

INTERVIEW: ON THE RIGHT COURSE WITH NEXTEER FOCUS ON: Vehicle simulation

MULTI-MATERIAL Structures

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SUVs and connectivity loom big at IAA



There were a few recurrent themes at this year's IAA in Frankfurt: it was virtually impossible not to see an SUV on most manufacturers' stands and those that weren't displaying them were making known their intentions to do so.

It's a phenomenal shift in customer tastes that is, probably, unparalleled. There might have

been a boom in hatchbacks, but that style has been the preserve of small family cars; certainly, the likes of Bentley never contemplated such a move. But SUVs, that's a different matter, and, as you can read on pages 18-22, its Bentayga is no VAG clone, but a new product in its own right.

Meanwhile, such is the surge in connectivity, that the organisers dedicated a hall to the technology.

Booth after booth displayed systems that calculate the most efficient routing. Intelligent transport systems (ITS) can have a profound impact on fuel consumption and emissions, as president of the European Automobile Manufacturers' Association (ACEA), Carlos Ghosn, outlined in his presentation.

According to the ERTICO study, in-vehicle eco-navigation systems (dynamic navigation tools that use real-time data to reduce fuel) have a 5-10% emissions reduction potential. Ecodriving systems – which recognise driving behaviour, and provide the driver with on-trip advice and post-trip feedback – can bring down emissions by 5-20%.

Regarding infrastructure, the two highest potential measures are traffic signal coordination and parking guidance. Giving drivers real-time advice on traffic signals and guidance to find a parking space could produce a further 10% savings in CO2 emissions for equipped vehicles in areas where these systems are deployed. And that infrastructure investment is down to European governments to get their collective acts together and not leave improving emissions just to the motor industry.

Ian Adcock, Editor in Chief

September 2015

Porsche launches eliminate 'Achilles heel'



Porsche has unveiled its latest three-litre flat-six engine, now with direct injection and twin turbochargers. It is 41 years since Porsche announced its first turbocharged engine developing 194kW and a fuel consumption of 20.9I/100Kms; its descendent – which shares the same 80mm bore spacing – has an output of 272kW and an NEDC fuel consumption of 7.4I/100kms.

At launch, Porsche is presenting two engines – the 272kW, 450Nm Carrera and the 309kW, 500Nm Carrera S – with both engines sharing the same 91mm bore and 76.4mm stroke, 10:1 compression ratio and rev bands with maximum power delivered at 6,500rpm and peak torque from 1,700 to 5,000 rpm and a 7,500rpm maximum engine speed.

Porsche claims that the Achilles heel of blown engines, turbo lag, has been eliminated in the new engine with a patented electro-pneumatic system, so that instant boost is always available. This is achieved by



opening the throttle to develop more speed and pressure in the turbo for quicker response, in combination with a unique control strategy for the variable inlet and exhaust camshafts and wastegate positioning whilst advancing the ignition.

This combines with the mode switch on the steering wheel: when engaged, it automatically engages the right gear to keep the engine in its optimum operating range of 4,500-5,000rpm for up to 20 seconds.

The engineering team, led by director powertrain product line 911, Thomas Krickelberg, developed an entirely new block manufactured from hypereutectic aluminium that is 1.5Kgs lighter than the old block; cylinder liners are now iron coated by plasma beam. This, he says, reduces fuel consumption and, with one eye on emerging markets like India and China, allows the engine to better cope with varying fuel grades.

A centrally located injector in each cylinder injects fuel at 250 bar for

Electric turbocharger offers choice of power modes

Pierburg has developed an electric turbocharger that can be powered by either 12v or 48v. The 'electric Air Charger' (eAC) also has the advantage of being able to be located anywhere within the airflow stream, making it ideal for multistage supercharging systems. Because of the intermittent nature of its operation, the eAC can be used in parallel with a bypass system that connects the eAC in series with an exhaust driven supercharger or delivers air directly to the engine, bypassing the eAC.

It is compatible with both diesel and petrol engines and is rumoured to be in series production in the 2017-18 timeframe with a 12v system on a small capacity diesel engine. Unlike some e-boost systems, Pierburg's runs wear-free, employing a brushless DC motor with permanent magnets, rather than switched reluctance magnets.

Depending on the application, it consumes between 3-4 kW power and is capable of spinning up the turbo to peak boost within 220-230 m/secs for the 48v or 12v system, respectively.

A modular system, it can be scaled to the engine and the OEM's target. "It can be applied to a sporting, high performance



optimum atomisation and low wall wetting for improved CO₂ emissions; each bank has its own high pressure fuel pump. Further weight has been saved by using a composite oil pan, 2kgs lighter than the previous generation engine.

The flat-six engine, with its low-mounted turbos on each side, presented Krickelberg's team with some significant lubrication challenges. As a result, the oil pump uses three soak pumps, one each for the cylinder heads and a third for both turbochargers, each of which has its own oil canister that needs evacuating, recirculating the lubricant back into the system.

Additionally, there are two pressure pumps: one steady state that provides the main oil pressure of 2-3 bars and a fully variable pump that reacts in accordance to engine speed, loads and acceleration. "It's not a unique solution, but we don't have gravity on our side with a flat-six engine unlike an in-line or Vee," said Krickelberg.

Both the air-conditioning and water pumps can be deactivated via clutches, so neither draws on any engine power. This allows the engine to reach 90°C operating temperature more rapidly before settling back to 85°C under normal running when the coolant circulates more slowly.

Intelligent overrun cut-off

Intelligent overrun cut-off occurs when the driver lifts off the accelerator – for instance, on a motorway descent. First, the drive control system switches to a coasting mode with open clutches, with the engine idling. If the car's speed increases, intelligent overrun cut-off is activated to engage the clutch and shut off the engine. The automatic stop-start system has also learned to interrupt the flow of fuel early when rolling to a stop. This combination automatically improves fuel economy, without the driver noticing changes in the car's handling.

The virtual intermediate gears have the same fuel-saving effect, reducing revs during quieter driving. If shifting to the next higher gear would drop revs below the engine's lower rev limit, the transmission controller engages adjacent gears, controlling both clutches for defined slip to transmit the power, so that, when the driver accelerates, the dual clutch gearbox rapidly downshifts to the optimum gear.

engine; the other could be downsized, which isn't in principle capable of supplying sufficient low end torque," Pierburg advised.

The first-tier supplier also predicts that diesel engines will be a key application to combine both a sporty response and emission control, because two-stage boosting systems have a heat mass, so the after-treatment system isn't brought up to temperature quickly enough. Having an e-booster to address the main engine power allows the OEM to play with selective catalyst reduction (SCR) to bring it up to operating temperature.

Simulations suggest that eAC could save between 3-5% in fuel economy in the NEDC cycle.

Although the system will likely prove less costly than in-series turbocharging systems, Pierburg warned that a secondary 48v system, including batteries and a DC-DC convertor, would push costs up; whilst; with a 12v version; there's a need to compensate for a higher current consumption using a buffer battery.

Pierburg claims its big breakthrough was configuring a sealing system to protect the roller bearings and the sealing of the motor and electronics to prevent the ingress of humidity, oil and soot.

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Dynamic cylinder deactivation system revealed

Delphi has created a joint venture with Tula Technology to develop its ground-breaking Dynamic Skip Fire (DSF) cylinder deactivation system, claimed to be the industry's first individual cylinder deactivation system capable of delivering improved fuel efficiency, whilst managing engine noise, vibration and harshness (NVH). In independent tests, DSF has improved fuel efficiency by 17%, as measured on a CAFE basis when compared to a vehicle that does not have cylinder deactivation.

Tula's revolutionary control approach integrates advanced digital signal processing, derived from consumer electronics technology, with sophisticated powertrain controls, to create what it described as the ultimate variable displacement engine.

DSF technology does not rely on fixed cylinder deactivation or switching between fixed patterns. Rather, it continuously makes dynamic firing decisions on an individual cylinder basis



to deliver the required engine torque for all vehicle speeds and loads, while avoiding unwanted vibration, but delivering optimal fuel efficiency over a wide range of driving conditions.

Matthew Younkins, Tula's chief engineer powertrain, explained that DSF can go from

"Zero to all cylinders, and any fraction between, allowing you to match the number of cylinders to the required torque need from the engine".

Largely a software company, Tula has developed a set of software algorithms that allows the engine management control to decide whether to fire or not fire every cylinder

Particulate emissions targeted ahead of Euro regs

Tenneco introduced its oval-shaped gasoline particulate filter (GPF) at the 2015 Frankfurt Motor Show, designed for gasoline direct injection (GDI) engines to reduce particulate emissions in compliance with the Euro 6c emissions regulations, which take effect in September 2017.

Although GDI engines help improve fuel economy and reduce CO2 emissions, they can have higher particulate emissions due to shorter in-cylinder fuel/air mixing times, compared with multiport fuel injection engines. Advanced fuel injection strategies are currently used to control gasoline particulate emissions in-cylinder, but they are designed for a particular emission test



cycle and may be less effective under real driving conditions. Gasoline particulate filters effectively control particulate emissions under all operating conditions.

"The cut-off is currently 23 microns," said Frank Terres, executive director, core science, advanced engineering and hot end development, Tenneco Clean Air, "but there's ongoing debate that could see it reduced to ten and that will create issues trying to engineer engine developments to meet that criteria."

GPFs use the same type of wall-flow substrates as diesel particulate filters and can be included in the exhaust system in addition to the series three-way catalyst, or the catalyst coating can be directly applied to the filter substrate to form a four-way catalyst. Tenneco has successfully adapted its canning technology to accommodate these highly porous, fragile substrates.

"The advantage GPFs enjoy over diesel particulate filters is that, because they run at 550°-600°C, there's no need for regeneration, as that will occur under normal operating conditions. It is, however, important to monitor soot levels with a sensor via the engine calibration as a precaution." The first applications are predicted to be "heavy cars with small 1.6-1.8-litre capacity" engine.

Tenneco also launched two new dampers: the CVSA2 (pictured) and its DRiV Smart Damper. CVSA2 is Tenneco's newest generation of lightweight semi-active dampers. It offers significant improvements in ride performance from single valve technology, as each damper features two independent electrohydraulic valves for the rebound and compression motions to provide an increased tuning range for even greater vehicle dynamics and higher comfort levels.

It will be launched on a luxury car later this year and, said Rudi Schurmans, executive director, global engineering, Tenneco Ride Performance, bridges the gap between the CVSAe and CV2A2/Kinetic dampers. DRiV Smart Damper has a range of 2 to 4 digital valves for up to 16 settings. Switching time is limited by hydraulic reaction to around 10 m/secs, but, added Schurmans, power consumption is minimised, as energy is only demanded during compression or rebound.

event to produce the torque –and with that scheduling facility reduce pumping losses in the engine, without creating unwanted NVH.

The software becomes an integral part of existing engine management strategy, determining whether to fire the next cylinder or not and make a transition from one sequence to another. "When competitive systems go from 3 to 6 or 4 to 8 cylinders, they get a bump in torque. We don't do that; we go from 2 to 2.4 or 3.2, up to 4, so we change the number cylinders fired in an analogue manner, maintaining the torque whilst we do that, so we don't have to pull the spark to achieve that smooth transition," explained calibration engineer Steven Carlsson. "You can't fire 0.4 of a cylinder; you can fire 24 out of 100 to get 2.4 roughly on average," he added.

As each cylinder closes down, it acts as an air spring, but the system also requires that a deactivatable valve train is demanded. "We're

working with Delphi, to put one together," explained Younkins, adding "on both the inlet and outlet side, driven by hydraulic pressure from the oil system, although it could be electrified if the OEM chose".

Company origins

The company was founded in 2008 by Dr Adya Tripathi, a former Silicon Valley digital signalling processing expert, now with more than 100 patents to his name for DSF. He took his knowledge from working with audio amplifiers to see if frequency content could be applied to the internal combustion engine.

Said Younkins: "You need to know the engine speed, requested load, but now have an extra degree of freedom that influences throttle position etc, and apply it to the current generation of powertrain, without a whole lot of problems, apart from modifying the valve train. So it could be deactivating lifters on a pushrod. The four-cylinder has a lash adjuster, roller finger follower and a hydraulic system that deactivates the roller finger follower."

Demonstrator vehicles have been running for five years and are now being demonstrated to potential OEMs and Tier Ones, Delphi being the partner for industrialisation.

Younkins was cautious about when DSF would be production ready, beyond saying Tula would have its own project running by the end of 2016 on a four-cylinder engine to prove out the concept.

Typical fuel savings are in the region of 17-18% on a 6.2-litre V8 , with a projected gain of up to a 10% on four cylinder engines.

An invisible transition between the number of cylinders firing is difficult to achieve. Tula does this by pushing the vibrations outside of low frequency range of 0.5 to 12Hz detected by vehicle occupants using the embedded algorithms.

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News in brief

Ford embraces Micromill

Ford will use Alcoa's Micromill material in multiple components on the 2016 F-150, becoming the first automaker to use the advanced automotive aluminium commercially. The companies entered into a joint development agreement to collaborate on next-generation aluminium alloys for automotive parts using Micromill technology. It is projected Ford's use of Micromill on its vehicles will more than double from 2016 to 2017.

NVH solution for OEMs

BASF is expanding its expertise in top mounts to provide OEMs with a combination of weight savings, good acoustics and vibration damping. This NVH (noise, vibration, harshness) solution is made possible by combining two of BASF's plastic specialties: the micro-cellular polyurethane elastomer Cellasto and the highly glass-fibre-reinforced polyamide Ultramid A3WG10 CR. The top mount with the Cellasto element and the Ultramid housing is around 25% lighter than conventional aluminium die-cast versions with rubber.

Indoor tyre facility

Camber Ridge is opening an indoor tyre facility in Charlotte, North Carolina (USA). Tyres will be tested on a unique indoor paved 0.5 mile (0.8Km) oval, using specially developed test carriages that are propelled along a guide rail system at up to 65 mph (105 Km/h). Initial running will be on dry reference surfaces at a controlled ambient temperature, but the facility is being designed for phased introductions of additional paved surfaces, water testing and other controlled conditions.

Test bench connection

FEV and the Institute for Combustion Engines of the RWTH Aachen University (VKA) have implemented a virtual connection between two test benches. The test environment consists of spatially separated test benches, which are connected by a real-time deterministic EtherCAT connection. "The dynamometers in both test benches are controlled in a way that achieves the equivalent system behaviour of a real mechanical shaft," it was confirmed.

New Astra hatch body shell is 20% lighter

Opel/Vauxhall's new Astra hatch body shell is 20% lighter at 280Kgs than the previous car with improved weight distribution, which included moving the battery from the engine compartment to beneath the boot floor at the rear, altering weight distribution to 60:40 front to rear, says vehicle line director Horst Bormann.

"The old Astra was up to 65% front, which makes it difficult to tune a car with too much under-steer to outperform our rivals with an engaging drive and good response." The



biggest contribution to reducing weight was in the body shell where GM took about 20% or 77Kgs mass reduction. "This was extremely challenging and only possible by analysing the

The beauty behind 3-D printing

"Many people are capable of designing beautiful cars; our job is to design a new experience for tomorrow's customers," says Matthias Hossann, head of concept cars and advanced design at Peugeot. And whilst his latest concept car, the Fractal, has been developed with the intention of providing electric vehicle (EV) drivers with an emotional, aural experience by collaborating with sound engineer Amon Tobin and StelLab - a PSA Peugeot Citroën research unit that has designed an innovative '9.1.2'sound system combining a high-quality set-up that features tactile bass systems built into the back of each seat - it is the extensive use of 3Dprinting that made the car possible.

Hossman's team was inspired by the concept of Fractal design to create the interior's semi-anechoic chamber architecture. "We worked with parametric design, using algorithms to define the shape and then apply it to all the lower shape, allowing the computer to automatically generate the shapes. Only 3D-printing allowed us to build the interior, as they were impossible to achieve using classic injection moulding."

More than 80% of the interior was built using 3D-printing and whilst some of the surfaces were covered, others, like the multimaterial steering wheel and the mono material head rest brackets, are as they emerged from the printer. Additive manufacturing was also used, says Hossman, for the rocker panel, grille and parts of the light systems.

"For the interior, we combined many, smaller, parts to assemble a complete section. 3D-printing is quicker for a concept car and for a designer it allowed us to create a new generation of shapes that would be completely impossible to do with conventional





optimum material quality and gauge. For example, the 'B' pillar has ultra high strength material, where those areas don't need to carry loads are standard gauge."

moulding or other processes; and, in terms of efficiency, like the steering wheel, it is as strong as a traditional wheel, but lighter. It's unusual that, despite being thin, it's hollow, so we can run all the wiring through it.

"Tomorrow, 3D-printing is a new industrial revolution; today, it's still experimental," he added. "But I do believe that, in the future, it will really change the way we conceive things, and allow us to personalise and customise interiors for individual customers."



Aluminium has been used in the front bumper crash structure. The chassis, he added, is 50Kgs, lighter, with every part redesigned; the engine sub frame and the rear axle control arm are now a variety of sheet metal, rather than solid. With the car's overall weight now reduced, that has enabled Borman and his team to address other components like wheels and brakes, which have reduced in size without any impact on dynamic qualities or braking distances.

"Because we have focused just on the

hatchback Astra and no derivatives other than the Sports Tourer, we didn't have to build in extra requirements for future products like the Zafira, for instance."

A global architecture developed at Russelsheim, other derivatives will be tuned for regional markets like China, where it's a Buick, and the North American Chevrolet Cruze.

Interestingly, Borman says body stiffness is "about the same, because the old body didn't have a problem regarding stiffness".



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TEARING DOWN the global barriers

Steering systems are becoming increasingly sophisticated, as Ian Adcock discovers when talking to the men leading Nexteer's European expansion

exteer is a perfect example of the growing globalisation of the world's motor industry where international boundaries are being constantly dismantled. The 100-plus year-old company is headquartered in Saginaw, Michigan, and after ownership by both General Motors and Delphi was sold to China-based Pacific Century Motors in 2010 and is now listed on the Hong Kong stock exchange.

Its technology and manufacturing base is equally diverse, with centres located in South America, India, China and Australia supplementing its US operations, as well as Europe, and particularly Tychy, Poland, where I catch up with both Guilherme Pizzato, Nexteer Automotive regional director for Europe division and the director of global supply management (International and Europe divisions), and his chief engineer Paul Poirel.

A long-serving member of the Nexteer team, Pizzato is keen to



Paul Poirel hosts the position of Nexteer Automotive chief product engineer Europe. In this role, he has the responsibility to develop and launch steering and driveline products manufactured in Nexteer European plants, or designed in collaboration with European customers' engineering departments on a global basis. Poirel is leading a team of more than 130 engineers, who are located at manufacturing sites, customer support centres and application centres across Europe, and serving more than 20 customers. He joined Nexteer Automotive in 1997 as product engineer for steering column modules.



Automotive Design Interview

extol the virtues of the new-ish Chinese owners. "From day to day, they're very hands off. The benefit was the long-term visibility. They're really looking into the future to grow the company, versus a short-term investor. They're able to give us that stability."

RIGHT COST & TECHNOLOGY

When it comes to the burgeoning Chinese car market, although the owners have helped access it "indirectly", their stewardship hasn't been "actively" pursuing new business, says Pizzato, although "it's well perceived in the Chinese market when they see us having Chinese ownership. But that's not what made the big difference; we need to continue having the right cost and technology to secure the business".

According to its latest company report from 2014, Nexteer engineering and product development costs amounted to US80.1 million (ϵ 71.3 million), representing 2.7% of income, an increase of US6.8 million (ϵ 6.05 million) over 2013.

"Our industry drives a lot of innovation, investment in research and development, and in capital expenditure, as you saw in the plant today, which is where we spend most of our money," he points out to me. "We're adding 9,000m² with the intention of moving the warehouse into the site, so we can manage that and also support a bigger manufacturing footprint. The building will be finished by the end of this year. As we grow the business and secure very important new projects in Europe, so we need to expand our floor space - we have very clear targets over the next 18 months that we're pursuing."

Similar expansion is taking place across the globe, although Pizzato concedes that Europe is "the toughest environment" to grow, because it's well established with mature players that have been leading the electric power steering (EPS) market for the past 15 years. "You still have conversion growth. but not like you see in the Americas and China. In those locations, you're fighting to get the first EPS in vehicles; in Europe, you're fighting to take business away from a rival. It's tough, but we're being successful."

Pizzato predicts that by 2025 the European market will be "close to" 100% EPS, with the USA a little way behind – mainly due to larger vehicle size – achieving 90% in 2020. The challenge for emerging markets like India and China is price. "Those markets are very cost sensitive, so EPS is still more costly than hydraulic systems; it's only regulations that persuades the OEMs to move into that technology, although they see the benefits and



Guilherme Pizzato 💟

Guilherme Pizzato hosts the position of Nexteer Automotive regional director for Europe division and the director of global supply management (International and Europe divisions). In the role of Nexteer Automotive European director, he is responsible for directing Europe's short-term operation plans and execution of the long term strategic objective, as well as managing manufacturing sites in Poland, along with supporting customer support centres in France, Germany, Italy and Turkey. He is currently leading the team of more than 1,300 European employees. As the director of global supply management (International and Europe divisions) he holds the responsibility for all activities related to supply management and purchasing for Asia Pacific and Europe operations. Pizzato started his career in 1996.

Nexteer's single pinion electric power steering system (below).

"By 2025, the European market will be 'close to' IOO% EPS, with the USA a little way behind mainly due to larger vehicle size achieving 90% in 2020," predicts Guilherme Pizzato

"We see an opportunity to drive costs out, with technology like the brush system in China. We developed a specific product for that market where system performance is not as highly required as other locations, but

importance in having EPS.

is sufficient to meet customer needs at a lower cost."

PINION OR COLUMN ASSIST?

The majority of systems today, explains Paul Poirel, are column assist, a legacy of platform architecture that saw body-in-white dashboards and cross-car beams engineered for these systems. "It may be excessively costly to revisit the architecture and go from column to under hood. It's not impossible, it has happened, but it's a bit unusual."

Technically, says Poirel, there's little to choose between either a pinion or column assist for power outputs up to 90Nm. "But beyond that, there's a need to make a worm gear that is excessively big, stiffer and bulky, and awkward to fit in the vehicle. Whereas, if I just take the equivalent of a rack EPS system, I can go very quickly up to an equivalent of 120Nm and beyond to 140Nm." Power levels, he maintains, that will be required in the future.

And he adds that the only vehicles likely to retain either hydraulic or electro-hydraulic systems will be some older generation light commercial vehicles, like Fiat's Doblo, spun off platform designs from the early 2000s.

But as steering systems take on a more central role to the vehicle's suite of safety systems, as the industry progresses to its long-term goal of autonomous driving, so does the demand intensify for greater reliability and technical safety nets that aren't going to alarm the driver in the, rare, event of systems failure.

"Instead of brutally shutting down the assist, we see if there's any way to deactivate just a portion of circuitry that is suspect and then

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Automotive Design Interview

The European market for electric power steering systems is proving a tough nut to crack for Nexteer, as it challenges established players.

to operate the rest of the system. For example, if we have a suspected failure with a torque sensor, the system will use a simplified vehicle model that estimates what the plausible driver torque would be, based on the vehicle speed and handling position. That is based on vehicle dynamics mapped out for this particular product, its torque response as a function of speed and the radius of the curve.

"If I am driving at 100 km/h, and my hand position is 5° based on the model, I should have a range of 200Nm of handling torque - but can't use it, because my signalling is suspect - the steering will operate with a calculated driver torque, informing the driver there is a suspect signal."

VALIDATION & TESTING

The first vehicle with such a limp home mode will, according to Poirel, appear next year. "We're in the

development phase, validating and testing the software."

Weight, the number one enemy of all engineers today, is also coming under scrutiny from Poirel and his colleagues. "We're just starting to work with a Polish university on composite materials as a replacement for aluminium. It will take about three years to complete the feasibility study and see if in the end the mass savings justify the costs. So that's one project. We're also investigating lighter alloys, for instance magnesium, for nonstructural parts. For structural parts, there's some strength concern with magnesium, but components with moderate stress in the operation, and if they're not in an under hood environment, then magnesium could be a good choice. However, we have to be careful about corrosion

"Technically, there's little to choose between either a pinion or column assist for power outputs up to 90Nm." Paul Poirel

and so need the right coating to protect it.

"There's also optimisation of the motor sizing, so it's a mix of looking at the winding density to minimise the amount of copper and then maximising the magnet's strength. Inside the motor, there are some heavy elements like iron core for the rotor, copper, magnets the more we slim that down, we can save up to 300 grams."

OEMs have become increasingly conscious about the contribution steering feel makes to the overall perception of their products, to the extent Pizzato reveals that, with one customer, Nexteer has started development on a new vehicle's steering before the design has been signed off. With that sort of endorsement, it seems that Nexteer's future looks well assured.

> Penetration into the North American market is growing



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Kevin Jost, The Columnist

SAE International Editorial Director

Propulsion Options

utomotive powertrain engineers have never been more challenged than they are today. They must balance consumer demands for greater performance and improved driveability with societal needs for better fuel economy and reduced emissions.

More stringent Corporate Average Fuel Economy requirements in the US, government mandates for CO2 reduction in Europe, and other efficiency and emissions mandates in the rest of the world, will require an evolution of customer tastes to more fuel-efficient vehicles.

There has been a revolution at OEM and supplier R&D centres to meet the aggressive goals, with dramatic changes to the fleet as manufacturers are increasingly slotting in lighter vehicles, as well as downsizing their passenger cars. Most of these strategies are being implemented alongside others aimed at improving internal combustion engines (ICEs) and increasing the electrification of powertrains.

New analysis from Frost & Sullivan, 'Strategic Analysis of Emission Control Programmes in Key Markets Towards 2020', finds that, while alternative propulsion vehicles continue to make inroads in several countries, ICE vehicles will constitute close to 95% of total production by 2020.

"In North America, higherpressure gasoline direct-injection systems, spray-guided injection, advanced electric assisted solutions, and wastegate turbo technologies will be key areas of focus," said Frost & Sullivan automotive and transportation senior research analyst Sudeep Kaippalli. "European countries will enforce stronger regulations for nitrogen oxide and particulate matter emissions in diesel."

The combination of direct injection and turbocharging has become increasingly popular for enabling downsized petrol engines to perform like larger-displacement ones, while consuming less fuel. Meanwhile, cylinder deactivation has helped big engines deliver surprisingly good economy, while





keeping deep reserves of torque available when drivers demand it.

Until recently, the technologies have mostly remained separate in the powertrain engineer community's toolbox. But the stringent CO2 emission demands of Euro 6, U.S. 2025 CAFE and new Asian regulations have engineers searching for solutions that leverage both.

Two significant constraints challenging powertrain electrification engineers are driving range and purchase cost. These two factors are in fundamental opposition, because the most costly part of a plug-in electric vehicle is its battery. Reduce the battery's size to hold down costs and the resulting driving range is unacceptably short.

A major way to overcome this situation is to drive down the cost of electric-drivetrain components.

Many challenges remain; key among them is to convince consumers, during a time of relatively low fuel prices, to choose the more efficient, but costlier, alternative-powertrain options available in the marketplace.

focus@sae.org

Cover story

€1.1bn worth of **Bentley Iuxury**

Bentley's Bentayga is the first in a new generation of luxury cross-overs. Ian Adcock reveals its engineering secrets



hat Bentley has added a luxury cross-over to its range should come as no surprise since the man heading up the Crewebased manufacturer, Wolfgang Durheimer, instigated Porsche's Cayenne. Although many believed at its 2002 launch that the words 'Porsche' and 'Sports Utility Vehicle' didn't belong in the same sentence, global sales of 630,000 since have proved the naysayers wrong.

Whilst Bentley will only be aspiring to sell some 4,000 Bentaygas a year, the £840 million (€1.1bn) investment programme in the Crewe site underlines the growing importance of the luxury car maker to the Volkswagen Audi Group.

Most importantly, Bentayga is not just a clone of other cars based on the group's MLB platform, but a vehicle engineered in Crewe to meet Bentley's unique requirements.

SEVERAL GOALS

"We were involved in the platform development from day one," explains Simon Blake, director, body and trim engineering. "There are a number of things we needed to achieve; our dimensions, the mass concept is different to others using the platform, load requirements, seating position, overall length, our W12 engine, which needs different fixing positions, braces and engine mounts. We have very big wheels, up to 22 inches; all that impacts the platform and style, which means, when you hang your hat on that, it inevitably leads to significant alterations."

Extensive use of aluminium, primarily 5000 series in structural areas and 6000 series for exterior body panels and closures, resulted in a 250Kgs weight saving over a steel structure, he claims, although it still weighs a hefty 3250Kgs.

Most impressive, perhaps, are the front fender and single-piece side

pressings, which are the deepest draws found in the automotive business, according to Blake. "The body side pressing depth is about 350mm, if we tip it in its worst case position. The bulk of that depth is over the rear haunch, so, if you take the dimension from the top of the roof out to the wheel arch eyebrow and then back into the tailgate where the rear lamp is, that defines the deepest point of draw.

"When we developed the rear fender that's as deep as we could possibly go, we worked hard with our styling colleagues to achieve their design for the muscular rear end – whereas the super formed aluminium front fender is about 520mm deep."

UNIQUE TO BENTAYGA

Feature line radii vary from 3.5mm to 6.5, depending on location and as they blend out. Wherever it's possible, the team has avoided using double strikes when forming the body to \times Crewe is now the centre of excellence for W12 manufacturing within VAG and played an integral role in developing the all-new engine. avoid potential problems with witness lines. Although a group platform is employed, "the only parts that are shared with Audi's Q7 are some of the screws and fixings," says Blake, adding: "The hat upwards from the floor is unique to Bentayga, designed by Bentley and engineered at Crewe by my team.

"The biggest challenge was understanding some of the specific requirements around SUV body structures, as it's the first time we've done a tailgate. That was a challenge, and it has roof rails that we've never done before and we had to take account of loads from off road driving."

The only similarity between this engine and its predecessor is that it bears the winged B badge and is a six-litre W12. otherwise it is all new and, as director, powertrain engineering Paul Williams tells me: "My team acted as an extension to the guys in Wolfsburg - we're not big enough yet to do a complete engine from zero – taking responsibility for two aspects in particular: firstly, around the air path, intake, exhaust manifolds, turbos; and, secondly, vehicle integration all around the package: Where do the turbos go? Where do you put the intake manifold? The whole structure of the periphery of the engine."

And, in what is a clear vote of confidence in Crewe, it is now the centre of excellence for W12 engines within VAG and will be supplying fellow brands, Volkswagen and Audi, with their own versions of this engine.

Its headline figures make impressive reading: 447kW at 6000rpm and 900Nm from 1500 to 4000rpm, yet the new W12 TSI is claimed to be the most efficient engine in the 12-cylinder segment. With the W12 TSI, a D-class saloon achieves CO2 emissions of less than 250 g/km (NEDC). Compared with the TMPI version, this marks an improvement of 37%; and an improvement of 28%, compared to Above: aluminium castings, highlighted in red, are vital to help reduce weight.

Right: aluminium-intensive underbody helps reduce vehicle mass substantially.

Below: highlighted green area depicts the unique 48v active roll-bar system another Bentley first.





September 2015

Cover story

the W12 MPI. Key to achieving these figures has been adopting a dual injection strategy, combining highpressure (up to 200bar) direct injection (DI) with low-pressure (6 bar) injection (MPI) into the intake manifold to achieve Euro 6 and ULEV 125, without needing exhaust after-treatment.

"The advantages of DI are obvious," states Williams. "Performance advantages are great, combustion control is fantastic and the ability to fine tune multiple injections etc are all very clear. At the same time, there are two big lengths, so DI has given us the advantage to balance out some of those inherent imbalances to provide a very balanced combustion between the different cylinders."

DI functions for most the engine cycle, about 78%, to a lesser or greater extent. It uses a mixture of both in most of areas and then emphasises either DI or MPI when

disadvantages: firstly, the creation of certain pollutants, particulates etc, and, secondly, noise. For us to use both and get all the benefits is a huge advantage.

"We worked a lot on the running strategy between the different injection systems, so: When do you use them individually or in tandem?

What advantages can we get from two different systems? You get considerable advantages at low speed, in terms of the cooling effect you gain in having port injection running down into the cylinders," he says.

"The W12 has the situation where the inside 6 cylinders and the outside 6 use different port it's emissions, acoustically or performance relevant. As Williams points out: "It's always challenging with a high capacity, high performance engine to have injectors that cover the range from very smooth idle with small injection quantities to continuous Vmax, 186mph (300 Km/h), on an "The advantages of DI are obvious, performance advantages are great, combustion control is fantastic and the ability to fine tune multiple injections etc are all very clear." Paul Williams

ongoing basis. But with MPI, you have the ability to make your injectors smaller and cover both ends better."

FAST RESPONSE TIME

Adopting twin scroll turbochargers with three cylinders feeding each side of the scroll has made response time "much better", with maximum torque at just 1250rpm. This is aided by the first application in a petrol engine of an integrated rev sensor in the turbos, which measures rotational speed, enabling full use of the compressor map all the way to the choke line. This permits the use of a machined compressor rotor with a small diameter and correspondingly low moment of inertia.

The other big breakthrough, explains Williams, is the inclusion of



Cover story



Port layout and separate secondary air supply for the all-new W12.

cylinder deactivation. "The Mulsanne uses a lost motion tappet system, but squeezing those into the W12 cylinder head would be difficult because there's insufficient space and we didn't want to increase the engine's length.

"You have the same problem in effect with the sliding cam lobe. The original technology that was developed off the Audi Avus system slipped between two cams using twin solenoids to pull the cam one way and another to return the cam the other way. The big innovation on this engine is to use the same solenoid to pull it both ways. This means it had to fire in only half the revolution of the cam. To get that control technology, the sensors and actuators to perform that rapidly was quite a challenge."

Combining the dynamic attributes of a 186mph car with one capable of surfing Dubai's biggest sand dunes Bentley's first SUV employs sophisticated electronics to manage its off-road capabilities.

was also a challenge, says director, chassis engineering, Ken Sharp. "We had to look at high-speed performance, agility, cornering, on-road ride comfort, all associated with Bentley brand values, then extend all that into offroad performance." Key to enabling that is the first application of electrically-actuated active anti-roll bars, powered by its own 48v super capacitor. "The principle aims are twofold: firstly, to provide dynamic improvements by reducing the amount of roll. which adds to comfort, and secondly improving ride comfort and offroad performance by, effectively, delivering a degree of decoupling the anti-roll bar from the suspension system.

"When one wheel goes over a bump, ordinarily the anti-roll bar will feed a force into the vehicle structure which is felt by the occupants," Sharp adds. "In this case, the system detects the wheel is going over a bump and actively drives the actuator away from the bump to reduce the amount of acceleration into the body.

"Similarly, off-road wheel articulation can be improved by actively driving the wheel up over the bump, rather than having an anti-roll bar that will lift the whole body or let the body drop into a trough, rather than driving the wheels up or down over those obstacles."

Bentayga is more than just Bentley's first SUV, as it heralds the start of a new generation of products from Crewe, underpinned by



Cylinder deactivation for the complex W12 proved a challenge for the engineering teams.

technology it has developed alongside their German colleagues. "Some of our rivals have less input into their products," one director confided, "but we have the best of both worlds, as we can lead the engineering development, whilst taking full advantage of Group resources."

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GOAL: 'VIRTUAL'

Should simulations be 100% accurate? It's impractical and unnecessary, says one expert, because you're spending so much time running the mode, it negates the accuracy

t's doubtful if there is any aspect of a vehicle's engineering, development, validation, manufacturing and performance that cannot be created in the digital world before physical models take to the road.

As Clement Dumand from PSA Research and Advanced Engineering points out in 'Question Time' on page 32, it's not just the time saved arriving at a given solution, but the ability to investigate numerous other avenues quickly before discarding the unworkable for genuine alternatives.

CAD-CAM is now unerringly accurate: programmes such as Exa Corporation's PowerFLOW Optimisation Solution enable engineers to accurately predict realworld flow conditions, without compromising geometric detail. The solution delivers accurate predictions of multiple attributes across disciplines. Resulting trends and statistics are more accurate and lead to a better design. Advanced morphing techniques allow for designquality solutions from statistical methods, delivering up to 5% improvement in fuel economy, along with 10% increase in mass flow rate.

But, warns Convergent Science's Rob Kaczmarek, it is unrealistic to expect simulations to be 100% accurate – or, indeed, even if there's a necessity for them to be so. "It's impractical to get a CFD model 100% accurate, or even 99%, because you're spending so much time running the model that it negates the accuracy," he states.

"What you want is an ideal solution – an analysis that gets you trending data, so you can say what the trend is in X amount of time, and that differs from OEM to OEM; that could be a week, a month, whatever.

"If you refine the grid, for instance, from 1.0 mm to 0.65 mm, as the runtime goes up, the accuracy might only improve 0.7%, so it doesn't make sense to be that fine a mesh, if it takes that much time. It's trying to find the sweet spot in each case, a trade-off between the time spent and the accuracy, and our philosophy is to run many ideas and rank the solutions."

AGILE APPROACH

During development of the Volvo S80, Anders Wirje, technical expert CAE durability, employed Adams-Marc cosimulation for level 2 skid against curb event to predict buckling and plastic deformation, matching physical testing results. "The ability to quickly and easily look at alternatives



Focus on Vehicle Simulation

PERFECTION

at a time when we aren't locked into any particular approach makes it possible to meet performance requirements with a lighter suspension that can improve the vehicle's fuel economy."

MSC's recently introduced Adams-Marc co-simulation capability makes it possible to include geometrically and materially nonlinear structural behaviour in multibody dynamics simulation. When setting up the co-simulation model for the skid against curb load case, the Marc model contains the lower control arm (LCA) and bushings connecting it to the subframe, whereas the rest of the half-vehicle model is included in the Adams/Car model. The simulated event had a duration of 0.7 seconds in clock time, whilst the communication interval was 5e-4 seconds in clock time, with a total simulation time of 40 minutes using a Dell laptop with 16 Gigabytes of RAM and a 2.7 GHz CPU.

"We were able to reduce the cost and time involved in suspension development by performing product development more accurately from the beginning, so fewer prototype verification cycles were required, prior to full physical verification being performed at the end of the project," explained Wirje.

THUMS UP!

During accidents, changes to an occupant's posture – relaxed or braced – aren't reactions that physical crash test dummies can copy, but Toyota has produced new software for its Total Human Model for Safety (THUMS) virtual human modelling that replicates these kinds of pre-collision reactions.

The latest version of THUMS adds a muscle modelling feature that simulates the body attitude of different vehicle occupants, allowing for more detailed computer analysis of the injuries that collisions can cause.

Until now, THUMS could only simulate changes in posture after a collision, but the new Version 5 model allows changes prior to an impact to be scrutinised. This means the





Volvo employed Adams-Marc cosimulation for level 2 skid against curb event to predict buckling.

performance of seatbelts, airbags and other safety equipment can be studied more accurately, as well as more advanced pre-collision systems. The intelligence gained will help in the development of new safety technologies that can provide better occupant protection.

By simulating many characteristics of different parts of the human body, from its overall shape to bones and skin, THUMS enables detailed analysis of the kind of injuries that can occur in a vehicle collision, such as fractures and severed ligaments.

THUMS Version 5 has already been adopted by other vehicle and parts manufacturers.

No matter how sophisticated virtual engineering becomes in the future, there will still be a need for the intuitive knowledge of the engineering community. However, as systems develop their meshing capabilities, this will free them up to deliver novel solutions for the vehicles of tomorrow.

THE WEIGHFING GAME

Ryan Gehm and Kami Bucholz report on how new materials help vehicles to shed weight

utomotive researchers and engineers are looking for ways to knock the fat off nearly every part of a vehicle in their efforts to achieve higher fuel economy.

"Target the things that are—for lack of a better term—deadweight, because these are the things that drive mass into other subsystems," says Dr Paul Krajewski, global manager and technical fellow for vehicle mass integration and strategy at General Motors.

Closure panels meet Krajewski's deadweight designation. "Whatever material you use for door panels, the body should carry those loads. Ideally, get the deadweight first, because that allows you to hit everything else strategically," he states.

Over the next decade, vehicles will get lighter on route to reaching stricter global fuel economy and emissions requirements. Jay Baron, president and CEO of the Centre for Automotive Research, says cars are going to be 10-15% lighter by 2025, in comparison to a 2010 baseline. "And that 10-15% represents several hundred pounds. So that's a big deal, especially when you look at history. We've been adding weight to cars for the last 25 years, every year incrementally. We are clearly at a tipping point."

MATERIAL MODELS

An important conduit for engineering lightweight vehicles are the tools to model the various material choices. As Krajewsk points out: "If there isn't a good material model, over-design can occur. When we were sourcing the composite parts for the new Corvette, it was difficult to get a 'very good apples to apples' comparison. Each supplier had a slightly different process and a different material. That made it challenging to be able to predict and optimise early on. This emphasises the need for standard material formulations and specifications in the composites industry."

The 2015 full-size Ford F-150 marks the first time a high-volume pickup truck will use aluminium for exterior panels. Peter Friedman, Ford Motor Co's manager of manufacturing research development, comments: "With the new F-150, we decided very early on that we were going to use lightweighting as an enabler to deliver both fuel economy and performance. The 2015 F-150 is aluminium-intensive in the front end, the cab and the box, and the frame is steel, with three times the amount of high-strength steel, compared to the outgoing model."

Ford's best-selling F-150 pick-up truck now features an aluminium-intensive structure, while the latest Corvette's bonnet (above) is carbon fibre.



September 2015

Focus on Multi-Material Structures





ThyssenKrupp's InCar plus (phase 2) project offers a high level of passive crash safety and about 10% weight saving.

According to Thomas Pilette, global vice president of product and process development at Magna Exteriors, multiple considerations factor into a material usage decision. "We're very well aware of low-cost materials. But what we're trying to mirror is the performance, cycle time and part quality expectations out of a single set of tools. So it's really balancing material, process and



performance with the understanding that nobody wants to pay more than the current material and the current process."

Paybacks are proving to be one of the outcomes of industry collaboration. "The steel industry saw the headwinds of the lightweight materials coming and has done a really good job of buttoning down, aligning and working together through the Auto/Steel Partnership. That's led to some great design solutions and development of new materials," says Krajewski.

Meanwhile Pilette insists that the automotive industry needs to underscore the concept of reinvention. "We have to make sure that we keep sharpening our advanced development techniques, and make sure that we have the right material and process applications."

SLIM PILLARS

One of the main goals of ThyssenKrupp's InCar plus (phase 2) project, which the company claims is the largest manufacturer-independent development project by an automotive supplier, is weight reduction. Experts achieved that goal in many areas, including the A- and B-pillars.

The slim A-pillars offer a number of advantages, such as a significantly improved field of vision, high level of passive crash safety and about 10% less weight. The reduction in material usage and new manufacturing technologies ensure moderate lightweight costs of about \$0.85/lb. Integration of the new A-pillar concept into a modular strategy offers possible cost advantages, the company notes. The B-pillars reportedly offer greater safety at lighter weight. A hot formed and rollclad steel-composite material TriBond 1400 allows for a weight reduction of 2.82 lb (1.28 kg) per vehicle, compared to a tailored tempering Bpillar made of MBW 1500. (Pictured is TriBond 1400 three point bending test setup and result.) The design costs less than \$0.85/lb.

Cold forming also can provide for lighter and cost-effective B-pillars. New materials, such as multiphase DP-K 700Y980T, open up further potential of lightweight design and cost advantages. Behind the exhilarating headlines that are the very stuff of motorsport, you will find the specialist entrepreneurs, using their multiple talents to take on the most daunting of engineering challenges

Enter the ENGINEERING ENTREPENEURS

ince the dawn of the motor industry, manufacturers have pitted their products against each other in competition to establish who is the fastest or most durable. That competitive spirit endures today in all categories of motorsport. But behind the headlines is a vibrant industry of specialist entrepreneurs who can turn their ingenuity to solving virtually any engineering challenge from manufacturing the main chassis for the Mars Rover (Prodrive) to developing industrial flywheels to harvest and store surplus electricity generated by turbines (Williams

Advanced Engineering). "The need for manufacturers to react quickly with special products is going to increase. That's where there's a really good fit for a business like ours where we can get involved quickly and support a particular programme. Might not be all of it, but large parts of it to deliver the product." That's Craig Wilson. managing director of Williams Advanced Engineering, but he could be talking about any of the UK's 4,300 companies that make up the world's most intensive motor sport industry that is increasingly being turned to by the mainstream automotive sector to help solve its problems.

In 2012, the UK motorsport engineering and services industry had a turnover of £9 billion, with those 4,300 businesses employing 41,000 people. In the same year, 31% of businesses made sales into the automotive sector, with a growing emphasis on efficient, low carbon technologies and an increasing presence in overseas markets, including emerging BRIC (Brazil, Russia, India and China) economies.

According to the Motorsport Industry Association, "most motorsport engineering firms believe energy-efficient, low-carbon technologies will be at the heart of

September 2015

Focus on Motorsport and OEMs

future growth. Many indicate an increasing opportunity, to exploit their motorsport engineering capabilities, to efficiently bridge the gap between rapid response, specialist prototyping and mainstream

commercialisation of low-carbon technologies by the automotive industry".

Although aluminium and magnesium, as well as advanced steels, are beginning to make inroads into the vehicle production, the wholesale adoption of lightweight materials is slow. "That's where our ability to think outside the traditional six material grades that OEMs have

James Setter, head of Xtrac's automotive and engineering business, confirms there are "significant opportunity to diversifying some of the company's motorsport technology into the mainstream automotive field; consideration of the 'weight-v-cost'



Craig Wilson

been used to working with comes in useful," explains Wilson.

A prime example of this is Prodrive Composites, which received £6 million (€8.2 million) capital investment from the UK's Business Growth Fund to expand the business. In the past 18 months, the company has achieved significant capacity improvements, reducing the cycle time from raw material to finished parts from an average of six to eight weeks down to two weeks. It counts amongst its clients Bentley and McLaren, and has recently announced contracts to develop carbon fibre components for four other sports car manufacturers.

In a similar weight-saving vein,

balance, for example, is common to both worlds".

Xtrac is also at the heart of an ongoing project, with possible farreaching implications, via its 1092 Torque Vectoring gearbox. This was developed for the REEVolution project, a collaborative research and development programme funded by the Technology Strategy Board to create range-extended electric vehicles (REEV) and plug-in hybrid electric vehicles (PHEV).

At the opposite end of the scale, Xtrac also supplies the transmission for Pagani's Huayra supercar, which, explains Xtrac's technical director Adrian Moore, presented its own

challenges. "The fundamental difference, between this gearbox and a competition one, is the refinement and noise, vibration and harshness (NVH). For this transmission, it has to be to a level required for a car that costs this sort of money. Gears,

in particular, have been designed to a very fine degree of refinement; it's a synchronised 'box, using commercially available syncros - proprietary parts not specially designed for this 'box. We have a pretty sophisticated tool that we use to simulate how big they need to be, and then go off to the supplier who validates all those calculations so they are sized and calibrated accordingly."

Xtrac Moore explains, "were involved with Pagani on the Zonda R programme and did that transmission for them, using the racing to road philosophy, as it's very much a race car and not a road car. We then developed a relationship with them for the road car. The original car was laid out with an alternative transmission, but they had some undefined problems with the other suppliers, and we came in and gave them a solution with a good package".

Fundamentally, it is that quick resolution of problems that makes the motorsport sector uniquely different to the mainstream: the ability to think on its feet to deliver what many might consider to be 'left field' solutions. Nor is it hidebound by layers of management protocol that can hinder mainstream engineering development.

"What you do get from the Formula One association is engineering capability," concludes Williams Advanced Engineering's Wilson. "So when you say, 'How do we solve this or that problem?' you have the intellectual capability to do that. The fact that in F1 you're asking a very specific solution doesn't mean that person isn't capable of developing something else quite different altogether."



Below the SURFACE,

'Sense, plan, act' is German supplier Continental Technology's mantra for future technologies. *Automotive Design* caught up with some of these at the company's recent symposium

he increasing sophistication of sensors and cameras, combined with ever more data available via the Cloud or other online services, is opening up a bewildering array of possibilities to engineers – limited, it seems, only by their own imaginations.

For the past 12 months, Continental's advanced engineering team has been working on a Surface Detection System that calculates the μ grip of the road surface to prepare and fine tune ABS, ESC and other electronic traction systems for deteriorating road conditions as well as give advance warning to the driver.

The first input is from digital

weather map downloaded from the nearest weather station to the car, calculated by using co-ordinates from the car's GPS. By using the temperature, humidity and air pressure the system calculates the dew point and how much the air needs to cool before it starts raining. Then, by using the right lens from the stereo camera system an algorithm determines if the road is wet, dry or damp by looking for and recognising specific characteristics like mirroring or colour (the team is about to start developing snow and ice alert software).

Next an infra-red laser operating at around 1000 nanometres mounted in the front bumper measures the varying amplitude of light reflected off the road surface immediately ahead of the tyres.

Finally, the ABS determines the difference between smooth and rough surfaces.

Bring all those parameters together and it would be possible to tune the car's power and traction systems according to the prevailing weather and road conditions.

DISPLAYS HIT NEXT LEVEL

Next-generation instrument displays, due in 2017-18, will combine electromechanical instruments with the latest

Focus on Continental Technology

Active Matrix Organic Light Emitting Diodes (AMOLEDs), as used in the latest smart phone and other media devices. AMOLEDS is a hybrid display technology that pairs the active matrix backplane from a traditional TFT display with an OLED display.

This results in faster pixel switching response times than traditional OLED displays, which can be prone to ghosting when displaying fast-moving animations.

"We see this as a way of adding value for the customer, especially as the latest developments in digital screens don't have the classic flat clusters traditionally seen in the premium segment. Digital dials don't have the same value as the originals with their 3D appearance and precision – it's the difference between an LCD watch and a chronometer,"



"The biggest advantage of AMOLEDs is that there's no back light like TFT or LCD. We have self emitting pixels, so, if you want to show a pixel in black, it's really black, because it's not glowing with light. That's the reason why you can't differentiate division, displayed its latest offering, Nobelis. Designed to trim instrument and door panels, as well as for seating, this polyurethane material has been created as an alternative to leather. It's claimed to have better heat and light fastness, and more impact

into the FUTURE



commented a Continental spokesman. In this instance, a deep drawn 3D formatted tinted, seamless polycarbonate face is filled with a bonding mass and behind that sits a 7-inch AMOLED display. between the black of the display and the instruments printed black. Every pixel in an AMOLED display consists of a red, green, blue colour. If we don't apply any voltage, its true state is black."

Power consumption is reduced because the back light only glows when required, which makes it interesting for hybrids and electric vehicles. The other advantage is that the instruments can be scaled according to what information the driver requires. For instance, if the car is cruising at 100Km/h, there's no need to display the complete 250 Km/h speedometer, with the rest of the instrument cluster showing more relevant information.

IN TOP TRIM

The symposium wasn't all about safety systems and electronics. Benecke-Kaliko, Continental's interior materials

resistance to abrasion when used as seating upholstery.

"Our aim is to have a better performance [than leather-IA], which comes from the lacquer, whilst the colour comes from pigment in the raw material. We can emboss any grain available using laser-engraved rollers. It can also be laminated with textile, cut and sewn," explained a company spokesman.

It can be laminated as well with a heat-conducting paste for warming steering wheels, arm rests or seats, without the need for wires.

Compared to the same thickness leather, it is 25% lighter, with a potential to save 1-2Kgs weight in the interior; and because there's no tanning process, its CO₂ performance is an improvement over hide.

The first application, a door trim, will be on a European product next year, but a big demand is expected from the USA.

GROUND-BREAKING engine concepts UNLEASHED

Clément Dumand, manager, advanced engineering and research department, PSA Peugeot Citroën, reveals to Ian Adcock how Convergent Science's meshing software is aiding engine design

ngine design is so complex nowadays, especially when working on future concepts to meet requirements in 2020 and beyond, that the human brain cannot solve them that easily, states PSA Peugeot Citroën's Clément Dumand – whose team first adopted Convergent Science's meshing software programme back in 2010.

"That's why we use Computational Fluid Dynamics (CFD) more and more, and some algorithms, to solve this very gritty problem. Before Convergent, my team mainly used CFD in order to understand some specific points during tests. We didn't really know why things happened. Now we do simulation in advance, using CFD to design the grid lines of new concepts and then test them on the bench."

SYSTEMS-BASED APPROACH

In practical terms, this has allowed Dumant to restructure his engineering team for improved efficiency, but also delivered greater flexibility to explore ground-breaking engine concepts. "In the past, I had 10 engineers in my team," he recalls. "Now, two do the same amount of work, freeing up the other eight to carry out other aspects of powertrain development.

"We focused just on the combustion chamber in the past; now I have an engineer dedicated to the powertrain, two engineers look at after-treatment and one is in charge of mechanics. So we have a more systems-based approach to the whole vehicle."

Dumant has two major requirements from simulation tools: first is the flexibility to evaluate a large variety of new engine and combustion concepts combined, secondly, with improved efficiency and productivity, in order to evaluate large number of configurations.

"Every year, we have to study and design new engine concepts, so that could be new architecture or combustion processes, or simple improvements of classic combustion chambers for petrol or diesel engines, trying to improve the heat transfer, mixing of exhaust gas recirculation (EGR) and air to make the combustion process or injection strategy better."

The great advantage that Convergent's programme offers Dumant and his team is that it generates its own mesh automatically during the simulation phase and is totally transparent for the user. "Thanks to that, and the balanced efficient way to simulate, we have



Question time

"Some engines run really cool; others have strange moving parts that you couldn't simulate in any other code. Those are really the biggest challenges that we're facing today."

then be transferred to the test bench for further validation."

BEST OF ALL WORLDS

Most of the work Dumant and his team are doing now is focused on engines for the 2020-25 timeframe, with new combustion chamber and piston geometries, as well as totally new concepts, along with revisiting past ideas that didn't come to fruition for one reason or another. "We're working on processes like homogeneous charge compression ignition (HCCI), and frequently we look at what has been done in the past and have a look was very easy and gave us a better understanding of what was happening in the combustion chamber, something we couldn't achieve in the past."

A key factor behind Convergent's success for Dumant is the automated meshing that handles complex moving geometries, coupled with the chemistry kinetics within the combustion chamber, "We're starting to see some distinctive engines being developed, like opposed pistons that will push the code to its limit by the very nature of how they operate.

"Some engines run really cool; others have strange moving parts that you couldn't simulate in any other code. Those are really the biggest challenges that we're facing today."

WORKING RELATIONSHIP

Developing piston bowl profiles and injectors might, on the surface, seem to be duplicating the research and development programmes of suppliers dedicated to those technologies, but Dumant doesn't see it in that manner. "We have two ways of working with [the supply chain]. Sometimes the suppliers come with a new idea or technology, allowing us to achieve new functions - for example, new highpressure injection systems for diesel applications with smaller injector holes tend to soot. So my role is to imagine how we could adapt the combustion chamber to this new injector.

The other way to work with them is from scratch, when we imagine some new concepts and approach them to ask if they can work with us to develop a solution and find the right technology to answer our needs.

"They can approach us with a new technology and readapt it or develop a dedicated solution for us. It's a partnership between them and us in the innovation phase that is more easily enabled by our use of Convergent's software."

New combustion strategies can be explored before they reach the test bench (above) or temperature maps simulated (top). at how we could make those concepts work, keeping in mind new developments in materials, control strategies etc, and use Convergent's CFD to explore their feasibility.

"For instance, two-stroke engines are very tricky to model and difficult to measure with conventional codes, because of the open intake tracts and other factors; but with Convergent, it

been able to multiply by 10 the

four years ago, now it's many thousands. So we gained a lot of

productivity and are able to

treat a large number of

configurations for many

concepts before homing

in on a few, which can

number of simulations we conduct

every year. The order of magnitude of

simulation was around a few hundred

60 second interview

Simon Cox, London design director, Infiniti

Making a real difference

We need to develop platforms that enable us to differentiate ourselves from the Nissan products, because, basically, we're a premium brand, setting our stall out as an individual, dramatic marque.

"It's very important for us that we develop our own proportions and packaging that enable us to really show, aesthetically and dynamically, how the product performs. What we don't want to do is follow BMW, Audi, Mercedes-Benz.

"We're currently working with Mercedes on the Q30 and synergies with those companies will continue, but it's very important that within Nissan we identify where we need to be, in terms of proportion, wheelbase, track, wheel-to-tyre and body relationship, so that we can develop platform proportions and packaging that will enable us to design vehicles that set Infiniti apart.

"Within the alliance, there's enough resource and creativity to develop the products we need, and in IO-I5 years time Infiniti will be a recognised premium brand. It's not a short-term success - it will take time."

But what frustrates Cox most is that the industry is "full of followers", which is where the supply chain can make a difference, as he explains: "We need our suppliers and companies that can offer hardware or software ways of tailoring a product in a different, bespoke, way. It may not be a fundamental change, but it enables us to do something different — a bit left-field. How can we take Infiniti in a different direction? "It frustrates me that in the automotive world people offer too many things that are nearly the same, because it's safe"

"It frustrates me that in the automotive world people offer too many things that are nearly the same, because it's safe.

"More and more — especially with younger, more demanding customers — they want different things and not the norm. So how can we tailor our product, whether it's dynamically, hardware, software, to deliver a different experience? It may be on the same wheelbase as someone else or, basically, the same product, but how does it feel, give you a different experience when interacting with the vehicle?

"It's about tailoring. That's a very important word for Infiniti: how do we tailor the ride, the handling, how can we change that interaction with the occupants? How can we take this from being a driver's car to a car that you're driven in?

"We're looking at how people will experience cars in the future and that's what we, "We're looking at how people will experience cars in the future and that's what we, as a brand, are working towards — making the experience of an Infiniti product different from other marques. How do we do that? It's a challenge. For me, Infiniti has all the core attributes that will succeed. We need to work very hard and not just on aesthetics. People buy into our concepts; it's now about getting that into reality, driving dynamics, product quality — it will come."



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