 hp).

The design enables engine-off coasting and Camtronic is used on the intake side. And Mercedes plans to expand its application of particulate filters across its gasoline engine range.

**Turbocharging and use of an electric auxiliary compressor (eZV) provide forced induction for Mercedes' new drivetrains. BorgWarner is a major supplier.**

## M256 "designed for electrification"

Prof. Weber underlined the importance of Mercedes continuing to develop and offer a wide range of co-existing drive systems: "Efficient and clean gasoline engines, diesels, plug-in hybrids, battery and hydrogen drives—each has its justification and future prospects. The M256 is the first engine that we have systematically designed for electrification from the outset."

The ISG, responsible for hybrid functions, achieves boost or energy recovery while allowing fuel savings that were previously reserved for high-voltage hybrid technology, he added: "And the electric auxiliary compressor makes for an impressive step-off with the M256, bridging the time lag before the large exhaust turbocharger cuts in to full effect."

Weber always talks of "rightsizing" rather than downsizing. "Instead of trimming the number of cylinders from the outset, thereby foregoing refinement and output, there are much more intelligent solutions," he noted. The M176 V8 uses cylinder shut-off; at part-load up to 3600 rpm it is an especially efficient 4-cylinder, he claims. Then, imperceptibly for the vehicle's occupants, cylinders 2, 3, 5 and 8 cut in.

Meanwhile, Mercedes' new Powertrain Integration Center houses 10 test rigs fitted with high-precision torque measurement directly at the wheels. Integration covers engine and transmission, comfort, dynamics and overall agility—essentially ride and handling. There's also a climatic altitude chamber and fully automatic vehicle operation on a dynamometer.

Mercedes is just starting work on a vehicle safety, electronics, and computer technology center. Just revealed is Mercedes EQ pure electric SUV coupe concept, with motors on front and rear axles to give all-wheel drive and front/rear variable torque distribution. A battery is positioned between the axles in the car's floor.

Mercedes has talked of a maximum 300-kW (402-hp) output and up to 700-N·m for the concept, and a potential 500-km (310-mi) range.

**Stuart Birch**

SAE INTERNATIONAL

# TOGETHER WE MOVE MOBILITY FORWARD

Collaboration. Despite today's highly competitive world, it's still how problems are solved, challenges overcome, and advances are made.

Since 1905, SAE International, a professional society, has been providing the platform for that collaboration among those who want to advance mobility.

In fact, the sharing of knowledge to solve common problems was the impetus of SAE's earliest standardization efforts—efforts that benefit all of industry by setting expectations for quality, safety, and efficiency and allow for focus on innovation.

Yet, while today's mobility challenges are very different from those of yesterday's, automotive, aerospace, and commercial vehicle engineers continue to look to SAE International to connect with each other and the technical resources needed to advance themselves, their companies, and industry.

SAE International is the authority on vehicle engineering—developing more vehicle technical standards than any other organization, offering the largest library of vehicle engineering content, and bringing together the largest global network of engineers in the world.

**How are the various mobility sectors solving for their toughest engineering challenges? Learn from them at *alwaysinmotion.sae.org***

US +1.724.776.4841 • Asia +86.21.6140.8900 • Europe +32.2.789.23.443 • **sae.org**

**See how collaboration through consensus-based standards are helping advance the complex issues of vehicle connectivity.**

Download 3-part infographic series at

***alwaysinmotion.sae.org***

**Essential automotive standards for connected transportation**

P1618239

# McLaren faces the electrified and autonomous future


**McLaren Automotive CEO Mike Flewitt says the company will remain "fiercely independent."**

Can low-volume supercars survive amid stringent $CO_2$ regs and robot cars? McLaren is betting £1 billion on a speedy, powerful—and independent—sports-car future.

**by Stuart Birch**

Pressing the engine start button of a **McLaren** ignites a cacophony of sound that signals its place in the vanguard of ultra-high performance supercars.

But even such an authoritative burst of decibels is not quite sufficient to drown out another cacophony—of rumors that the company had been in discussions with **Apple** regarding acquisition of the British sports- and race-car icon.

When *Automotive Engineering* recently was invited to drive two of McLaren's products in the U.K., it was a question that still


**McLaren is nosing into the future with a £1B R&D budget.**

hung in the air. And to which CEO Mike Flewitt replied: "McLaren will remain fiercely independent; the company is not in talks with Apple."

Never has been? "Such is the nature of our business we have discussions with many parties," Flewitt said. "These are confidential and must remain confidential." So it's neither yes or no.

But as many experts have observed, McLaren Automotive would bring to any potential suitor industry-leading expertise in advanced materials and lightweight construction, chassis and suspension technologies, aerodynamics and powertrain controls. It also is developing a pure electric car, albeit a very, very high-performance one.

## Winning in electrification

Compared to the automotive giants, McLaren is a minnow. It has huge technology potential, with a remarkable turnover-to-R&D-ratio enabler. Flewitt confirmed

## McLaren faces the electrified and autonomous future

**Interior of the McLaren 650S. The exhaust soundtrack is as good as the cabin looks but will customers miss the combustion 'music' that will be absent in future electric models?**

that McLaren Automotive's Track 22 R&D business-plan spend through 2022 will be £1 billion—and entirely self-funded.

"For a small company like ourselves, that is perhaps a large sum, but last year we put 30% of our turnover (£120M) into future-product investment and that is how we intend to move forward over the next six years," Flewitt explained. "In terms of our future-product strategy it is quite simple: sports cars. It will be a mix of series production cars and limited-production cars like the P1. But definitely no SUVs—we have no desire to make one."

One new model per year is the projected product cadence, with the upcoming EV "conceivably" plugged into the Ultimate Series level in its range. But again there is tantalizing haze around the project. Says Flewitt: "We have begun work on an electric vehicle. Probably you will not see it in the timeframe of the six-year business plan...but you may!"

For EVs to be truly efficient in terms of range, ride and handling, they have to be lighter than their combustion-engine counterparts. Any non-automotive industrial organization considering edging into that sector knows that lightweighting is absolutely vital. And McLaren is very good indeed at shaving away the kilos.

Flewitt has a neat phrase to encapsulate this: "We are now in a weight race, not a power race."

At present, the signs are that its electrification program will depend on batteries delivering a significantly improved energy

**McLaren's advanced, mixed-materials chassis construction with major structural elements in carbon fiber is a preview to future mainstream electrified-vehicle architectures.**

density, for greater range. The difficult part of the "fiercely independent" McLaren, though, is its dependence on battery producers. "It is a technology beyond our control," Flewitt admits.

What of a hydrogen-based fuel cell solution? "Not in McLaren's thoughts at this moment," he asserted.

The auto industry has embarked on what he terms a serious journey to develop and produce battery-electric vehicles. McLaren wants to be ahead of that curve, reflecting the McLaren Technology Group's maxim: "We exist to win in everything we do."

There are two McLaren companies: McLaren Automotive and the Technology Group that includes Applied Technologies and Racing. McLaren Automotive builds on F1 knowledge to create high-performance sports cars; McLaren Applied Technologies brings expertise in electronic systems, modeling, simulation and design engineering, its disciplines spanning health and wellness to transport and energy. And Racing, not surprisingly, is all about Formula 1.

All aspects of the McLaren companies demand an element of somewhat esoteric "emotions." These include that fabulous combustion soundtrack—but an EV's appliance-like whirr is unlikely to prove a soul-stirring attribute, as Flewitt and his teams are well aware.

A solution will doubtlessly be found. "Our engineers are getting their heads around that," Flewitt says. Meanwhile, the aural delights are certainly delivered

by McLaren's present model range that has three strata: Sports, Super and Ultimate.

## Driving with 'Inertia Push'

To help understand this "emotion" and other aspects of what makes a McLaren, the author was provided with the no-frills 478-kW (641-hp) 650S (Super Series) and the new, more cosseting 419-kW (561-hp) 570GT (Sports Series). Model nomenclature refers to PS output.

Dihedral doors and a high sill make the 650S marginally more difficult to enter than some jet fighters in which the author has flown, but that's all part of the image.

The car's MonoCell carbon-fiber chassis is claimed to be 25% stiffer than a comparable aluminum chassis. The 650S comes as a coupe and spider; no change in the tub's basic structure ensures requisite torsional stiffness.

Unlike some supercars, the 650S is driver-friendly in terms of visibility, ergonomics and driving position. Pedals and steering wheel are directly in front of the driver with no offset. Being all about performance, the 650S delivers impressive figures with accompanying "emotional" noise—but not to excess; it's mature, with nothing to prove.

The 650S's 3.8-L M838T twin-turbo V8 has a claimed peak torque of 678 N·m (500 lb·ft) to complement its power output. Acceleration from standing start to 100 km/h (62 mph) comes in 3.0 s and 200 km/h in a blistering 8.4 s.

McLaren explains that for maximum acceleration the car has "Inertia Push," a control algorithm that harnesses the engine torque levels, raising the rpm at a faster rate for each gear.

Transmission is a twin-clutch 7-speed. Ceramic brakes are


**The 570GT adds more comfort to provide what McLaren describes as a "luxury sports car."**

**The P1 was in McLaren's Ultimate range. A new pure electric McLaren supercar just might be, too.**

standard and on the latest version of the 650S, developed to be more progressive at high speed but with added predictability and modulation at low speed.

The Sports Series 570GT is the "luxury sports car" of the range, the luxury coming from a panoramic glass sunroof and a side-opening rear hatch that creates access to an additional 220 L (7.7 $ft^3$) of leather-decked luggage space, offering a maximum 370 L (13 $ft^3$).

The 570GT uses a carbon-fiber tub that weighs all of 75 kg (165 lb) and provides easier occupant access via lower sills. Visibility betters that of the 650S due to the A-pillars moved further outwards and narrower B-pillars. The use of superformed aluminum body panels marks a first for McLaren.

Despite a claimed 0-100 km/h time of 3.4 s, the GT is slightly less powerful than the 650S but retains the latter's muscular exhaust tone.

Driving both McLaren models on regular roads leaves lasting impressions not only of towering performance and adroit handling but also of comfort and easy, confidence-generating controllability—aspects that are not always supercar plus points.

So, could all this technology—and more to come—find a place in a takeover or partnership involving any company new to the auto industry? And still manage to remain "fiercely independent?"

Only time will tell. At present, McLaren will not. ■

# New Peugeot SUVs jump to modular platform, increase composites content


**Voila—le nouveaux SUV! The new Peugeot 5008's 7-seat, 3-row passenger accommodation precludes a hybrid version while its shorter 3008 cousin will get the HEV option.**

**PSA Peugeot Citroën** used the 2016 Paris Motor Show for the public launch of the Peugeot 3008 and 5008 models, now redefined as SUVs. The 3008 accommodates five passengers while the larger 5008 offers seven seats in three rows. Both models use the PSA Efficient Modular Platform 2 (EMP2), already employed on a number of the automaker's models including the recently revised Citroën C4 Picasso and C4 Grand Picasso, the Peugeot 308 C-segment model and the recently launched Peugeot Expert and Citroën Jumpy cargo vans.

The flexible EMP2 can be extended by adding 55-mm (2.1-in) extensions to the rear section of the platform. Bertrand Clergeot, 5008 SUV Project Director, explained: "From a structural point of view we have the front part and what we call the rear synthesis. The rear synthesis is the part that can accept extensions, so enables the wheelbase to be adjustable."

Clergeot noted that the front section is common with the 308, 3008, 5008, 308 SW and Citroën C4 Picasso. The rear section is modular. The construction enabled the 5008 to have nearly the same wheelbase as the C4 Picasso.

The idea behind the 55-mm extensions is that they give the engineering and design teams flexibility to match the wheelbase as closely as possible to their needs, while keeping the vehicle's overall length within European C-segment parameters. So the 5008 wheelbase represents three extensions more than the wheelbase of the 3008 and 4008, the latter built specifically for the Chinese market. It has one extension more than the 3008.

## PHEV coming in 2019

PSA's Grip Control driveline provides front-wheel-drive models with improved traction on different terrain and now includes a hill-descent control feature. "We've left the 4x4

systems because they are heavy and have high fuel consumption. I think that's not the trend today," Michel asserted.

As on the previous model, there will be a hybrid variant that will provide all-wheel-drive through an electrically-driven rear axle; 5008 models will not be offered with a hybrid powertrain because of the packaging difficulties of accommodating a third row of seats and a hybrid battery pack. PSA engineers are working on a plug-in hybrid version, which will be available in 2019, Michel said.

Weight reduction was one of the key program objectives of the new 3008 SUV according to Project Director Frank Michel. "We worked on new steels and new materials, to save thickness and save weight, including more aluminum and composite materials at the very beginning," he told *Automotive Engineering*. "This means that when we started to design the parts, we decided how much each part was supposed to weigh."

As a result, up to 100 kg (220 lb) was saved compared with the previous model. Mass-reduction measures include using aluminum for the hood and front fenders, which meant that the hood stamping tooling needed careful design to ensure the sharp creases in the hood outer were well defined. Peugeot engineers also saved mass using composite parts.


**Peugeot 3008 SUV features an aluminium hood and composite tailgate to reduce weight.**

"We optimized the thickness of the floor," said Michel. Part of the EMP2 platform involves composite material in the floor. He said the car's composite liftgate is the company's "third or fourth experience" with engineering composites in this application, in the ongoing quest to reduce vehicle mass by "100 g here and 100 g there."

Peugeot worked with **Michelin** on a new low rolling-resistance tire design, which Michel described as "tall and narrow," for the car.

New interior materials were chosen for the 3008, but Michel noted that it is difficult to find companies that can produce materials on the scale needed for car production. "We were involved in very specific activities to produce these new materials on an industrial scale," he commented.

**John Kendall**

# Mercedes EQ concept previews 2019 electric SUV

**Mercedes-Benz** officially revealed its comprehensive electrified-mobility strategy at the 2016 Paris Motor Show, while unveiling a new electric concept vehicle, the Generation EQ, that previews an electric SUV slated for production by 2019.

The new strategy, named CASE—which stands for Connected, Autonomous, Shared and Electric—incorporates all electric mobility-related activities under the EQ brand. These will include a diverse range of services including energy storage units, designed for both private and commercial customers and charging technologies, including inductive charging. Sustainable recycling will also be included.

Mercedes-Benz says that by 2025, the company aims to have more than 10 all-electric vehicles in its model range. Heavy investment, over €1B ($1.12B U.S.) will be made in battery production around the world. €500 M ($560 M) will be invested in a second battery production site in Kamenz, Germany.

Describing the new electric models, Dr. Thomas Weber, Member of the Board of Management of **Daimler AG** responsible for Group Research and Mercedes-Benz Cars Development, said, “The new generation of electric vehicles will be based on an


**The Generation EQ concept unveiled at the 2016 Paris auto show, previews a production electric SUV due to arrive by 2019. EQ is the new Mercedes brand for all EV related activities.**

**Practically all switchgear in the Generation EQ concept is operated by touch.**

architecture developed specifically for battery-electric models, which is scalable in every respect and usable across all models. It is suitable for all model series as well as sub-models, such as SUVs, saloons and coupés. Wheelbase and track are variable."

This dedicated architecture will incorporate two electric motors driving both front and rear axles, with a total power and torque output of up to 300 kW (402 hp) and 700 N·m (516 lb·ft). The Generation EQ concept car has a range of up to 500 km (310 mi), Dr. Weber claimed.

The design of the new EVs will include a specific "radiator" grille and new exterior lighting treatment. Inside, the only traditional switchgear to survive will be the electric seat adjustment switch. All other controls will use touch-sensing switchgear.

This includes the steering wheel spokes, where the touch controls are integrated into Organic Light Emitting Diode (OLED) displays. A 24-in (609-mm) TFT dashboard display carries all relevant driver information. The displays can be customized to suit individual needs.

The scalable architecture of the new EVs will provide for varying wheelbase lengths and track width. Battery architecture will also be scalable using a modular system, with the batteries contained in the floor section within the wheelbase. Mercedes-Benz has chosen to build the cars in a mixture of steel, aluminum and carbon fiber.

Features include tight panel gaps, concealed windscreen wipers, cameras replacing conventional door mirrors and no conventional door handles. The front features a black panel with a three-pointed star illuminated in white and surround illuminated in blue, with LED headlamps. At the rear LED optical fiber illuminates the rear panel surround and switches to red when the vehicle is moving, providing a tail light function.

The concept EQ will illuminate automatically when the driver approaches, with digital lighting embedded in the interior door panels. Mercedes-Benz mapping partner **HERE** (co-owned with **BMW** and **VW Group**) will provide mapping that can integrate with autonomous drive functions.

**John Kendall**

# 2017 Nissan Rogue adds hybrid system with EV-only mode

**Nissan** gives its Rogue compact crossover utility a hybrid-electric powertrain option for model year 2017, boosting the estimated fuel efficiency of the front-drive model to 33 mpg city/35 highway and that of the all-wheel-drive version to 31 mpg city/34 highway. That's an increase of approximately 5 mpg combined city/highway for both the FWD and AWD hybrids versus the standard Rogue.

"The CUV segment is on fire in the U.S. and that's why we're putting a lot of emphasis on this segment," said Ty Webb, Senior Manager of Rogue Marketing for Nissan North America. He said Rogue is poised to become Nissan's top-selling model, overtaking the Altima midsize sedan.

Rogue Hybrid provides a full EV mode, unlike the milder hybrid systems on the 2014 MY Pathfinder, which ceased production in 2015, and the current midsize Murano CUV.

**Nissan's Motohisa Terada, group manager of electric powertrains, with the 2017 Rogue Hybrid.**

"The electric-only mode on the Rogue Hybrid automatically engages when the vehicle is coasting at highway speeds up to 75 mph, and for a short time during speeds up to 25 mph," according to Motohisa Terada, Manager of Electric Powertrain Project Group for Nissan Motor Co., based in Kanagawa, Japan.

Terada and other Nissan technology product experts spoke with *Automotive Engineering* during a recent ride-and-drive program. While the conventionally-powered 2017 Rogue is powered by a 170 hp (127 kW) 2.5-L gasoline I4, the new Hybrid model features a 2.0-L 4-cylinder gasoline engine generating 141 hp (105 kW) at 6000 rpm and 144 lb·ft (195 N·m) at 3600 rpm combined with a 30-kW (40-hp) e-motor for a combined system rating of 176 hp (131 kW).

## Packaging the battery

The Rogue Hybrid driveline uses Nissan's one-motor/two-clutch Intelligent Dual Clutch Control system in which a wet clutch is located in the traditional torque-converter space between the engine and e-motor and a dry clutch is fitted between the motor and the **JATCO**-supplied Xtronic CVT. The dry clutch is used only to start-stop the engine. The overall system design

allows the engine and e-motor to operate flexibly and offer the electric-only mode depending on load and driving situations.

A **Hitachi**-supplied 56-cell lithium-ion battery pack is located under the cargo deck, resulting in a slightly higher floor height. That height difference means the standard Rogue's 18-configuration Divide 'N Hide cargo system isn't part of the hybrid vehicle's cargo bay.

In addition, the second-row seat in the hybrid vehicle doesn't have 9 in (229 mm) of seat travel like the standard Rogue, according to Brian Wilson, Nissan North America's Product Planning Department Manager for Nissan Vehicles.

"Battery packaging didn't affect the cargo area," Wilson said, noting that both the standard and the hybrid Rogue have more than 61 $ft^3$ of stowage space behind the first seating row.

## Electric A/C system

Rogue Hybrid's electric A/C system is an application-first for a Nissan vehicle in North America. Said Terada, "If we used a mechanical A/C system, the A/C would stop during engine idle when the stop/start technology is activated. With the electric system, the flow of cool air isn't interrupted when the Rogue Hybrid is in an idle stop/start mode."

Paul Cullen, drivability engineer at Nissan's Arizona Testing Center, said both

**The 2017 Nissan Rogue Hybrid, offered in FWD and AWD, is expected to provide an additional 5 to 8 city/highway mpg on average.**

the standard hybrid versions of Rogue have similar acceleration G-force curves. "The tuning of the powertrain is not a mirror image between the standard and hybrid Rogue, but the performance will feel similar to a driver," Cullen said.

Rogue Hybrid's high-output Li-ion battery pack charges and discharges quickly, contributing to high-speed, precise control of the electric motor and optimum clutch control as well as enabling quiet and quick acceleration, according to engineers.

"We have a great hybrid vehicle that has a nice balance of performance and fuel economy as well as a seamless transition between the electric-only mode and the ICE-only mode," Cullen said.

Pricing will be announced closer to Rogue Hybrid's production launch in late 2016. The warranty for the battery pack and inverter unit covers 8 years or 100,000 miles.

**Kami Buchholz**

# Renault's kids' racer


**Renault Clio Cup Junior championship race car for 14- to 17-year-olds. It is based on Renault's Sport 220 Trophy.**

The strategy of using junior racing to interest youngsters in automotive engineering careers gets a boost in Europe with **Renault**'s decision to launch a UK Clio Cup Junior Championship for 2017.

Drivers will be from 14 to 17 years of age and will be competing in race cars capable of running 160 km/h (100 mph).

The announcement closely follows Renault's announcement of its 2017 model range, in which the road-going Clio gets two fresh powertrains, a 1.5-L dCi 110 turbodiesel 4-cyl. and 1.2-L TCe 120 gasoline 4-cyl., the latter driving through a 6-speed manual gearbox. The most powerful new Clio model is the turbocharged 1.6-L Trophy, making 217 hp that can accelerate the car from 0-100 km/h in 6.6 s and on to a top speed of 146 mph (235 km/h).

## Racing hoped to stoke interest in engineering

Scheduled to start next year, the UK Junior Clio Cup already has gained outline approval from the championship control panel of the Motor Sports Association (MSA), the UK motorsport governing body. The new junior series' spec race car is based on Renault's Clio Sport 220 Trophy.

Teams will use identical racing versions of the Sport 220 trophy, which also is used by adult drivers in Renault Clio Cup series that races in conjunction with the **Dunlop** British Touring Car Championship.

The junior-league drivers are expected to become familiar with all aspects of the cars they race. Turbocharged 1.6-L direct-injection engines employ **Cosworth** SQ7 Di – XAL electronic controls. The gearbox is a

**Sadev** ST82-17 6-speed sequential automated manual—but with sixth gear blocked via an ECU modification. Steering wheel-mounted paddle shifters mirror the gear-shift interface used by the Clio Cup racers.

A Sadev 23/90 self-locking limited slip differential is fitted and tires are **Michelin** Pilot Sport 3. Maximum power output is limited by MSA Junior regulations and with only a 5-speed gearbox to limit top speed to 160 km/h.

Because the modifications for the juniors' cars are described by Renault as being "simple" (i.e. mainly electronic) these can be adapted, so the same car may be used in both Clio Cup categories.

The junior racing cars also are fitted with a steel roll cage.

Will Fewkes, Renault Sport UK's Motorsport Championship Manager, said: "We hope that a Junior entry-level championship, with backing from Renault UK and, centrally, Renault Sport Racing and all the associated expertise and professionalism, will appeal to smaller racing outfits and also to more female drivers. We feel this marks a real shift in the junior-racing marketplace."

Renault UK Communications Manager Jeremy Townsend, added: "This marks the first time we have entered the junior racing marketplace. Extensive testing of the UK Clio Cup cars shows that it can easily complete a full season of both Clio Cup categories without need for engine rebuilds—the product really is that good in terms of engineering and reliability."


**Ready for racing in 2017, Renault said its Clio Cup car can be easily modified to be raced by young teenage drivers (junior category) as well as serving in the existing adult-driver series.**

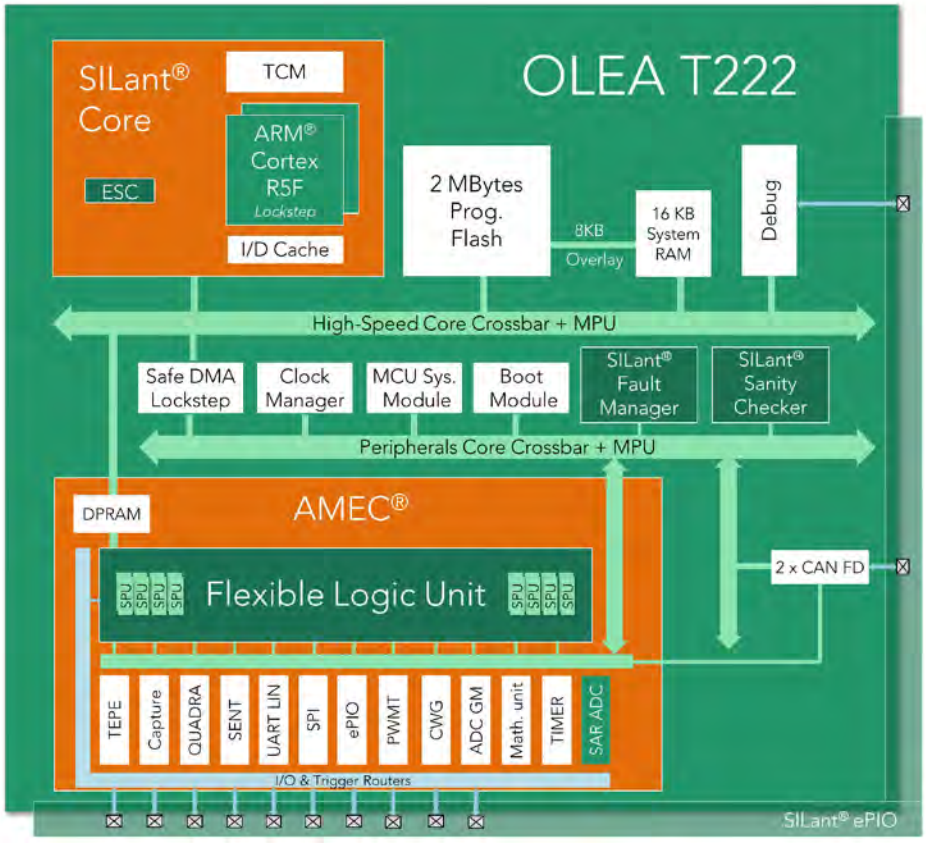
Renault subtly links high performance with safety; shortly after it announced the Junior Clio Cup plan, it revealed that the 2017 Mégane-based Scénic has received a 5-star safety rating from Euro NCAP.

The award makes it the 20th Renault model to receive a top NCAP rating. The Scénic has active emergency braking with pedestrian protection as standard, claimed as a first in its segment. Euro NCAP gave it a 90% score for adult occupant protection, 82% for children and 67% for pedestrians. Parts of the car's structure are described as "ultra-high elastic"—each square mm can resist up to 120 kg of pressure.

**Stuart Birch**

# SPOTLIGHT: ENGINE COMPONENTS

## Hybrid and electric powertrain microcontroller




**Silicon Mobility**'s (Sophia-Antipolis, France) OLEA T222 automotive microcontroller is a dedicated solution for hybrid and electric powertrain control. According to company claims, it is the first-ever automotive microcontroller with embedded, robust and secured programmable logic. Based on a standard ARM Cortex-R5F CPU running at 200 MHz, OLEA T222's flexibility, hard real-time parallel processing and safe architecture makes it suitable to control all types of hybridization—micro, mild or full, including integrated belt starter-generator, crankshaft motor-driven generator, gearbox motor-driven generator, in-wheel motor or in-axle motor, dc/dc converter, and full electric powertrains. OLEA T222's technologies and feature set address other applications and make it a suitable controller for a battery-management system, exhaust or selective catalytic reduction systems or even a conventional internal-combustion engine. OLEA T222 directly contributes to a vehicle's $CO_2$ emissions reductions by enabling the democratization of electrification, says Silicon Mobility. For more information, visit **www.silicon-mobility.com**.

# SPOTLIGHT: ENGINE COMPONENTS

## Engine, transmission and alternative-drive seals

**Freudenberg Sealing Technologies** (Plymouth, MI) has expanded its LESS (Low Emission Sealing Solution) lineup to include new products designed to address challenges associated with powertrain friction, smaller spaces, lighter weight vehicles and growth in the electric mobility vehicle arena. Covering the engine, transmissions and electric mobility product groups, the LESS portfolio was developed to focus on four core areas: emissions, friction, weight reduction and downsizing. One of the products in the portfolio suitable for the reduction of emissions and friction is the gas-lubricated mechanical face seal Levitex (pictured), which lowers $CO_2$ emissions by up to 1 g of $CO_2$ per km during driving, says the company. The Levitex seal also promotes a longer operating life by reducing powertrain wear. The seal's greater pressure stability is assisting with new developments in engine technology. According to Freudenberg, a German manufacturer has selected Levitex for its first series-production order. For more information, visit **www.fst.com**.

## Fan selection application

The OPTIMISER 10 Fan Specification App, from supplier of high-performance axial-flow fans **Multi-Wing America** (Burton, OH), is a resource for original-equipment engineers to specify the most-efficient, tailor-made Multi-Wing fan for their application. The app is suitable for specifying fans in several applications, including engine cooling in off-highway equipment and power generators. It features an intuitive user interface, advanced natural-frequency sound calculations and visual display of total efficiency on the fan performance curves. OPTIMISER 10 also offers blade-profile previews with available diameter ranges, materials and rotations. For more information, visit **www.multi-wing.net**.

## Biodiesel hoses

GH100 and GH101 hoses from **Eaton** (Eden Prairie, MN) are suited for high-percentage biodiesel blend and high-temperature oil applications. Engineered for maximum performance in systems with a variety of fuel types, the hoses feature a unique polymer that more effectively resists degradation. The GH100 and GH101 are designed to perform in high-temperature mobile applications, including trucks, buses, agriculture and construction equipment and eco-friendly power vehicles.


Compatible with high-percentage biodiesel fuels and new synthetic oils, the GH100 and GH101 support a longer hose life while also ensuring safety requirements and quality standards are met. They are qualified for -40 to +150°C (-40 to +302°F) with B2, B5 and B20, -40 to +125°C (-40 to +275°F) with B100. For more information, visit **www.eaton.com**.

## Arc suppressors


NOsparc arc suppressors from **Arc Suppression Technologies** (Bloomington, MN) are designed for both AC and DC power applications. The AC products are currently produced to operate between 100-V AC and 480-V AC while DC products operate from 12-V DC through 250-V DC. The company claims the devices suppress 99.9% of the electrical arcing in relays, which increases their operational life and saves the cost of up to nine replacement relays, as well as protects the associated motors from failing. This off-the-shelf technology is easy to install, says the company, and may be used in any electromechanical switch application, including automotive and precision manufacturing. For more information, visit **www.arcsuppressiontechnologies.com**.

## Noise and vibration-resistant rotary latch

**Southco**, Inc. (Concordville, PA) has launched the stainless steel R4-10 rotary latch with integrated bumper that can be combined with the company's line of mechanical and electronic actuators and cables for a complete rotary latching system. Available in single- and two-stage options, the R4-10 features an integrated rubber bumper that eliminates noise and vibration

caused by normal operation. The R4-10 with integrated bumper features a design that traps the striker between a rubber bumper and rotor. Without extra clearance or room to move, any noise potential that could be caused by metal-on-metal movement or vibration is eliminated. The stainless steel version offers corrosion resistance for consistent performance in harsh environments. For more information, visit **www.southco.com**.

# AD INDEX

| ADVERTISER | PAGE |
|---|---|
| Anritsu Company | 5 |
| Evonik Cyro LLC | Opp. Front Cover |
| Fujipoly Inc. | 9 |
| Kaman Precision Products | 11 |
| Omega Engineering | Cover 2 |

Digital *Automotive Engineering*©, December 2016, Volume 3, Number 3. Digital *Automotive Engineering* (ISSN 2331-7647) is published 3 times a year by Tech Briefs Media Group, an SAE International®, 261 Fifth Avenue, Suite 1901, New York, NY 10016. 
(ISSN 2331-7647 digital)
(ISSN 2331-7639 print)



# RESOURCE LINKS

Sales Team
Contact Us
Archives
SAE Board of Directors
SAE Membership

# UPCOMING
## FROM THE EDITORS

**DECEMBER 1**
**Aerospace Engineering**
Technology eNewsletter

**DECEMBER 5**
**Automotive Engineering**
Technology eNewsletter

**DECEMBER 13**
**Off-Highway Engineering**
Technology eNewsletter

**DECEMBER 15**
**Automotive Engineering**
Technology eNewsletter

**JANUARY**
**Automotive Engineering**
Print Magazine
- Sensors
- ADAS technologies
- Sensors product spotlight

**JANUARY 5**
**Aerospace Engineering**
Technology eNewsletter

**JANUARY 11**
**Automotive Engineering (CES coverage)**
Technology eNewsletter

**JANUARY 18**
**Truck & Off-Highway Engineering**
Technology eNewsletter

**JANUARY 19**
**Aerospace Engineering**
Technology eNewsletter

**JANUARY 26**
**Automotive Engineering**
Technology eNewsletter

# OTHER MAGAZINES FROM SAE INTERNATIONAL


**Aerospace & Defense Technology**
magazine.sae.org/aero

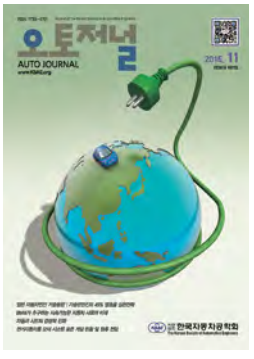

**SAE Off-Highway Engineering**
magazine.sae.org/ofh


**SAE Update (SAE members)**
www.sae.org/update


**Momentum (SAE student members)**
magazine.sae.org/mom


**Mobility Engineering (India)**
http://magazine.sae.org/meindia/


**Engenharia Automotiva e Aeroespacial (Brazil)**
www.sae.org/magazines




**Auto Journal (Korea)**
www.sae.org/magazines


**Automotive Engineering China Edition**
www.sae.org/magazines


## EDITORIAL

**Bill Visnic**
Editorial Director
Bill.Visnic@sae.org

**Lindsay Brooke**
Editor-in-Chief
Lindsay.Brooke@sae.org

**Ryan Gehm**
Associate Editor
Ryan.Gehm@sae.org

**Jennifer Shuttleworth**
Associate Editor
Jennifer.Shuttleworth@sae.org

**Lisa Arrigo**
Custom Electronic Products Editor
Lisa.Arrigo@sae.org

### Contributors

**Kami Buchholz**
Detroit Editor

**Stuart Birch**
European Editor

**Jack Yamaguchi**
Asia Editor

Steven Ashley, Dan Carney, Terry Costlow, Richard Gardner, John Kendall, Bruce Morey, Linda Trego, Paul Weissler

## DESIGN

**Lois Erlacher**
Creative Director

**Ray Carlson**
Associate Art Director

## SALES & MARKETING

**Joe Pramberger**
Publisher
joe@techbriefs.com

**Debbie Rothwell**
Marketing Director
drothwell@techbriefs.com

**Martha Tress**
Recruitment Sales Manager
+1.724.772.7155
Martha.Tress@sae.org

## REGIONAL SALES

### North America

**New England/Eastern Canada:**
ME, VT, NH, MA, RI, QC
**Ed Marecki**
+1.401.351.0274
emarecki@techbriefs.com

**CT:**
**Stan Greenfield**
+1.203.938.2418
greenco@optonline.net

**Mid-Atlantic/Southeast/TX:**
MD, DC, VA, WV, KY, TN, NC, SC, GA, FL, AL, MS, LA, AR, OK, TX
**Ray Tompkins**
+1.281.313.1004
rayt@techbriefs.com

**NY, NJ, OH:**
**Ryan Beckman**
+1.973.409.4687
rbeckman@techbriefs.com

**PA/DE:**
**Desiree Stygar**
+1.908.300.2539
dstygar@techbriefs.com

**Midwest/Great Lakes:**
IN, MI, WI, IA, IL, MN
**Chris Kennedy**
+1.847.498.4520, x3008
ckennedy@techbriefs.com

**Midwest/Central Canada:**
KS, KY, MO, NE, ND, SD, ON, MB
**Bob Casey**
+1.847.223.5225
bobc@techbriefs.com

**Rocky Mountain States/NM:**
CO, ID, MT, UT, WY, NM
**Tim Powers**
+1.973.409.4762
tpowers@techbriefs.com

**Southern CA, AZ, NV:**
**Tom Boris**
+1.949.715.7779
tomboris@techbriefs.com

**Northern CA, WA, OR, Western Canada:**
**Craig Pitcher**
+1.408.778.0300
cpitcher@techbriefs.com

### International

**Europe – Central & Eastern:**
**Sven Anacker**
**Britta Steinberg**
+49.202.27169.11
sa@intermediapartners.de
steinberg@intermediapartners.de

**Europe – Western:**
**Chris Shaw**
+44.1270.522130
chris.shaw@chrisshawmedia.co.uk

**China:**
**Alan Ao**
+86.21.6140.8920
alan.ao@sae.org

**Japan:**
**Shigenori Nagatomo**
+81.3.3661.6138
Nagatomo-pbi@gol.com

**South Korea:**
**Eun-Tae Kim**
+82-2-564-3971/2
ksae1@ksae.org

## Integrated Media Consultants

**Angelo Danza**
+1.973.874.0271
adanza@techbriefs.com

**Patrick Harvey**
+1.973.409.4686
pharvey@techbriefs.com

**Todd Holtz**
+1.973.545.2566
tholtz@techbriefs.com

**Rick Rosenberg**
+1.973.545.2565
rrosenberg@techbriefs.com

**Scott Williams**
+1.973.545.2464
swilliams@techbriefs.com

## SUBSCRIPTIONS

+1.800.869.6882
AEI@kmpsgroup.com