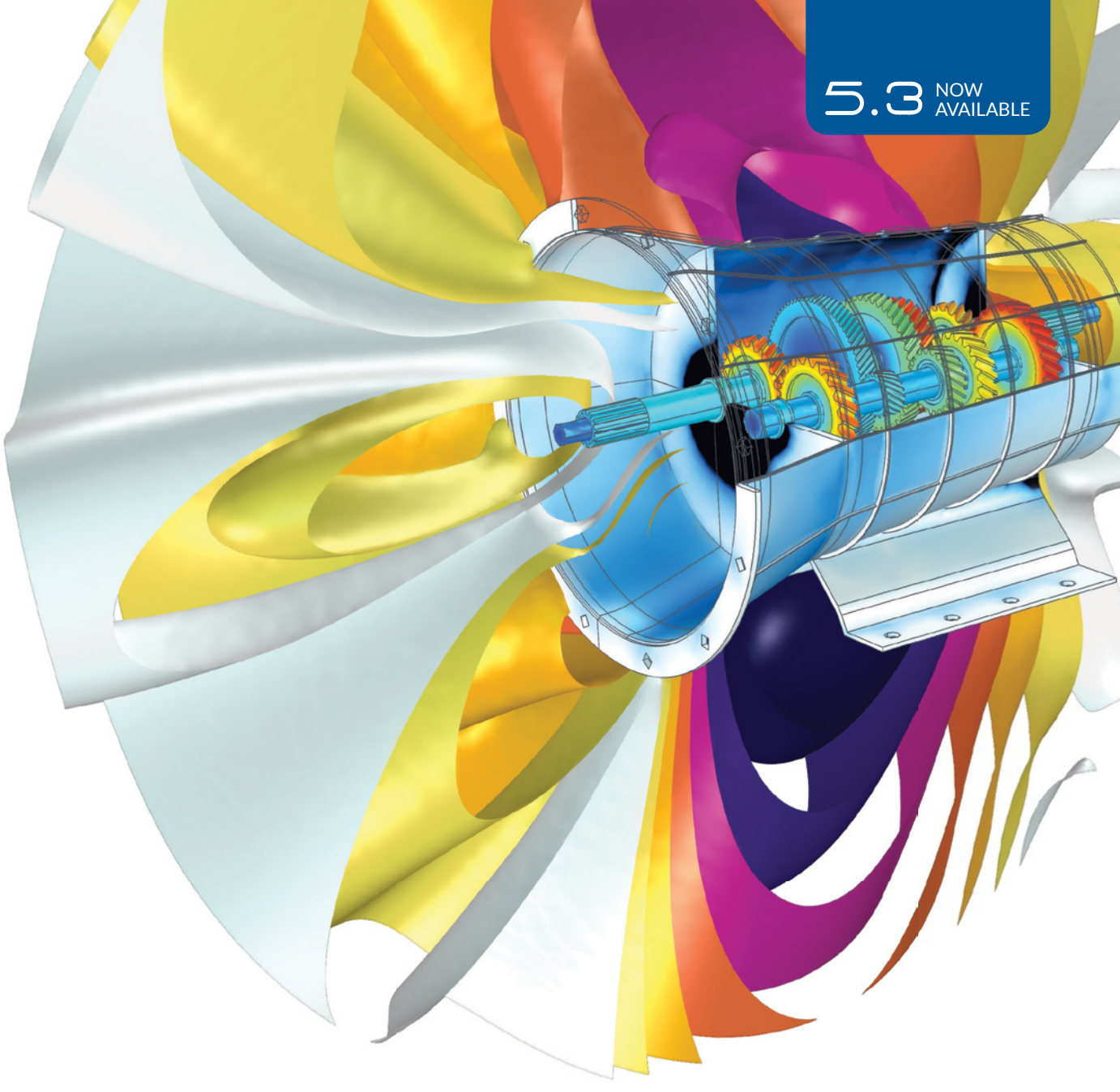

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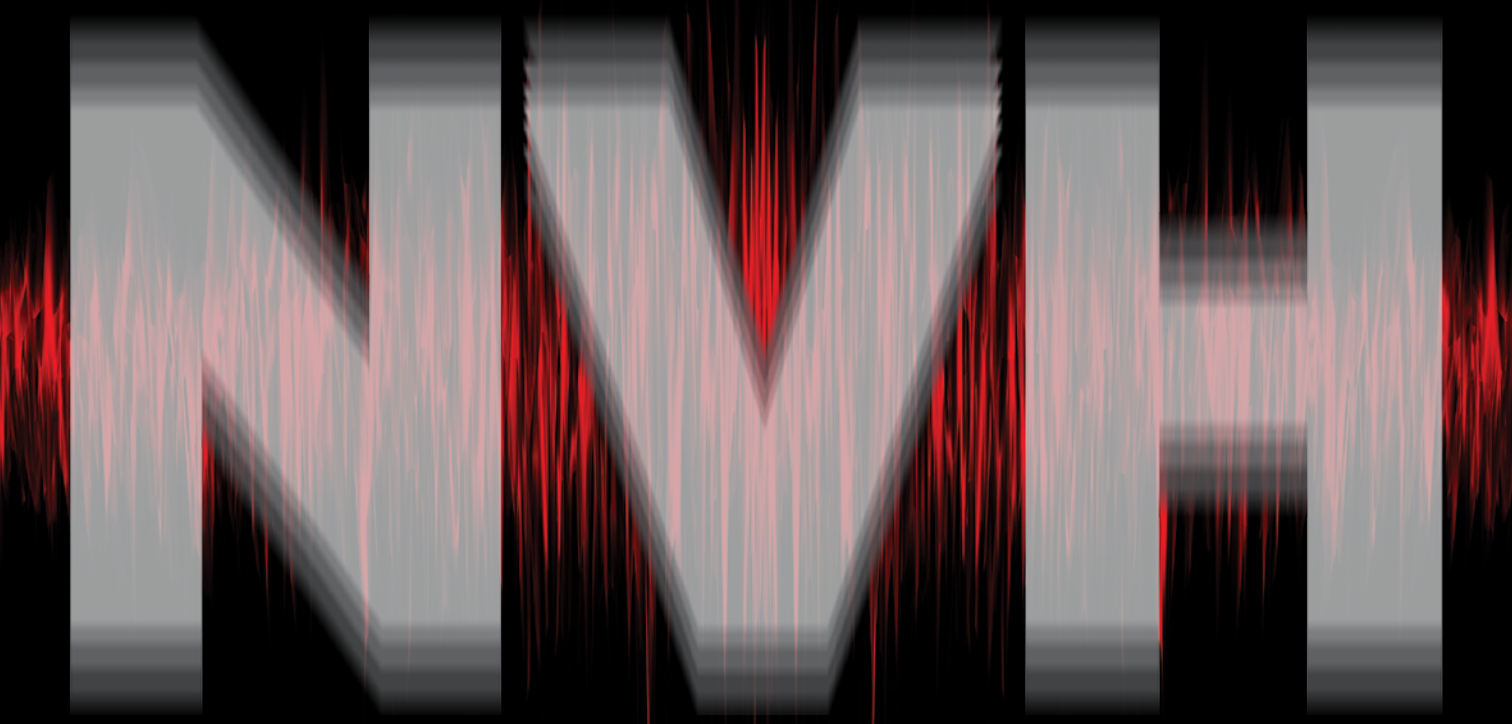

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FEATURES

ON THE COVER

The science of analyzing, attenuating and eliminating Noise, Vibration and Harshness is now integral to vehicle development. OEMs now brag about the superior interior sound quality and low noise levels of one model versus another—a trend that's certain to continue as more cylinder-deactivation engines, hybrids and EVs enter the market. Our NVH feature begins on page 18 and NVH is also addressed in the Supplier Eye, page 8.

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EDITORIAL

Core Ford, New Ford...One Ford?

Soon after news broke late on May 22 that **Ford Motor Co.** was replacing its president and CEO, the calls, emails and texts started to roll in. Rank-and-file Ford engineers, some relative newbies and others whom I've known for 20 years or more, needed a little catharsis.

"It's been like the 'Nasser era' around here—distracted! Eyes off the real business," one chassis veteran told me. He was equating the strategic direction of deposed CEO Mark Fields to the 1999-2001 tenure of former CEO Jac Nasser who aimed to transform "a boring old car maker" (his words) into a consumer-products and services company. Disruption of the wrong kind followed.

Texted a powertrain test engineer on May 23: "Credit not given to 1000s in trenches delivering our profitable products." And my favorite, from an electronics whiz at the Michigan Proving Grounds: "We make durable goods that have to last 15 years—a concept that's alien to Silicon Valley."

In the press conference that followed the CEO shakeup, Bill Ford asserted that he and new CEO Jim Hackett will not permit their "One Ford" global vision to degenerate into "Core Ford" and "New Ford" factions. The former is the traditional engineering-manufacturing dynamo that last year generated 90% of the company's $10.4 billion in pretax profit. Amazingly, investors don't assign much value to such a business.

The so-called "New Ford," by comparison, encompasses the advanced programs—vehicle electrification, autonomy and "mobility"-related ventures such as ride sharing. They only burn cash at present and may continue to do so for another two decades.

Meantime, X dollars from the sale of each "Core Ford" F-150 and Focus must go into funding R&D for the self-driving podicles now in development. The same reality faces **Toyota**, **Mercedes**, **Honda**, **GM** and other incumbents: "Core" products engineered for human drivers — those "boring old cars"—will be subsidizing the new self-driving ones for years after they enter production. I'll wager that the transition takes longer than the forecasters ("10 million self-driving cars by 2020!) breathlessly predict.

Engineers don't get credit for simply delivering safe, durable and in many ways fun vehicles that delight customers. I think this is the root of the frustration that's been growing within Dearborn.

Wall St. hijacked the term "Technology" about 15 years ago to organize the mobile-device makers and telecoms into one tidy bin.

Those engineers who feel marginalized by future hype can aim some of their frustration at Wall St. It was the investment community who hijacked the term "Technology" about 15 years ago, to make it easier for them to organize the mobile-device makers and telecoms into one tidy bin. Their "tech media" accomplices then declared new reporting boundaries. So, if you're developing nano-composites, or lean-combustion strategies, or active noise cancellation, or new seat structures...sorry. You don't warrant their attention.

Ford Motor Co. itself fell into this sad communications hole. Product launches have often veered toward social media "selfie" fests. The sole PR staffer who was dedicated to digging out novel engineering and product-development stories quit the company but was not replaced. "No longer a priority" was the reason given to me later. Apps R us!

I hope Ford's new leadership sees it differently. Mobility companies are Engineering companies, first and foremost. Bill Ford got it right. Ford's technology valuation, as perceived by investors, media and customers, will rise or fall on one equation: Core + New = One.

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SAE STANDARDS NEWS

Seeking a common language for vehicle automation

In late March, **SAE** had a unique opportunity—a first, according to the record books: Testifying before Congress about an SAE Standard. More specifically J3016—Levels of Vehicle Automation.

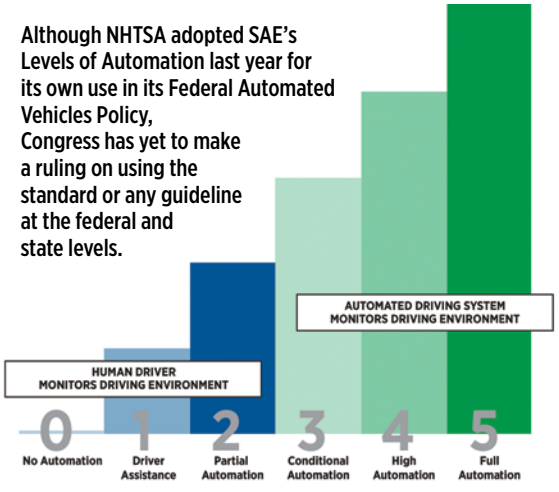
William Gouse, who directs SAE's Federal Program Development activity, faced the U.S. House of Representatives Subcommittee on Digital Commerce and Consumer Protection that is addressing self-driving cars. Gouse served as witness, his testimony aimed at getting the federal government to adopt SAE J3016 both in federal policy and state regulations/legislation. He was joined by three other SAE members, Dr. Kay Stepper of **Robert Bosch**, Jeff Klei of **Continental** AG and David Zuby of the **Insurance Institute for Highway Safety**. This was itself another first—a Congressional hearing made up strictly of SAE members.

In September 2016, **NHTSA** adopted SAE's Levels of Automation for its own use in its Federal Automated Vehicles Policy (http://articles.sae.org/15021/). However, Congress has yet to make a ruling on using the standard or any guideline at the federal and state levels.

Gouse told *Automotive Engineering* that there currently isn't a common language—a vocabulary—used consistently for referring to the levels of automation across the U.S. at both federal and state levels. This has caused extensive confusion.

"I have been trying to get people to use the same terms and how to define automated driving [levels]," he said. In Gouse's role as a witness at the hearing, he informed the subcommittee members about SAE's leadership in consensus-based standards development and about SAE J3016.

Although NHTSA adopted SAE's Levels of Automation last year for its own use in its Federal Automated Vehicles Policy, Congress has yet to make a ruling on using the standard or any guideline at the federal and state levels.



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SAE's testimony before Congress aims to establish a standard vocabulary for automated and self-driving vehicles.

"This Recommended Practice originally published in 2014 and revised last September, and referenced in the Federal Automated Vehicles Policy, provides stakeholders including federal, state, and local/municipal legislators, regulators and policy-makers with a taxonomy describing the full range of six levels (SAE 0 through 5) of driving automation in on-road motor vehicles," Gouse stated in his testimony. "These six levels span from no automation to full automation."

During his allotted five minutes of testimony, Gouse also noted: "Importantly, what these standards do not provide are specifications, or otherwise impose requirements on, driving automation systems or active safety systems. Nor does it imply any particular order of market introduction or adoption."

Gouse explained that standardizing levels of driving automation and supporting terms serves several purposes, including:

- Clarifying the role of the (human) driver, if any, during driving automation system engagement.
- Answering questions of scope when it comes to developing laws, policies, regulations, and standards.
- Providing a useful framework for driving automation specifications and technical requirements.
- Providing clarity, consistency, and stability in communications on the topic of driving automation, as well as a useful short-hand that saves considerable time and effort.

He also said that J3016 is "designed to be useful to many beyond the engineering community, such as legislators, regulators, others in the legal profession, the general and trade media and consumers and the public that are buying, riding in, or having freight delivered in a vehicle with some level of driver assistance or automation."

"In the current system, you can drive your car or a rental car to New York, Ohio or Virginia, for example, and there aren't separate laws [in each state]," he told *AE*. "But you can't do that with **Google** or **Uber** cars right now. That's what's happening because they're being governed by separate state laws. Some states are changing them [laws] to allow for the testing, others are not. It's a complicated deal."

The hearing and Q&A session, along with Gouse and the other three SAE members' full testimonies, can be viewed at https://energycommerce.house.gov/hearings-and-votes/hearings/self-driving-cars-levels-automation. ■

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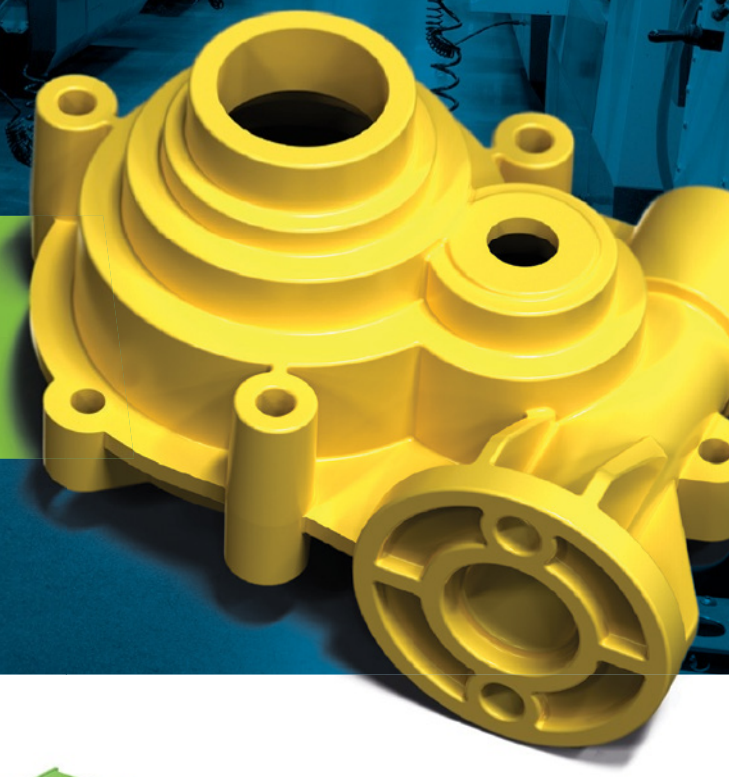

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SUPPLIER EYE

Are you innovating for NVH?

I'll never forget the experience, as a kid, of lifting the massive steel hood of my father's 1971 **Dodge** Monaco and seeing nothing but V8 engine and a few rubber hoses. The vast compartment was so uncluttered, I could look straight down and see the pavement. By comparison, the view under today's vehicle hoods reveals a dense landscape of technologies aimed at acoustic control: covers, shields and insulators designed to keep injector clatter, induction honk and even pulley whirl muffled.

Supplier innovations are central to winning the ongoing war with NVH—noise, vibration and harshness. The battle started decades ago and will certainly increase in the future. This is an engineering realm with numerous tradeoffs involving total piece cost, capital cost, stranded fixed capital, tooling complexity/count, system optimization, flexibility, intellectual property and even downstream warranty. But because NVH (more accurately, the lack of it) has direct impact on the end customer, it has become a commitment rather than an option across vehicle segments.

Controlling NVH and its annoying little cousin, BSR (buzz, squeak and rattle) is a never-ending crusade. What value is a new fuel-efficiency technology such as direct injection, for example, when it increases underhood noise? Customer satisfaction, sales and future vehicle value will suffer. The goal is to offer 'no compromise' technology, with suppliers responsible for raising the bar with each new model.

The "N" in NVH is a constant challenge for engineers but offers opportunities for suppliers. The advent of acoustic glass came from collaborations among glass and film/laminate companies. Advanced door sealing systems, fuel tank isolation, floor/door panel insulators, foam-based HVAC ducting, laminated structural materials in the cowl/floor and a focus on new fastening technologies are critical to today's acoustic experience and mainly come from the supply base.

This journey is more than material/process science—it also includes system optimization. Nine- and ten-speed transmissions are only as smooth and unobtrusive as their calibrations allow them to be. New material/process innovations by chemical-solution providers such as **Dow** and **BASF**, and component/system suppliers including **Rochling**, **MSC**, **Mahle** and **Autoneum** are key to ensuring systems "tuned" to the customer's ear and all control surfaces including the steering wheel and pedals.

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Suppliers be forewarned: The OEMs' drive to reduce and abate NVH is just getting started.

Suppliers be forewarned: the OEMs' drive to reduce and abate NVH is just getting started. The **IHS Markit** forecast for vehicle electrification and greater regulation-driven emissions performance underscores this. Per the latest forecast, 32% of the global light vehicle sales in 2025 will exhibit some sort of electrification—mild-, plug-in and full-hybrid or full battery-electric. As the proportion of vehicles operating under electrified propulsion rises, noise from other systems becomes more audible and will require control. HVAC, wind, tire (low rolling resistance), external noise and electric motor/gear resonance will become more apparent in the absence of the combustion engine.

There's also vehicle lightweighting, a trend that can exasperate NVH engineers. The goal for many consumers is to have an even quieter interior than in the past. Thus shifting to materials outside the norm (higher-gauge steels, aluminum sheet/structure or alternative plastic formulations/applications) can lead to the need for insulation countermeasures. Suppliers need to understand this gap and respond. In this case, less is more when optimizing mass reduction while maintaining the acoustic experience and vehicle performance. This will open new doors for supplier innovations throughout the tiers.

New opportunities have emerged recently in noise abatement/compensation and attenuation. The major vehicle audio companies including **Panasonic**, **Bose** and **Harman** are developing solutions to mask unwanted frequencies and enhance the driving experience. As alternative materials and technologies are integrated into tomorrow's offerings an emerging market is born.

Virtually every supplier will need to consider NVH innovations, as the "sound of silence" becomes a baseline for future business. ■

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SOFTWARE | SIMULATION

Exa simulation aims to keep ADAS sensors clean

A vehicle this soiled by snow, slush, mud or dirt may compromise the effectiveness of its ADAS sensor suite that is vital for operational safety.

Looking "backwards" will soon become increasingly necessary for aerodynamics engineers and simulation specialists. In this case, it's about the industry's interest in abandoning exterior rearview mirrors in favor of small cameras, partly to reduce the vehicle's coefficient of drag (Cd) for improved fuel efficiency and also to enhance safety systems to provide a wide-angle view around and behind a vehicle.

A key element of that is ensuring the clearest vision possible in a wide range of road conditions, including those that would create camera-lens soiling. Visualization and simulation software specialist **Exa** Corp.'s teams now are focusing on this vital and sometimes overlooked aspect of ADAS (advanced driver assistance systems) development and integration. After all, users are hardly likely to carry a chamois cloth to clean mirror glass or onboard sensors.

Exa's Executive Vice President, Ales Alajbegovic, explains the alternatives: "Design iterations with various underbody components, aerodynamic devices and shape factors can be used to find the best balance between aerodynamics and [sensor] soiling performance. They can dramatically alter the wake location and motion, and influence the trajectory, of rain particles which could interfere with cameras."

Simulating the lifecycle of raindrops

Cameras have been seen as obvious replacements for hefty fender or door-mounted mirrors for many years, but their development and acceptance (for safety reasons) path has been extremely difficult. The ultra-low-volume (250 units) **Volkswagen** XL1 demonstrated that rearview cameras could meet requirements. In testing an XL1 during its 2014 debut the author found them surprisingly acceptable in both city traffic and high speed motorway scenarios in Europe.

At Exa, where extensive vehicle anti-soiling work (snow, water and dirt) is underway using its PowerFLOW software to help keep the vehicle's greenhouse clear for maximum visibility, the likelihood of conventional exterior mirrors becoming obsolete is being taken seriously.

Said Alajbegovic: "Firstly, cameras should be placed in areas that are not exposed directly to large raindrops and rivulets on the surface of their surface. PowerFLOW simulates the lifecycle of raindrops as they approach the vehicle, break up due to the aerodynamic flow field, splash on the surface, are entrained into the vehicle wake, and are deposited on the vehicle's surfaces."

Cutlines and other bodywork features could be added to a vehicle's surface to control water film motion. "We see this a lot today on mirror housings," he explained.

Some solutions already exist for keeping exterior rearview cameras clean, including a jet of water followed by a puff of air. But this type can be avoided, Alajbegovic noted, through early design improvements "using more simulation and concurrent evaluation of aerodynamics and soiling at each design stage of a vehicle."

As for the application of PowerFLOW to assess hydrophobic and hydrophilic coatings on cameras and sensors to assess their ability to keep a camera lens clean, Alajbegovic confirms: "This capability is still under development."

Gaining more accuracy

Digital anti-soiling simulation work will be particularly significant in the upcoming world of sensor-controlled, fully autonomous vehicles. The prospect of exponential test requirements

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Dirt deposition on side and rear of a vehicle (left) and after aerodynamics' modification (right), with side body coverage noticeably decreased and rear area soiling slightly increased. This demonstrates the potential for subtle control of vehicle body soiling.

is costly and time consuming. But it is not just futuristic vision systems to which Exa is applying PowerFLOW's capability. It is also used to achieve better management of contaminants on the surface and in the air, on and around a whole vehicle.

As previously reported by *Automotive Engineering* (http://articles.sae.org/15034/), **Land Rover** used it during development of the 2017 Discovery. Engineers ran more than 1000 simulations to better manage dirt and water management, obviating the need to use sometimes limited capability climatic wind tunnels. Exa's highly repeatable particle simulations can be combined with real world predictions by including realistic wind conditions in simulations including turbulence caused by traffic, states the company.

The work generates a more accurate prediction of the level of soiling and spray patterns experienced in a vehicle's daily use.

Exa recently launched its new PowerFLOW 5.4 software, designed to further improve real-world accuracy and the digital simulation process. The robust release "will enable engineers to predict even more accurately how new vehicle designs will perform and interact with their environments," said Senior Vice President and marketing boss Suresh Sundaram. It will also help keep vehicle sensors clean for safe, autonomous driving "and understanding the effects of variable road conditions on vehicle performance, fuel efficiency and range."

Simulating sprayer coverage

During an initial assessment and cross-correlation exercises between simulation and experiment, **BMW** was able to verify the potential and robustness of the Exa PowerFLOW water-management capabilities in relation to windscreen sprayer modules, the company revealed. The sprayer modules are provided by suppliers to BMW and functional targets are set for the installation configuration on the series vehicle. The targets for the sprayer operation are subject to numerous vehicle aerodynamic considerations.

Revealed at the 2017 Geneva Motor Show: Mercedes-AMG GT Concept with rearview cameras instead of door mirrors.

BMW simulation specialist Holger Gau noted: "We have worked with the Exa PowerFLOW water-management application to assess its potential in the BMW engineering cycles, and to develop a process where, given the sprayer properties, simulation can predict the sprayer coverage over the entire operating range of the vehicle. We see growing requirements for water management simulation applications."

Gau said BMW expects that future simulation may address topics such as side-window soiling, backlight visibility and others.

Stuart Birch

SAFETY

CO_2 buildup in vehicle cabins becoming a safety issue

High carbon dioxide concentration in a small area, such as a passenger-car cabin, is a health hazard. For many years, the outside-air flap on most HVAC systems was notched so that in recirculation there always was some "fresh" air flowing into the cabin. Even without the notch, the vehicle body was relatively leaky and the blower switch didn't have an off position, just a low speed to purge stale air.

To improve A/C performance, the recirculation switch (or Max A/C position) in newer vehicles permits shutting off outside air. Now there's even a **U.S. EPA** fuel economy credit because this approach improves fuel economy. However, for passenger comfort in regions with high ambient temperatures, shutting off outside air is common.

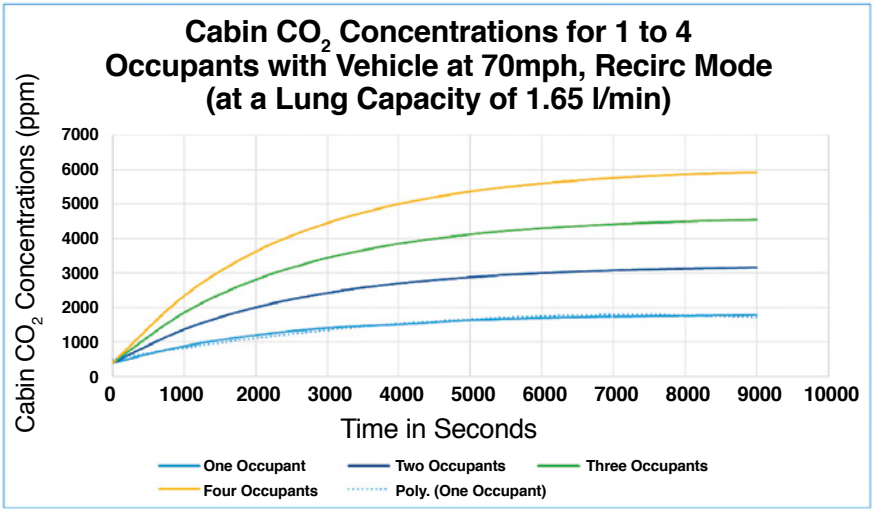
Comfort level just 0.1%

This has an obvious effect on passenger-compartment air quality and CO_2 buildup from human respiration can affect passengers. As Dr. G.D. Mathur, senior manager for test and development at **CalsonicKansei North America**, pointed out in a 2017 **SAE** World Congress (WCX17) presentation, just 0.1% concentration is the comfort limit. The EPA's short-term exposure limit (15 min) of 3% and a maximum exposure of 4% in the breathing zone was promulgated only for R-744 air conditioning (carbon dioxide used as a refrigerant), to address a large leak, not a human-caused buildup.

ASHRAE (American Society Heating, Refrigerating and Air-Conditioning Engineers) says the comfort limit for CO_2 concentration is 700 ppm over the ambient level, which is approximately 400 ppm, for a total of 1100 ppm (0.11%).

CO_2 sensors provide one avenue for automotive control, but more likely is the timed approach used by some manufacturers (10-20 minutes at a time in recirculation). However, there is a need to maintain maximum recirculation to meet the intent of the EPA credits.

The recirculation position on the HVAC switch can shut off outside air. With the "Max A/C" label, it's the hot-weather choice.



CO_2 level buildup with four passengers can exceed 0.6% (6000 ppm) in under 1.5 hours.

For all the modeling and the limited testing that has been done in this area, Mathur noted that better data is needed to cover vehicle ageing. Most new vehicles start life with triple-sealing of the doors and glass areas, but seals deteriorate over time. A researcher can model CO_2 buildup based on number of passengers against cabin volume, air leakage and blower flow rate. However, there is great variability in exhalation CO_2 for passenger activity level (sitting quietly vs. parent screaming at a youngster in high activity, for example).

There also is a major difference in human lung capacity, and work on R-744 air conditioning systems has led to studies on that subject, showing a range of 3.8% to 5.8% CO_2 (38,000-58,000 ppm) in human respiration. Mathur's research led him to quantify lung capacity at 1.65 L/min, which he said matched well with previous work he had performed. It indicates a buildup to 1100 ppm—just over the comfort level—within the first 4-5 min of a simulated test drive. With a vehicle range of over 500 mi/800 km, an eight-hour trip can raise CO_2 concentration to dangerous levels.

% VOL. OF CO_2 IN AIR	EFFECT ON AN AVERAGE ADULT
<0.07%	Normal air
0.1%	Comfort limit
0.2%	Increase in the breathing rate
2%	50% increase in the breathing rate
3%	100% increase in breathing rate, 10 minutes short term exposure limit (PEL)
5%	300% increase in breathing rate; headache and sweating may begin in 1 hour. Note this is tolerated by most persons, but is physical burdening.
8%	STEL
8%~10%	Headache after 10 to 15 minutes, dizziness, buzzing in ears, rise in blood pressure, high pulse rate, excitation and nausea.
10%~18%	Cramps after a few minutes, epileptic fits, loss of consciousness, a sharp drop in blood pressure. Note the victims will recover quickly in fresh air.
18%~20%	Symptoms similar to those of stroke.
30%	Unconsciousness in 24 second.

CO_2 levels and their effects on passengers.

CO_2 effect on vehicle crashes

Mathur noted several deaths recorded by the **Arizona Dept. of Transportation** were blamed on crashes from CO_2 buildup affecting the driver. The attributions were validated by blood analysis of the crash victims, indicating the issue is real-world.

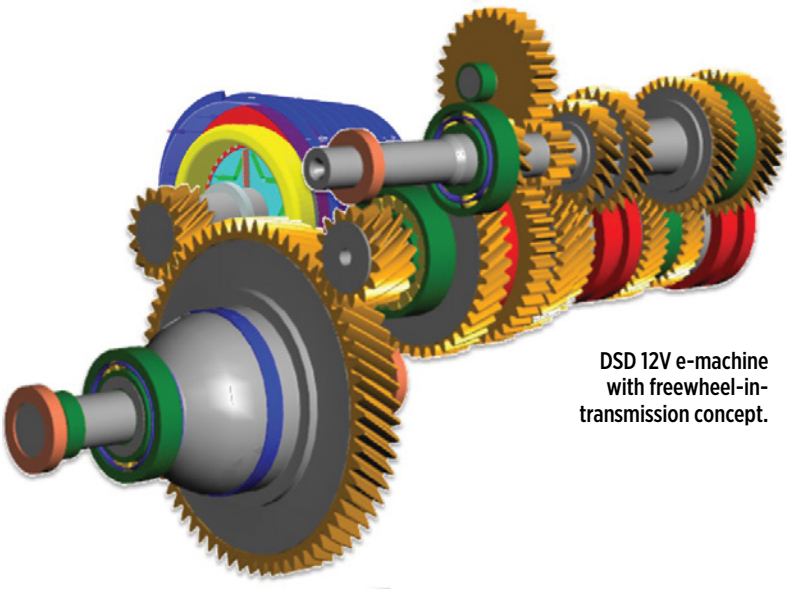
Although he had no specific data, Mathur said that research also needs to consider possible contributions from carbon monoxide (CO). He observed that in recirculation there is no positive pressure in the cabin, so with exhaust and underbody seams leakage, CO can penetrate. The level would be subject to great variability based on the exhaust system and vehicle. If it reaches a level of 30 ppm, it is likely to cause passenger headaches.

Prior to Mathur's presentation, the SAE Interior Climate Control Committee had discussed this subject at its previous meeting and a call was issued for a working group. The purpose was described as to focus only on occupants respiration, not leakage from an R-744 system. Participants would agree on vehicle interior volume, passenger volume, air exchange rate, drive cycle, also engine off and at idle. Testing would be performed with a CO_2 cylinder, and specific settings for vehicle sensors and HVAC operation, including possible preconditioning.

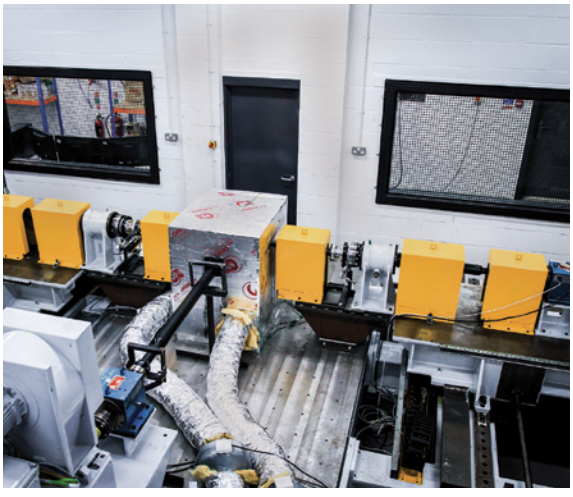
Paul Weissler

POWERTRAIN | PROPULSION

DSD's low-cost 12V hybrid aims for small cars



DSD 12V e-machine with freewheel-in-transmission concept.



DSD recently expanded its transmission and driveline test center by adding three test cells.

As hybrid solutions for vehicles gain broader applications, reducing cost in technology-dense systems that demand 48V power is a constant challenge. It is particularly important for A-segment cars, superminis and microcars and equally vital for emerging markets such as India, which have traffic-clogged major cities.

To this goal, driveline and transmission engineering specialist **Drive System Design** (DSD) recently revealed a mild-hybrid concept that it claims offers up to 60% of the energy recovery typically achieved by more sophisticated (and costly) full hybrids. And it can be done using 12V electrical architecture as a major contributor to cost control.

According to DSD Technical Director Alex Tylee-Birdsall, the new concept "is especially suitable for small vehicles with manual or automated-manual transmissions." He adds that significant CO_2 vehicle emissions reductions can't be achieved while the hybrid population of vehicles globally remains low. So small, high-volume hybrids would make a significant contribution.

DSD's system connects a 12V electric machine via a freewheel device on the output (road wheel) side of a car's transmission. It is compatible with manual gearboxes and facilitates engine-off mode while the e-machine provides creep and hill-hold functionality, Tylee-Birdsall claims. The system also provides a coast or sailing mode when the accelerator is released, reducing torque-effect interruption during a gearshift (typically an AMT downside).

And when the engine is switched off, the system continues to provide electrical power. It will deliver what Tylee-Birdsall describes as "significant CO_2 savings."

The freewheel device facilitates engine and transmission decoupling from the road wheel, thus reducing drag. According to DSD engineers, mathematical modeling has demonstrated that a 12V machine on a small car could achieve more than 60% of the energy recovery of a full-hybrid system, obviating the need for an additional high-voltage battery pack, DC-DC converter and associated control systems.

As hybrids steadily gain market share, OEM and Tier 1 suppliers' requirements are growing. To support its own and the industry's testing needs, DSD has expanded its test facility capabilities, developing it to meet the particular challenges of determining driveline efficiency.

R&D work is concentrating on robust low-noise gear design for high-volume production, in addition to efficiency improvements for axle and transmissions and lightweighting and e-drive solutions for both pure EV and hybrid architectures. In the recently expanded transmission and driveline test center, three new test cells were commissioned, bringing the total to ten. The company states that to maximize the value of the expanded facility, it has developed in-house techniques designed to solve the problem of determining driveline efficiency.

Rob Oliver, the company's Chief Engineer, explains: "As torque capacity increases, the differences we are looking for become a smaller proportion of the maximum figure. To improve measurement accuracy, we have developed our own techniques for the calibration of torque transducers which help overcome this."

The test facility also has the capability to enable hydraulics systems to be combined with their electronics before assembly in the transmission.

DSD's largest test cell incorporates five electrical machines having output motors capable of 7000 N·m (5163 lb·ft) and 700 kW 939 hp), catering to 4WD and HEVs, plus drivelines of small cars to trucks and off-highway vehicles.

Stuart Birch

VW finally fills its SUV gap with 2018 Atlas

VW's development team benchmarked the Ford Explorer, Honda Pilot, Toyota Highlander and Chevrolet Traverse in developing the new Atlas.

With the market rushing headlong toward trucks, SUVs and crossovers, **Volkswagen** has badly needed a mid-range SUV between its $25,000 compact Tiguan and $50,000-plus premium Touareg. And now, finally, it has one.

Designed and engineered in Wolfsburg, built at VW's billion-dollar Chattanooga plant and riding on the modular MQB platform, the 2018 Atlas ($31,000 base price) enters production three years after the CrossBlue concept made the auto-show rounds. Atlas was developed as "a vehicle to go straight at the heart of the mid-size SUV market," explained Michael Lovati, Vice President of VW's mid-size/full-size product line.

"We had to make something that those customers want through a lot of benchmarking, clinics, feedback and collaboration to understand how they think and what's important to them, then translate that into a vehicle concept and design. That is a challenge for anyone, particularly a European company," he admitted.

Interior spaciousness, driver visibility and cabin comfort were among the Atlas development team's primary bogies, Lovati noted. The team benchmarked key segment players **Ford** Explorer, **Honda** Pilot, **Toyota** Highlander and the slightly larger **Chevrolet** Traverse. "Those vehicles are doing something right to win so many customers," he said, "so we took a close look at every feature to be sure that we hit the sweet spot on what those customers want."

Commodious cargo hauler

At 198.3 in (5037 mm) long overall, Atlas's ruggedly-styled exterior is fractionally equivalent to Explorer and exceeds Pilot and Highlander, while its 117.3-in (2979-mm) wheelbase is longer than all but Traverse. All three seating rows are roomy, in the author's view, and the adult-size third row is easily accessed via (7.7-in/195.5-mm) fore-aft sliding, forward-flipping and reclining 60/40 second-row seats even with child seats in place. Lovati claims third-row access to be best in class. Second-row captain's chairs are optional.

Atlas offers 20.6 ft^3 (583 L) of cargo capacity behind the third row, 55.5 ft^3 (1572 L) with third row folded down and a whopping 96.8 ft^3 (2741 L) with second and third rows folded down. Lovati is proud of the flat, flush cargo floor devoid of obstructions. He also noted that VW's use of ultra high-strength steel alloys in the Atlas's A-pillars enabled a slender pillar cross section, which in turn helps provide superior outward visibility, obscuring the driver's view by only 7°.

Mass efficiency was a priority in the steel-intensive Atlas's development, but the engineers did not aim to make it lightest in class. "The complete package has to all fit together, so that's where the focus has been," he explained. "We are always optimizing for certain characteristics, including mass." At 4,336 lb (1967 kg) in front-drive configuration and 4,502 lb (2042 kg) with AWD, Atlas's curb weight sits roughly mid-pack among its competitors.

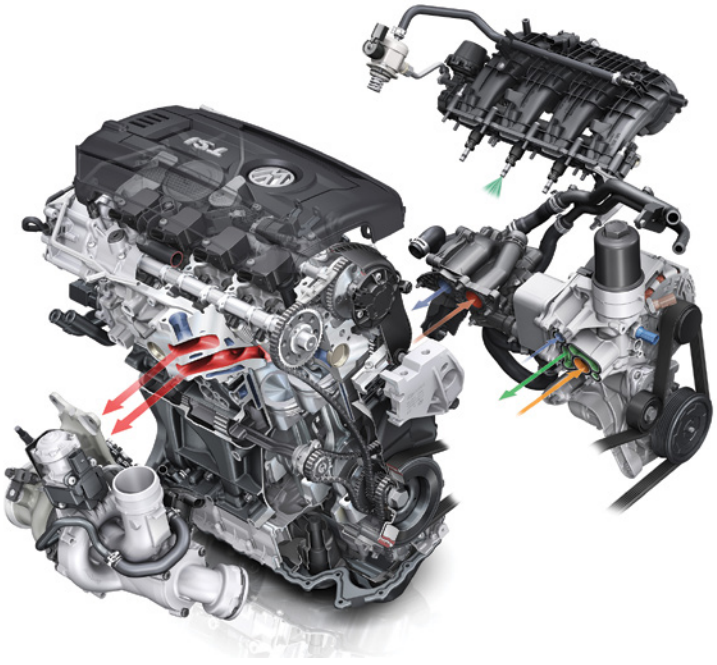
Minimizing NVH was high on the team's surprise-and-delight list. "That is something we have looked at through a lot of drives, testing and analysis, measuring and tweaking specifically for this market," Lovati noted. He said optimum material gauging, use of premium door seals, body joint sealing, flocked wheelhouse liners and "very heavy dampeners and insulators throughout, particularly on the firewall," work in combination to attenuate and block noise and harshness.

While Atlas uses front and rear subframes for suspension and engine mounting, both are solid mounted rather than isolated.

VR6 and turbo-four power

The vehicle's cleanly styled and functional cabin features dashboard and interior trim was co-developed by VW supply partner **Yangfeng Automotive Interiors** and sourced from Yangfeng's new Tennessee plant. Because the new SUV is underpinned by the MQB "toolkit," as Lovati calls it, Atlas shares little with the Passat (still based on the old PQ platform) that is built alongside it in Chattanooga. He adds that Atlas is

Cleanly and tastefully executed in the VW-Audi tradition, the Atlas's cockpit features standard 8-in infotainment screen. A 12.3-in unit is available.



Optional EA288-based 2.0-L turbo four delivers 235 hp.

package-protected for hybridization "with some modifications," but there is no current plan to do so.

For its powertrain choices, Atlas debuts with a standard 3.6L VR6. Introduced in 1991, the VR6 may be the industry's most package-efficient six. Its narrow 10.6° cylinder-bank angle and single DOHC cylinder head (now fitted with direct injection and variable valve timing) make it nearly as narrow as an inline six but much shorter for transverse packaging in FWD-based architectures. It delivers a claimed 276 hp (205 kW) at 6200 rpm and 266 lb·ft (360 N·m) at 2750 rpm.

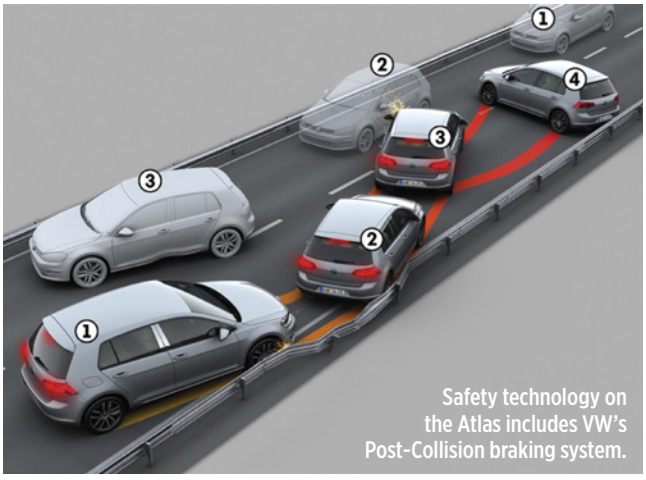
By late summer a 2.0-L turbocharged four from VW's ubiquitous EA288 family joins the lineup. Rated at 235 hp (175 kW) and 258 lb·ft (350 N·m), the turbo four is calibrated for premium 91 RON fuel.

Both engines are equipped with stop/start and are paired with an **Aisin** 8-speed automatic. Driveline choices include FWD (rated at 18 EPA mpg city/25 highway/20 combined with the VR6) or the **BorgWarner**-sourced 4Motion AWD (17/23/19 mpg, with VR6). **EPA** certification of the 2.0-L engine had not been completed at time of publication.

The 4Motion AWD transmits up to 50% of available torque to the rear wheels and vectors torque side-to-side, as needed. Electronic controls offer a selection of driveline modes: Onroad (with Normal, Sport, Comfort and Individual settings); Snow; Offroad and Custom Offroad.

Maximum claimed tow rating with the VR6 (with a factory hitch) is 5000 lb (2268 kg).

Suspended by struts with lower control arms and an anti-roll bar in front, and a multi-link rear set-up, the Atlas is fitted with 245/60R18 **Continental** CrossContact LX Sport tires;



Safety technology on the Atlas includes VW's Post-Collision braking system.

20-in tires will be offered. The vehicle steered and handled crisply and rode smoothly on the twisty Texas two-lanes where we drove it during the media introduction. From behind the wheel, Atlas feels smaller than it is and the VR6 offers pleasing performance.

"For a vehicle of this size, it's very stable on the road," Lovati observed. "The driving dynamic is what customers expect from our MQB technology, adapted to the Atlas' size and weight." Splitting time between two drivers during the media preview, with some aggressive accelerations, we averaged roughly 20 mpg as indicated on the vehicle's display cluster.

A full-LED headlight array (including daytime running lights) is standard; LED taillamps are available Other safety features include VW's Automatic Post-Collision Braking; Lane Assist; Blind Spot Monitor; Autonomous Emergency Braking with Pedestrian Monitoring; Rear Traffic Alert with Braking; Area View; Adaptive Cruise with Stop & Go, and Light Assist and (parallel and perpendicular) Park Assist.

Infotainment and connectivity are served through an 8.0-in Car-Net Infotainment screen in all models except the base S, with available App-Connect (for **Apple** CarPlay); Android Auto and MirrorLink are the standard platforms. For big-screen lovers, a 12.3-in customizable digital cockpit is available. The long list of available features includes sporty R-Line and road-trip-capable Weekend Edition packages; three-zone HVAC; heated outboard rear seats; Fender premium audio; KESSY keyless access; power-operated liftgate with foot-kick "Easy Open" and a panoramic sunroof.

While the Atlas is targeted primarily at North America, it will be exported to Russia, Saudi Arabia and some other markets as the Teramont, a nameplate that also will grace the version manufactured in China (by **SAIC**) for sale there.

VW has been without a competitive entry in this hotly contested segment. The new Atlas appears to have the design, engineering, features and performance it needs—plus a six-year/72,000-mi transferrable "bumper-to-bumper" warranty—to be a serious player in it.

Gary Witzenburg

Loss leader: 2018 Chevy Equinox gets smaller, lighter, tidier

General Motors has made vehicle weight reduction something of a mission for all its brands—and as with every other example we've seen, the weight chopped from the all-new 2018 **Chevrolet** Equinox delivers nothing (well, almost nothing) but good tidings.

Nothing all that radical happened: most of the 2018 Equinox's approximate 400-lb (181-kg) weight loss came from adopting the new D2XX vehicle architecture (also see **GMC** Terrain and **Buick** Envision) that brought a hefty 5.2-in (132-mm) wheelbase reduction from the former 112.5 in (2858 cm) and a 4.7-in (119-cm) clip from the overall length. Engineers also credit the use of a full lineup of downsized turbocharged engines (the first-ever Chevy vehicle to feature all turbocharged engine choices), considerably more use of high-strength steels and an aluminium hood.

The previous Equinox definitely was sized as a "tweener" model—something of a GM penchant—so the size reduction brings the new 2018 model more in line with its rivals. And the tidier dimensions also help the Equinox feel pleasantly nimble on the narrow and twisting two-lane roads on and around the Blue Ridge Parkway where *Automotive Engineering* sampled the new-generation model. It doesn't hurt that the electric power steering's sublime state of tune is one of the best we've lately tried in any crossover.

The 2018 Equinox is 400 lb lighter than the outgoing model and Chevrolet claims class-leading aerodynamics.

The new wheelbase still is 2.5 in (66 mm) longer than the class-benchmark **Honda** CR-V and the 2018 Equinox's overall length of 183.1 in (4651 mm) reflects just about that same difference. In front-drive layout, the newly-lightened Equinox weighs 3327 lb, Chevy said—20 lb (kg) more than a base CR-V. Those numbers indicate the Equinox is a plump-ish tweener no more.

All turbos—including a diesel

There's satisfying if not scorching shove available from the turbocharged 1.5L launch engine that develops 170 hp and 203 lb·ft

(203 N·m) and pushes exclusively through a 6-speed automatic transmission (CR-V's turbo 1.5L: 190 hp/179 lb·ft). This setup would be plenty adequate for the around-the-'burbs duty that comprises the bulk of many compact-crossovers' duty cycle, while the estimated 31 mpg (7.6 L/100 km) highway fuel economy is a strong inducement to consider this smallish powerplant.

To sample GM's new 9-speed automatic, customers will have to plump for the pluckier turbocharged 2L four-cylinder and its 252 hp and 260 lb·ft (353 N·m). The Equinox's market differentiator (at least we'll see if customers see it that way) is the fall arrival of a GM's "whisper" 1.6L turbodiesel four-cylinder that's slated to generate 136 hp and 236 lb·ft (320 N·m); it'll be backed by GM's higher-capacity six-speed automatic. A unique switchable all-wheel-drive system enables selectable decoupling of the rear axle when AWD capability isn't desired.

One teasing diesel thought-starter presented by Steve Majoris, Chevy's marketing boss: some 33,000 people who own a diesel-engine Chevrolet pickup also own a diesel-engine Volkswagen model. As we know, there will no longer be any diesel-powered light-duty vehicles from VW, so where might those Chevy pickup owners turn?

Although the 2018 Equinox is smaller in most critical dimensions, interior volume remains nearly unaffected.

Engineers said some 600 hours of wind-tunnel tweaking went into the new Equinox's smooth, Chevy-familiar shape, paying off in what the company said is a class-leading drag coefficient of 0.336.

Clever rear-seat design enables near-flat floor when backrests are folded.

We can attest to hushed wind-noise levels in the cabin, while the presumably smaller interior doesn't seem that way at all, possibly thanks to the lower windshield and generally more-open cabin design; Chevy backs up this impression by saying measured interior volume is barely changed. Most of the plastics and other interior materials are a noticeable step up from the previous Equinox.

The only cabin compliant we can lodge is with the rear seat. Bravo to engineers for eliminating the fore-aft sliding function, which research determined was virtually unknown and unused by owners and shaved some 50 lb (23 kg) from the crossover's curb weight. And further kudos for the seat's cleverly simple seatback-recline mechanism. But we found the seat bottom to be hard as a parson's pew, a inflexibility that cannot be construed as "support." Weight savings gone a bit too far?

With three attractive engine choices and a new, wieldier size that makes it more dynamically satisfying, the 2018 Equinox is a formidable effort in a segment that, along with fullsize crossovers, now accounts for one of every four light vehicles sold in the U.S. The former Equinox already was GM's second best-selling model, trailing only the Silverado pickup line, and Majoris is understandably confident the all-new 2018 Equinox can do better.

"We're here to gain share," Majoris asserted. "We plan to sell more Equinoxes than ever."

Bill Visnic

Nissan engineers Sport into its hot-selling CUV

With smaller exterior dimensions, a 200-lb (91-kg) mass reduction and unique chassis tuning, the 2017 Rogue Sport crossover utility is a variant of **Nissan**'s top-selling U.S. model. Called the Qashqai in Canada and other markets, the vehicle is based on Nissan's CMF-CD platform.

"For ride, handling, steering, NVH and quality, the Rogue Sport is close to a circle on a spider chart; it's a very well-rounded vehicle," said Bruce Robinson, Senior Project Engineer for Vehicle Performance Development-CBU at the Nissan Technical Center North America in Stanfield, Arizona.

The Rogue Sport's primary engineering work was done in Japan and suspension tuning and steering calibrations were handled by Robinson's NTCNA team. They changed the base tuning that came from Japan.

"We wanted a little bit lighter steering effort for parking and city driving and a more on-center, stiffer steering feel for highway driving," Robinson told *Automotive Engineering* at an April media ride-and-drive program in Nashville, TN. Rogue Sport features electric power steering with a Sport mode that's not offered on the conventional Rogue.

Rogue Sport is approximately 200-lb lighter than Rogue, due in part to the vehicle's smaller body. Its 104.2-in (2647-mm) wheelbase, 172.4-in (4379-mm) length, 72.3-in (1836-mm) width, and 62.5-in (1588-mm) height for the front-drive model make for a more compact vehicle. Both Rogues ride on the same Common Module Family platform and are available


The 2017 Nissan Rogue Sport is assembled in Japan. Its engine is assembled in Mexico.


The smaller body of the new Rogue Sport (left) enables the vehicle to be up to 200 lb lighter than the conventional Rogue.

with FWD or all-wheel drive.

A 2.0-L inline 4-cylinder (MR20DE) delivers a claimed 141 hp (105 kW) at 6000 rpm and 147 lb·ft at 4400 rpm. That same engine powers the hybrid-electric Rogue, which uses a 30 kW (40 hp) electric machine for a combined system rating of 176 hp (131 kW). Rogue Sport's engine mates with a JATCO-supplied Xtronic CVT with eco mode switch and sport-mode shifter.

Smaller exterior dimensions for Rogue Sport mean reduced cargo space versus the Rogue and its available third-row seating. With the second-row seat upright, Rogue Sport has up to 22.9 ft^3 of stow space, compared to Rogue's 32 ft^3. With second row seat folded, Rogue Sport has up to 61.1 ft^3 of storage versus Rogue's 70 ft^3.

Rogue Sport went on sale in the U.S. on May 17 in three trim levels with a $21,420 MSRP for the base FWD model. The base AWD model is $22,770.

Kami Buchholz

Tackling NVH

ONE dB PER DAY

A familiar sight to vehicle acoustics engineers: an Aachen HEAD binaural measurement system HMS IV is installed in a test vehicle. (Wade Bray/ HEAD Acoustics Inc.)

New tools and technologies are helping engineers reduce vehicle Noise, Vibration and Harshness.

by Lindsay Brooke

The vehicle chief engineer did not like what he was hearing on this recent evaluation ride.

He was reviewing a new transmission scheduled for production in his company's iconic sporty car. But the marriage of transmission and platform was generating unacceptably high cabin-noise levels. The CE wasn't pleased. His design and manufacturing engineers explained that the new gearbox featured a thin-wall aluminum case for reduced mass. However, the lightweight case was the noise transmitter.

The tooling investment had been made and the program clock was ticking. So a phone call went out to Pranab Saha.

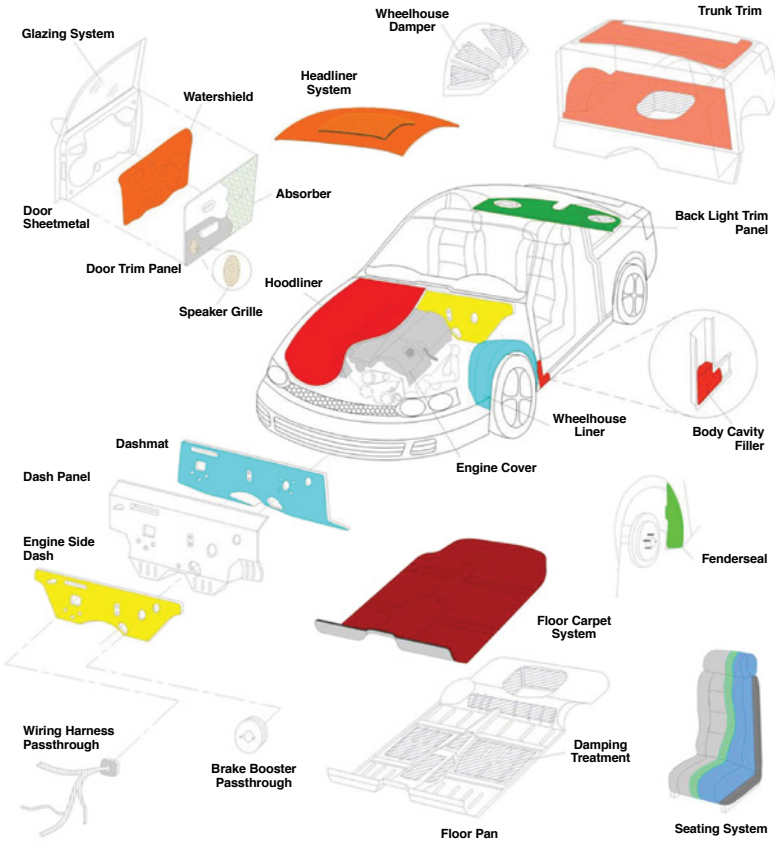
"They called me in to help them devise a solution," said Saha, an acoustics expert and board-certified noise control engineer with consultants **Kolano & Saha** in Waterford, MI. He said the client's original design blanketed the lightweight transmission case with a foil-backed insulation material. Problem was, the blanket included multiple cut-outs so that linkages and wiring could pass through. The cut-outs were built-in noise paths.

Saha's suggestion: Rather than place the insulation material on the transmission case, use it to line the underside of the transmission tunnel. The engineers would revisit their CAD drawings and revise the parts. Their next step is to launch a noise study to prove the new solution's effectiveness.

"That's one of many examples of us getting called in to solve a problem—where is the best place to install NVH countermeasures?" Saha noted.

The science of analyzing, attenuating and eliminating Noise, Vibration and Harshness has become an integral aspect of vehicle development. NVH engineering teams now push for "one dB [decibel] per day" reductions in cabin noise levels with the same verve their colleagues devote to attacking excess vehicle mass and increasing fuel efficiency.

"The N&V [noise and vibration] discipline is unique because it's driven by market competition, rather than by government legislation," Saha explained. "The OEMs now brag about the superior interior sound quality and low noise levels of one model versus another. And this will certainly grow more important as technologies such as cylinder deactivation, hybrids



The complexity of a typical passenger vehicle's NVH package laid bare. The potential to add mass is obvious. (Kolano & Saha Engineers)

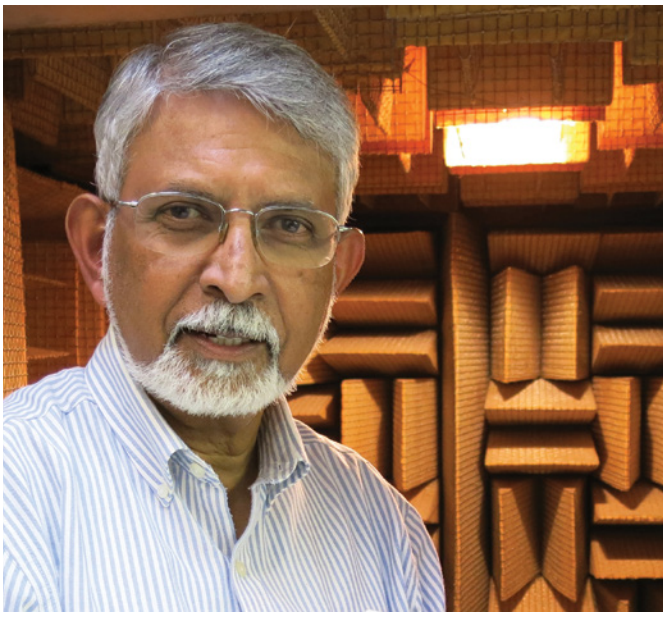
and electric vehicles enter the market."

Quieter and smoother are requisites for the new human-machine interfaces (HMI) being developed for automated vehicles, said Joe Emmi, vice president of global product strategy and head of the Anti-Vibration Systems group at **Cooper-Standard**. "Reduced cabin noise is particularly important for voice-recognition systems," he noted.

OEMs and Tier 1s have invested billions in new NVH software, facilities, materials R&D and in the expertise of acoustics specialists in the field. Makers of the absorptive materials that are vital to automotive NVH abatement also are riding a hot growth curve. The global market for their products is projected to reach $13.52 billion by 2021, at a compounded annual growth rate of 6%, according to a 2017 study by **Grand View Research**.

Astute suppliers are branding their technologies to suit. The growing list includes **Material Sciences** Corp.'s "Quiet Steel" used in dash panels; Japan-based **Technol Polymer** Co. Ltd's "Hushlloy" anti-squeak thermoplastics, and **Sika Automotive**'s "Sika Damp," a co-extruded elastomer aimed at dampening body-panel resonance.

The industry's commitment to NVH engineering has driven the market for dedicated software programs familiar to engineers: **SCS**'s V-Path for transfer path analysis; **HEAD Acoustics**' Artemis; **Genesis**' LEA; **Altair Engineering**'s HyperWorks suite, as well as NVH toolsets built into **Dassault Systemes**' CATIA V6/3DS, **Siemens PLM** and many others.



Pranab Saha, Ph.D, P.E., at one of his company's anechoic test chambers. (Lindsay Brooke photo)

SAE International has long served as a professional forum for NVH engineers, with its biennial Noise and Vibration Conference and Exhibition (held this month in Grand Rapids, MI) the premier technical event on the subject.

Playing the 'what-if?' game

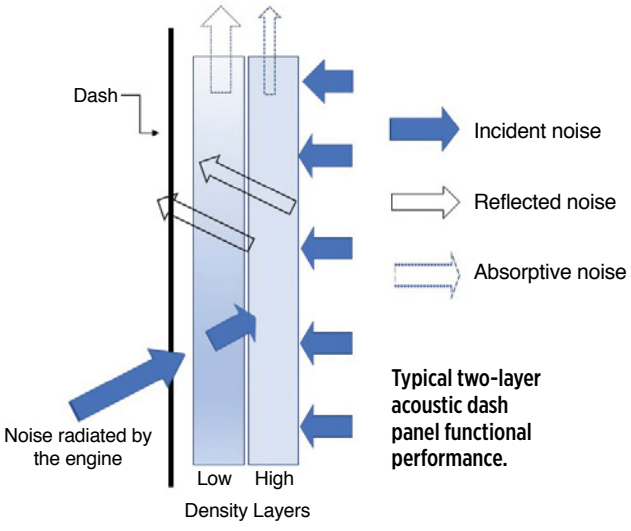
N&V engineers live in a realm of Sources, Paths (structure-borne and airborne) and Receivers (the noise and vibration targets) where up-front problem identification and solving are critical to success. They focus on quantifying the relationship between objective parameters, such as precise sound and frequency measurements obtained through data-acquisition methods, with a degree of informed subjectivity.

End-customer input is part of the analysis process; to many of them enhancing sound quality is as important as reducing annoying noises and overall volume. Psycho-acoustics specialists agree. Loudness, sharpness and the articulation index (a measure of the intelligibility of hearing speech within a given noise environment) are all subjective parameters.

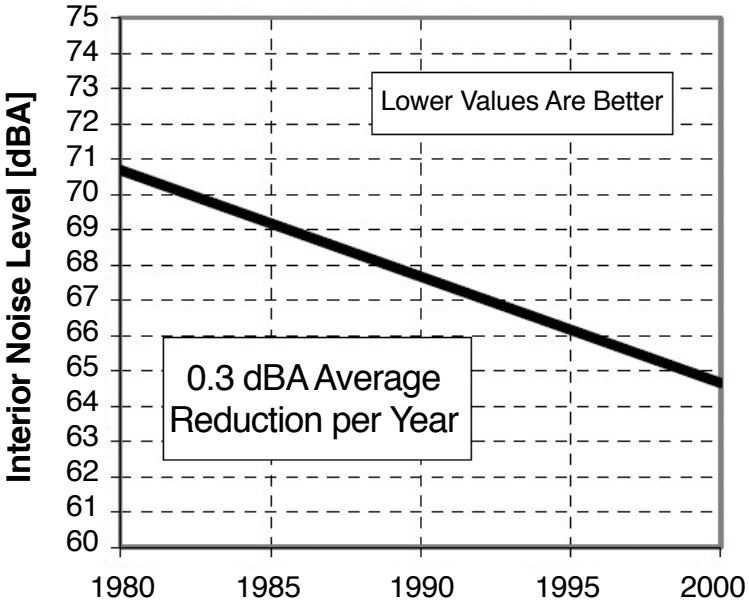
Experts interviewed for this article agree that lightweight aluminum body structures, in modal analysis, present different and often more challenging N&V characteristics than do steel structures. Keeping vibration in check requires greater stiffness in the body panels and additional damping materials such as LASD (liquid applied sprayable dampening) underbody mastics and cavity-filling acoustic foams.

Tackling NVH

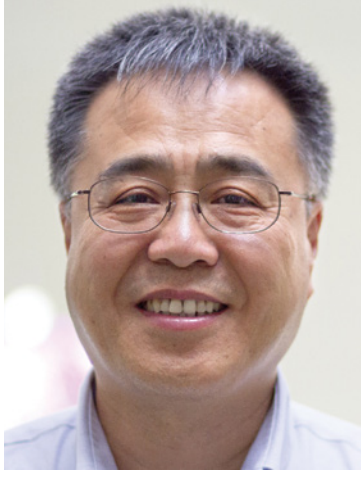
ONE dB PER DAY



Typical two-layer acoustic dash panel functional performance.



Interior noise level reduction during the first 20 years of the industry's focus on attenuating NVH. The job has gotten tougher in recent years. (Car and Driver)



"Without a full-vehicle model we wouldn't be able to determine how aluminum factors into the vibration requirement versus a steel vehicle," noted Jianmin Guan of Altair Engineering.

In some applications, active noise control systems are employed (see **Honda** sidebar). Such solutions are sometimes dubbed "band aids" because they don't address root causes that typically originate in a fundamental structure—an excessively resonant cylinder block, for example. And they add mass.

Observed Richard Yen, Senior VP Automotive at Altair Engineering: "A lot of companies do a good job in NVH but basically they're applying a lot of testing at the end of the vehicle development cycle. They spend a lot of money trying to fix the problems."

When working with aluminum, engineers often add more material to achieve the same amount of NVH reduction of a heavier steel structure. As a result, NVH specialists "see evidence of trying to 'buy more space' within the vehicle to make room for absorptive materials, instead of addressing the fundamental structure issues," said Saha. "They rationalize that absorption materials don't weigh as much."

Dash mats have become a strategic bulwark in the battle to keep powertrain noise out of the passenger cabin. The mats cover the cabin side of the dash-panel bulkhead formerly known as the firewall. They used to serve as a barrier and decoupler. Today, dash mats essentially play an absorptive role. Known as 'dissipative' materials, they require more cross-sectional space.

The growing number of OEMs who have embraced engine cylinder deactivation as a fuel-efficiency play is sparking innovations related to NVH created by uneven firing when a 60° V6 switches to V4 and V3 operating modes, for example. Signature vibrations and acoustic patterns are created by these events, with powertrain excitation entering the cabin as low-frequency "boom," depending on the leak paths.

Managing torque-converter clutch slip, adoption of active engine and transmission mounts (typically effective but costly) and active noise control using the vehicle's audio system can be effective solutions for mitigating the unique NVH challenges of cylinder-deactivation engines. [SAE Technical Paper 2014-01-1675, published by **Tula Technologies**, offers more detail on this subject.] Composites offer vibration-absorbing benefits in some torque-reaction applications. For this reason Cooper-Standard is launching a new continuous-fiber thermoplastic engine mount on a European vehicle.

Full vehicle modeling

Modeling in the NVH arena is increasingly sophisticated. Core among them are SEA (Statistical Energy Analysis) packages including SEAM 3D, developed by **Cambridge Collaborative** Inc. to study structure-borne noise in submarines. It has since been adopted by the auto industry as an effective CAE design tool to develop NVH sound packages for use in lightweight vehicle design. Using SEA, engineers can evaluate the dynamic response of complex structures at mid and high frequencies

A view "behind the wheel" of Altair Engineering's pioneering full-vehicle NVH simulator.

and recover the NVH deficiency created by the lightweighting actions.

SEA "enables acoustics engineers to play the 'what-if' game," said Saha. "For example, if mass is reduced in a subassembly, what then will be the noise level?"

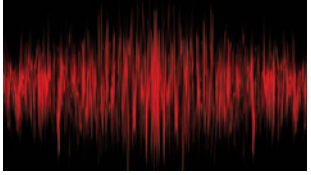
General Motors recently began using a modeling tool developed in-house called DISPET that lets engineers optimize NVH packages across vehicle families. With primary inputs being vehicle body design and powertrain noise, they can specify the NVH materials needed. "Users only input the measured acoustic data for a given thickness and surface density," says an engineer familiar with DISPET. "The system will tell you if it meets the target or not. And if you don't know the target, DISPET will tell you if you're 1 dB above or 1dB below (or not), at every frequency."

Full-vehicle NVH simulation is viewed as a competitive advantage whose internal processes the OEMs guard closely. About five years ago, Altair Engineering took the lead on commercialization.

Altair's NVH Simulator looks like the console of a cool computer video game, with a big flatscreen in front of you that puts the driver "on the road."

"With the Full-Vehicle Simulator, we build a simulation model that uses testing data to drive a model of the vibration and acoustic environment in the vehicle," explained Jiamin Guan, Altair's Director of Vibration and Acoustic Solutions. "It takes data from vehicle operation under various conditions and allows you to listen to those as you would hear them in a real vehicle."

Altair partners with noted instrumentation specialists **Brüel & Kjaer** to create the "real vehicle" experience. The model is built right at the beginning of a vehicle program, during benchmarking and specifications-setting. Altair starts with an imagined target customer and data on how the vehicle fits into their usage. The model team then builds a competitive set, adds packaging and functional requirements, then brings in customers to listen to and experience the measured data.



Tackling NVH

ONE dB PER DAY

The full-vehicle model "allows a broad spectrum of people to experience the noise and vibration levels we're trying to target—and see if they agree with those targets," Guan noted. "Based on the playback of the noise and vibration we hone in on specific areas. We see what people really prefer and object to and what "sound quality" means to them. Once we have the targets, this helps us and the client consider how we will achieve them."

The tool, Guan claims, gives engineers the freedom to make changes and evaluate conceptual options under weight and cost constraints. "Without a full-vehicle model we wouldn't be able to determine how aluminum, for example, factors into the vibration requirement versus a steel vehicle. These are constructs you can evaluate in the full-vehicle model, whether you can meet the targets or not."

The subject of Vehicle Electrification seems to enter most conversations about NVH. Is it making acoustics and N&V experts' jobs easier or more difficult? "We're getting calls to help decide on sound-package materials—acoustics and seals—for new EV programs," said Saha of Kalano & Saha. "The supply base is moving on this trend although we haven't seen dramatic changes yet." He and other experts noted that although EVs' overall sound level is low, other noises previously masked by the combustion engine are now more audible.

"NVH engineers are still working out the sound packages to address the new frequency ranges of future electrified vehicles," he explained.

Life in the 3rd-row seat

Andrea Martin, Honda's principal engineer for cabin quietness, talks to Editor Lindsay Brooke about developing the 2018 Odyssey NVH package

Andrea Martin led the NVH engineering team that created the new Odyssey's placid cabin. (Lindsay Brooke photo)

Tell me about the genesis of Honda's NVH work on the 2018 Odyssey.

We started with a blank sheet. Improving cabin quietness was an investment priority, particularly the AI [articulation index] from the first row to the third row. Sometimes third-row seating noise levels can be an afterthought, but I spent a lot of time sitting in that third row during development! I wanted to make sure we made it almost as quiet as the front row. It's a high-frequency issue when you're talking about making a conversational cabin.

What does that mean in terms of dB?

The new Odyssey is about 2-3 dB improvement over the current vehicle. Anyone will be able to hear 2-3 dB in both mid and high frequency. For NVH our high frequency range is 630 Hz to 10,000 Hz. We went after 1000 Hz because that's about the frequency of our voices, where we speak. That way you can have easy and clear conversations and not have interference from the road and the wind.

There are many compromises in achieving good NVH, such as minimizing the number of holes in the structural bulkheads.

Correct. We started on our NVH work early in this program. We went to our body designers and said, 'We can't have too many holes.' Where we have holes in bulkheads we have to do a really good job of treating and sealing them, such as where

Honda committed major NVH engineering resources to give the 2018 Odyssey's cabin best-in-class AI performance. OEMs , here's your new benchmark minivan.

the wire harness passes through. Noise is very sneaky! Working on this was very tedious, I'll tell you. The nooks and crannies are of the utmost importance in delivering a quiet cabin.

Where the dash insulator and carpet connect is an engineered interface. We had lots of iterations to ensure we balanced out cost and weight. NVH can be both very expensive and it can also be low-hanging fruit. So we started from the fundamentals: What can we fix and improve without having to add a 'band-aid' later on?

The first thing we looked at was the body structure itself. It's all steel except for the hood and 44% more rigid than the outgoing vehicle. The cross-car structure is Magnesium, cast in one piece versus a multipiece fabrication in steel. We get significant rigidity out of the single piece and save 10 kg. We also have the new Honda 10-speed automatic and torque converter that gave the Powertrain group more flexibility in developing their N&V package.

How about underhood blankets, mastics, etc.?
The treatments are engineered to best handle specific source frequencies. Our dash insulator has a heavier barrier for example because it handles low and mid frequencies from the engine. On the outer side we have an insulator that's good for higher frequencies. The underhood insulator is a fiber-based material that's very light and absorptive for the high frequencies.

We don't have as much insulation as on the previous vehicle because we made sure this one was sealed! Every little joint where the sheet metal intersects is sealed; we worked hard with the factory to do this. The welds are sealed. We worked with them in spray-foam applications as well. All of the pillars are blocked; a fly could not get in. There is spray-foam insulation on 14 specific applications. And all of our doors are triple sealed.

Any changes in the vehicle carpet?
Huge changes there. Before we had a shoddy type of material that was formed with a tool. The new Odyssey has foam underneath the carpet and the barrier is heavier in cross section. This will give us improved mid-frequency performance in road noise. It's really thick underneath the third seat, too. The headliner has foam, too, and provides some level of absorption.

Did you employ active noise cancellation?
Yes, the 2018 Odyssey has ANC. We use it primarily for the cylinder deactivation when we go from six-cylinder to three-cylinder mode. Without it we'd get some booming in the cabin.

How about the Aero component in the new Odyssey?
Lots of CFD analysis and wind tunnel modeling. The exterior mirrors were the focus of a lot of CFD. We used acoustic glass in the windshield and in the front doors. Acoustic glass is lighter than conventional glass and gives us that 1000-Hz benefit. ■

Artificial Intelligence becomes A REALITY

Artificial Intelligence will help vehicle systems identify objects and determine how to navigate around them. (image: ZF)

Automakers could be among the leaders in deploying AI in free-standing, high-reliability environments. But developers must determine how to mitigate undesirable side-effects.

by Terry Costlow

The soaring role of software has already fostered many changes for automakers, but those transitions may pale in comparison to the challenges expected when Artificial Intelligence is employed in the race to autonomous driving. Machine learning cedes even more control to software, raising myriad design and testing issues—while also provoking legal and ethical questions.

Automakers and Tier 1s alike are embracing AI's potential, saying it's needed to analyze the myriad elements that self-driving cars must understand. **Ford** invested $1 billion in startup **Argo AI**. **Toyota Research Institute** will devote $1 billion to AI development over five years.

When the **Bosch** Center for Artificial Intelligence was created, executives said "ten years from now, scarcely any Bosch product will be conceivable without artificial intelligence." These investments are needed because programmers can't write the software code that will be needed for vehicles that navigate without human control.

"Most current advanced driver-assistance systems based on radar and cameras are not capable of accurately detecting and classifying objects—such as cars, pedestrians or bicycles—at a level required for autonomous driving," said **Visteon** President and CEO Sachin Lawande. "We need to achieve virtually 100% accuracy for autonomous driving, which will require innovative solutions based on deep machine-learning technology."

Although AI's been heavily touted, deploying it won't be easy. The technical issues are many—and its role in shaping autonomous-driving principles also means social and regulatory issues will be key factors in its acceptance.

Critics question whether anyone will be able to find all the potential bugs in AI-reliant software to make it live up to the hype of accident-free roadways. Developers note that AI can reduce accidents and related injuries. But it will be hard to quantify those improvements.

"We can't promise that self-driving cars won't cause accidents," said Martin Richter, Vice President, Vehicle Systems at **IAV** Automotive Engineering. "But we can make sure that these vehicles will kill fewer people than human drivers. Companies will need to keep statistics, looking at the number of accidents to determine if they're developing good systems. Companies will have to prove that in so many miles, vehicles had this number of accidents. Companies and regulators will have to define acceptable levels for accidents."

The difficulty of defining performance levels for software that changes its responses over time is augmented by the need for cloud computing and over-the-air (OTA) updates. As vehicles learn, strategists also have to figure out how to share the learning throughout fleets. Many observers feel that individual vehicles shouldn't be allowed to alter their behavior without some form of authorization.

"When it comes to safety-relevant features, vehicles should not be allowed to learn by themselves," said Demetrio Aiello, Head of Artificial Intelligence and

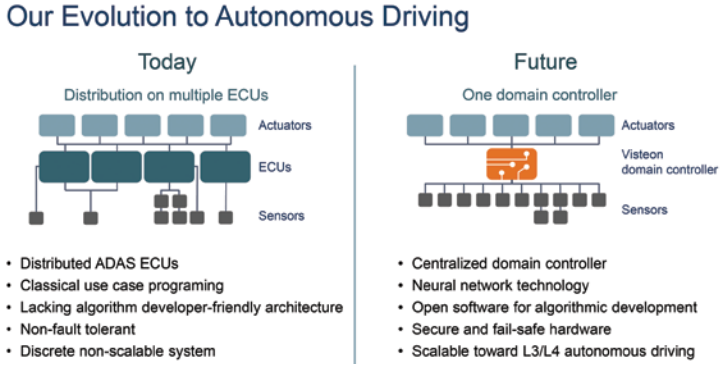
Robotics at **Continental**. "Rather, each vehicle should forward its experiences to a back-end system for collection. These data can then be used to generate—and validate—new and more performant algorithms that can be distributed to all the vehicles via OTA updates. Therefore, during the vehicle lifetime safety can only be increased and not compromised."

Cloudy future

Remote computing will be a critical aspect of any AI-based system, following the trend in commercial environments to process AI using cloud computing. A growing number of automakers are setting the stage by using the cloud for complex tasks like voice recognition.

The combination of autonomy and cloud computing makes security a primary design concern. AI may go beyond its role in driving decisions and help in the battle to prevent hackers from tapping into cloud connections to control autonomous cars or steal information.

"Connectivity will enable developers to continuously upgrade software and also to monitor the performance of automotive systems," said Upton Bowden, director, advanced technology planning at Visteon Corp. "Clearly, the connection also brings about the requirement for internet security protocols to make these connected vehicles 'hack proof.' Artificial Intelligence will also play a role in detecting malicious hacks and in training vehicles on how to block threats."



Electronic architectures from Visteon will evolve significantly as AI and autonomy roll out.

Hardware sets the stage for AI advances

The adoption of Artificial Intelligence both heightens and alters the auto industry's need for greater processing power. When machines learn using information from several high-bandwidth sensors, microprocessors often manipulate gigabits (Gbit) of data in seconds.

"Systems do need a lot of processing power; the amount of data is pretty large," said Pat Bassett, Vice President at **Denso**'s North American Research and Engineering Center. "Systems have to make hundreds of thousands of decisions."

That's driving rapid changes in both microcontroller electronic control unit (ECU) architectures and networks. Ethernet, graphics processing units (GPUs) and field-programmable gate arrays (FPGAs) are currently in the spotlight.

"Many companies are developing centralized controllers that are connected using Gbit Ethernet," said Oliver Briemle, Senior Manager Domain Units & Car2X at **ZF**. "Parallel processing with AI is key for us; it will be a game-changer. **Nvidia** currently has the advantage; they have an established network of developers. But all CPU companies recognize that AI is a game-changer, so my view is that we'll see many new market entries."

Central-processing electronic control unit (ECU) architectures and communication networks are evolving as AI requirements become better understood. (image: ZF)

While Nvidia has built a solid reputation in what it calls "deep learning," other chipmakers aren't willing to concede the enormous market predicted for AI-based products. While other chipmakers focus their controller strategies, many developers may utilize FPGAs; FPGAs are comparatively expensive for production runs, but that's a somewhat minor concern given the long-term nature of many AI projects, since there's time to turn FPGAs into system-on-chip solutions.

"GPUs and FPGAs are fundamentally different," said Stephan Tarnutzer, Vice President, Electronics, at **FEV** North America. "GPUs use a lot more power than FPGAs, but platform development with GPUs is easier because with FPGAs you have to set up the FPGA before you start. Still, the power requirements are significantly different and that's a factor when we're doing everything we can to improve fuel efficiency."

Technical issues must be measured in conjunction with business goals of efficiently embedding the necessary level of AI within the vehicle. Automakers will probably leverage cloud connections. But analysis of factors like crash avoidance can't rely on cellular links to servers that may put requests into queues.

"AI has typically been implemented in large server farms for computer and internet applications," said Upton Bowden, director, advanced technology planning at **Visteon** Corp. "For autonomous driving, a portion of AI will need to be fully contained within a vehicle for time-critical processing that cannot rely on a data connection beyond the vehicle."

The latency of 4G and eventually 5G networks is far from the only communications concern. Design teams also are concerned about the speed of communications between sensors and ECUs.

That's prompting a changeover to Ethernet-based networks. When vehicles are making life-and-death decisions to steer and brake, system developers need to employ communication systems with established latency times so they can account for these delays. Some developers plan to add time-sensitive technologies to Ethernet.

"The network must be scalable in terms of bandwidth (different speed grades) and in terms of real-time capabilities, quality of service," said Demetrio Aiello, Head of Artificial Intelligence and Robotics at **Continental**. "This network is going to be the first automotive one offering its own functionalities on a network level. Therefore it is named 'intelligent network,' which is based on time-sensitive networking (TSN); TSN is a set of standards which is in specification phase at IEEE at the moment."

Terry Costlow

Artificial Intelligence becomes A REALITY

AI systems such as those from Continental will learn continuously as they strive to drive more like humans.

Lidar, cameras and other sensors are employed by Toyota to provide the inputs necessary to navigate safely.

Prove it

AI will bring many benefits, but they won't come without challenges. Testing and validating software already is a huge chore for developers. Understanding how AI impacts reliability over time will make that task even more difficult; AI in fact may become integral to testing the software created by other AI systems.

"It's a huge challenge to test something that changes its behavior," said Stephan Tarnutzer, Vice President of Electronics at **FEV** North America. "When you bring in AI, you have to bring in ways to ensure that in two years, the systems still have the same outcome. Highly-piloted cars can't be tested with traditional techniques; testing also needs to go to AI very soon."

Determining the risks associated with these technologies will be equally challenging. AI programs often involve many systems. The complex, multi-disciplinary aspects of autonomous driving pose major challenges to those who must ensure that the benefits are gained without any undesired side-effects.

"A key role of the developer will be to develop the skill to apply the industry's risk assessment tools in a complex, multi-dimensional environment where subsystems are interacting with other subsystems, and where vehicles are communicating between vehicles, to external infrastructure, and to the cloud," said James Schwyn, Chief Technical Officer at **Valeo** North America. "Developers also need to stay abreast of the latest developments in hardware security."

Though AI is a new technology in the fledgling autonomous driving field, some companies already have used it in speech recognition and advanced driver-assistance systems. Developers of piloted and autonomous vehicles are likely to begin employing it in fairly controlled applications, then expand into more areas. As Lidar and more sensors are deployed, AI's ability to accurately recognize objects will improve.

"A key technological challenge is improving robustness," said John Leonard, Autonomy Director for the Toyota Research Institute. "Current AI systems can achieve high performance in relatively narrow domains and in favorable conditions, but can encounter difficulties when operated in challenging environments."

Automakers could be among the leaders in deploying AI in free-standing, high-reliability environments. Development tools aren't yet available off the shelf, so design teams typically have to pull elements from a range of sources.

"Some comes from universities, some from public domain; there are also freeware and open code-sharing tools," FEV's Tarnutzer said. "You probably need a combination of the three. In nearly all cases, there's a lot of software integration, calibration and a whole lot of testing."■

AI digs deeper

Artificial Intelligence has been around since the 1950s, but in many ways it's still an emerging technology. Large systems for years have utilized various forms of AI, but the technology only now is becoming viable in mass markets like automotive.

AI's evolution has snowballed in recent years, gaining momentum as more sophisticated techniques could be deployed on more-powerful microcontrollers designed for tasks like graphics processing and image recognition. AI has morphed into variants like machine learning and deep learning, which make it easier for systems to basically program themselves. AI remains something of a catch-all term for the newer variants.

Deep learning is evolving quickly now that microprocessor power and parallel architectures let engineers create systems that better understand inputs from sensors like cameras and Lidar and develop strategies to quickly deal with detected objects. It adds more levels during processing, which helps ensure accuracy while providing more depth of understanding for objects and related decisions. Deep learning, which has been used to improve voice recognition, helps automotive systems learn that hexagonal red signs require a vehicle to stop, for example—and eventually help drive more like a human.

That's important because no programming team can write all the code needed to identify pedestrians, bicycles, road signs and all the other objects and situations autonomous vehicles need to understand. AI-based systems can train themselves to recognize objects in a range of variables such as weather, lighting and obstructed views. They also can learn how to navigate based on parameters like the location of fixed objects, which can be relatively simply mapped.

Often, AI systems are taught by observing human drivers. But as developers push toward autonomy, they're devising more ways to create learning programs that live up to their name, with little input from humans.

Terry Costlow

Valeo's CES 2017 booth let humans pit their skills against an AI-based autonomous vehicle on a simulated course.

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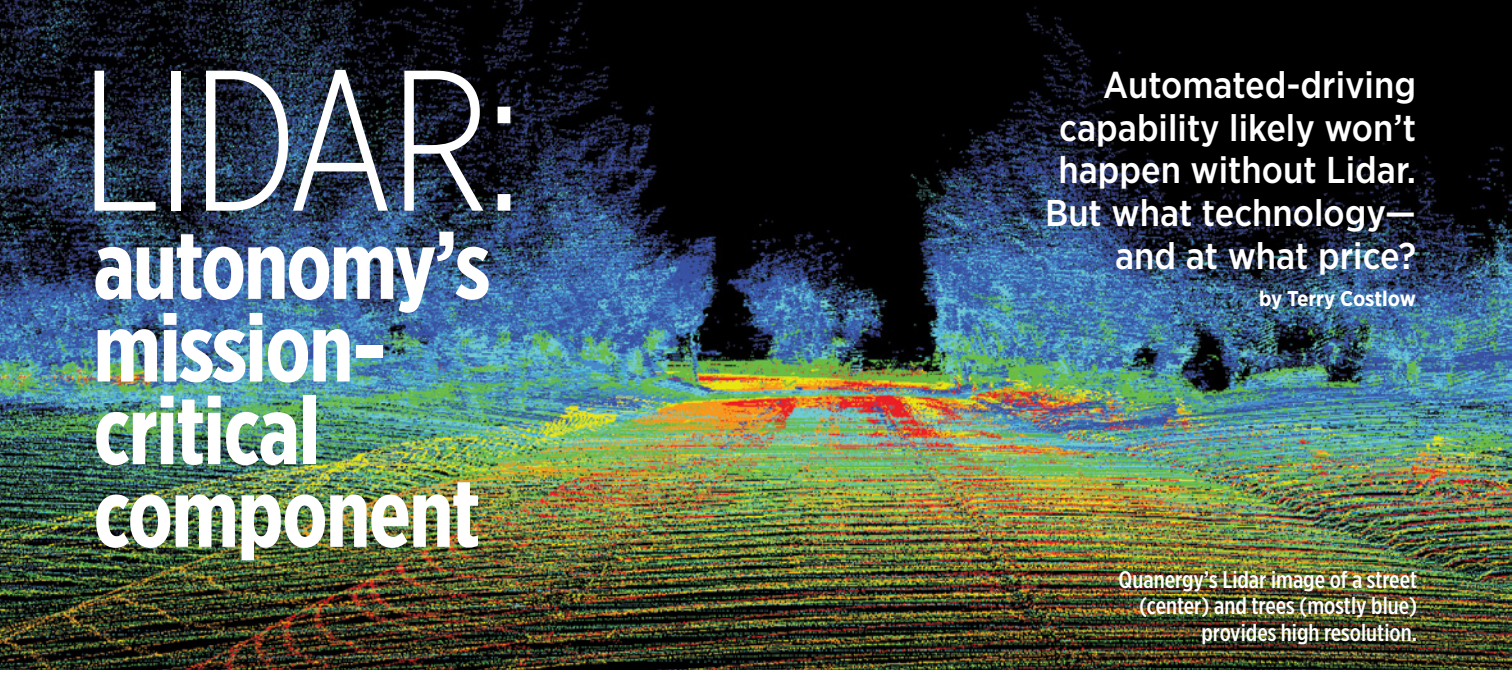
LIDAR: autonomy's mission-critical component

Automated-driving capability likely won't happen without Lidar. But what technology—and at what price?

by Terry Costlow



Quanergy's Lidar image of a street (center) and trees (mostly blue) provides high resolution.

Many autonomous-driving development plans call for deploying a handful of solid-state Lidar sensors on each vehicle, but the Lidar modules used for today's prototype vehicles all are mechanical systems with moving parts. That's prompted huge interest in Lidar, with OEMs and suppliers racing to invest in non-mechanical technologies.

Several small companies have developed solid-state Lidar technologies that aren't ready for automotive applications—and some of those have been gobbled up by major automotive companies in the past 18 months. **Ford** made a large investment in **Velodyne**, while **ZF** bought a 40% stake in **Ibeo**. **Continental** acquired **Advanced Scientific Concepts**. **Analog Devices** Inc. (ADI) acquired **Vescent Photonics Inc.**

The interest stems from Lidar's use of emitted laser light to measure the distance of objects, functioning much like radar. The laser lets the system provide high-resolution imagery at night and in rain or snow.

"High-resolution 'flash' Lidar is a necessary technology for autonomous driving because its capabilities are available in all lighting and weather conditions," said Dean McConnell, Director of Customer Programs, Advanced Driver Assistance Systems, at **Continental** North America. "We're capturing images at 30 Hz, constructing 3D point clusters thirty times per second."

The technology also helps safety systems zero-in on objects of interest, to determine whether an object is a threat to driving.

"Lidar acts more like the human eye: it views a broad scene, doing a quick scan, then if it sees something interesting, it can focus in on that," said Chris Jacobs, General Manager of Automotive Safety for ADI.

Lidar providers currently are racing to develop compact solid-state modules because the large mechanical "pucks" now used by autonomous-driving researchers are too bulky and costly to go into production vehicles. Researchers are striving to shrink sizes and come up with a good combination of distance and field of view.

"Our solid-state box measures 9 x 6 x 6 cm, about the size of two decks of cards," said Louay Eldada, **Quanergy**'s CEO. "Currently, it has a 120-degree field of view, so with three you have 360 degree coverage. There will always be two in the front, on the right and left sides, and one in the back middle or one on each corner."

Determining the vehicle's distance to objects, a key parameter for safety, can be increased by narrowing the field of view. Developers are trying to achieve the same distance levels as cameras and radar, with a goal of around 200 m (656 ft). To achieve desirable distance performance, several tradeoffs are being considered. Location points are key parameters that help determine field-of-view coverage; modules looking to the sides, for example, won't need the same range capability as forward-facing units, so their field of view can be wider.

"We've demonstrated 70 meters (230 ft) with a 15-degree field of view, which is clearly not sufficient," said Aaron Jefferson, Director of Product Planning for ZF's Active and Passive Safety Division. "It needs to go up to 50 or 60 degrees to start. When the cost gets down, it's conceivable that they could be integrated into taillights and headlights."

Lidar will complement cameras and radar, providing information that typically will be "fused" with that from other sensors to create a reliable image of vehicle surroundings. All these sensors generate a huge amount of data, making communications and data management an important factor in overall designs.

"3-D Lidar sensing will create a significant amount of data, but similar to radar and camera, there are software techniques to help minimize the amount of data, eliminate useless or unimportant data and extract the detail from the data of concern," Jefferson said. "Furthermore, the techniques used to filter data, group/cluster data, identify objects, etc., also determine the amount of data that needs to be processed, which is the real concern in terms of managing data volume."

Curiously, no real hurry

Though there's plenty of development, the market isn't expected to see much activity for some time. Many engineers say Lidar can develop slowly while waiting for autonomous vehicle designs to solidify. For now, system designers can create prototypes using mechanical components while they wait for next-generation modules.

"Solid-state Lidar will be in production later this year, but for pilots and software development, you

Solid-state Lidar modules from Continental (shown) and others are expected to be on most autonomous vehicles.

don't need solid-state," Eldada said. "Though we plan to ship solid-state products in September, we won't have automotive-grade parts ready until a year later."

The rollout of Lidar-equipped vehicles is as murky as the emergence of autonomous cars. Corporate fleet programs like **Uber**'s autonomous current tests in Pittsburgh may expand into market opportunities before mainstream OEMs start ordering Lidar sensors.

"We're looking at series production in the 2021 timeframe, but it may happen faster in different segments," McConnell said. "Some fleet-service companies are aggressive about getting vehicles out with automated driving in a geomapped area."

Once Lidar is in use, many developers don't expect it to displace many other sensors. A range of technologies is needed to provide the capability and redundancy needed to drive autonomously in all weather conditions.

"We do not see 3-D Lidar as a sensor replacement, but rather as an innovation that can enables the high-resolution sensing needed to realize **SAE** Level 4-plus automated driving," Jefferson said. "3-D solid-state Lidar, camera, radar, ultrasonic sensing and other technologies will continue to play a role—a combination of these will be necessary to properly sense the vehicle environment in 360 degrees, in real time."

That's not a universal conclusion, however.

"Ultrasonics will go away," Eldada countered. "Video is needed for color, things like seeing traffic lights. Fusing Lidar and cameras 'colorizes' our data so it's more valuable. Radar is needed for redundancy; you need another sensor before deciding to steer or hit the brakes." ■

FORMULA ONE goes longer, lower, wider for 2017

Formula One's 2017 look: in addition to being wider, the front wing stretches farther forward, while the rear wing is moved farther aft (image: XPB/James Moy Agency via RenaultSport).

The complexity of the multi-element front wings is on display here (image: XPB/James Moy Agency via RenaultSport).

New rules make the cars faster and more aggressive-looking, with a wider track, wider tires and bigger wings.

by Dan Carney

American Formula One viewers squinting through bleary eyes at the live early-morning broadcasts from Europe have noticed changes to the sophisticated race cars for 2017: they are visibly lower, wider and squatter-looking than last year's cars.

What hasn't changed is the continuing use of the hybrid-electric systems with electric motors to augment the combustion power of turbocharged 1.6-L 90-degree V6s. Teams admit that the internal-combustion engines produce more than 600 hp (447 kW), while the electric motors add another 160 hp (119 kW) for about 33 seconds during each lap—though it is suspected that the front-running **Mercedes-Benz** and **Ferrari** teams are well ahead of the official ratings.

Engines are restricted to 15,000 rpm by the regulations, but a mandatory instantaneous fuel-flow limit has the practical effect of keeping them from ever reaching that peak.

The 2016 system of limited "tokens" that permitted in-season updates to powertrain technology has been eliminated, permitting unlimited ongoing development, which is anticipated to help power output laggards **Honda** and **Renault** catch up with front-runners Mercedes-Benz and Ferrari as the season progresses, rather than locking them into their inferior places, as was the case in past seasons.

Lap times have tumbled this season as a consequence of fatter **Pirelli** racing tires and wider wings that stick them to the pavement with enough grip that the cars now corner with an even more neck-straining 6.5 *g* of force.

Wide track

"Practically just by looking at it, one can tell the speed the new car has increased as a result of more downforce and shorter braking distances—measured against lap time, not top speed—it is written all over its face," enthused **Sauber** technical director Jörg Zander about his team's 2017 challenger.

Most of the changes for this year, as Zander suggests, are visibly obvious. Front wing span is increased from 1650 mm (65 in) to 1800 mm (70.9 in) and the car's maximum width is up from 1800 mm to 2000 mm (78.7 in).

At 950 mm (37.4 in), the rear wing is 200 mm (7.9 in) wider than before, but at 800 mm (31.5 in) tall, it sits 150 mm (5.9 in) lower than in 2016. Rear downforce is further bolstered by an enlarged diffuser, which is now 175 mm (6.9 in) deep rather than the previous 125 mm (4.9 in) depth. Finally, the maximum width of the car's fuselage is increased to 1600 mm (63 in) from 1400 mm (55.1 in).

"It is a sea change for Formula One," noted Bob Bell, technical director for **RenaultSport**.

The sport needed one after several seasons of predictable Mercedes-Benz dominance. "When you get a reset, that [performance] gap closes down," he said. "The regulation changes help level the playing field a little bit."

The deregulation of some aerodynamic restrictions also permits some creativity, Bell pointed out. "We are freer on aero than before."

RenaultSport explored some of those options using Europe's largest 3D printer for sintered metal parts to produce components for the team's 60%-size wind tunnel model. The 20,000 printed metal parts each year are supplemented by the team's **3D Systems** plastic printer.

The 305 mm front and 405 mm-wide 2017-spec rear tire give this season's driver huge contact patches (image: Pirelli).

Pirelli presents the entire spectrum of its 2017 race rubber in ascending degrees of hardness (left to right) of the slicks, plus the two wet-weather tires.

Today, teams use 3D printing for models, but **McLaren** revealed that it is using a **Stratasys 3D** printer at the track to produce some replacement parts on-site. RenaultSport predicts that within a decade teams will be able to replace complex castings such as the gearbox housing with printed parts.

An invisible change to the 2017 cars that is related to the wider wheels and tires is the use of "blown hubs." The cars' wheel hubs have been designed to flow air to cool their bearings and the cars' brakes, but with the wider tires creating more aerodynamic drag, teams were motivated to reduce front-tire drag by increasing the airflow from the brake cooling-duct by filling the low-pressure wake alongside the wheel face with higher-pressure air from the hub.

Fatter rubber

Pirelli says it has rethought the entire concept of the F1 tire in response to changes in technical regulations that make the tires wider than before. New construction techniques have improved the distribution of forces in the bead area and footprint, providing greater consistency and driveability through corners, according to the company.

The object, in response to criticism in recent seasons that drivers were forever taking it easy on their tires when fans wanted to see them race, was to provide more durable tires as well as to raise the level of grip.

"Sometimes a problem in the past was that the drivers could not be aggressive and attack on the tires," noted 1997 F1 world champion driver Jacques Villeneuve. "Right now it is a tire where the drivers can actually be aggressive."

"Drivers can now enter a corner a little bit sideways and not destroy the tire and still be aggressive," he explained. Last year, such behavior would quickly disarm an attacking driver, as the ruined tires would slow his car.

Tires for 2017 are about 25% wider than before, with the fronts growing from 245 mm (9.6 in) to 305 mm (12 in) wide and the rears expanding from 325 mm (12.8 in) in 2016 to 405 mm (15.9 in) this season. These wider tires are also 10 mm (0.4 in) larger in outer diameter, though the wheel diameter remains unchanged at the sport's historic 330 mm (13 in).

With the battery-electric Formula E cars running a much-larger 457-mm (18-in) wheel diameter, the traditional F1 wheel diameter seems ripe for updating the next time the tire rules are revisited—but for now that one measurement remains sacrosanct.

Pirelli distinguishes its tire compounds using different-colored sidewall lettering so that fans can tell which tires that drivers are using, providing an immediate visual cue regarding how much grip the driver might have or how long the tires might last before the need to pit for fresh rubber.

This season sees the arrival of a new, purple-lettered "ultrasoft" compound that is grippier still than the existing red "supersoft." Yellow indicates "soft" and white is for medium tires. Orange sidewall lettering indicates "hard" compound. For the rain tires, intermediate rain tires are green and the full rain tires are blue.

"For the 2017 season, the sport asked us to develop tires with less degradation, which allow drivers to push to the maximum," said Mario Isola, Pirelli racing manager, during a tire test. "The target was for lap times that were five seconds faster compared to Barcelona (race course) in 2015. Yesterday, Valtteri Bottas set a best time of 1:19.705 on ultrasoft tires. Considering that the pole time in 2015 at Barcelona was 1:24.681, I would say that this objective has been met."

Even the regular, yellow-lettered medium-compound Pirelli tire is hugely improved from last year. "At the test in Spain, it appears to be a very fast, very strong and extremely consistent tire, enabling drivers to be extremely fast. Already it is more than three seconds faster than the same situation last year."

Indeed, this seems to be a summation of the overall results of the 2017 Formula One changes, which have seen drivers racing harder than in recent years, to the satisfaction of the fans. While many enthusiasts still long for the sound of the late V10 engines, 2017's changes are indicative of a new responsiveness to fans' interest in more compelling racing and more exciting cars, which bodes well for upcoming seasons. ■

PRODUCT BRIEFS

SPOTLIGHT: NVH

Miniature triaxial ICP accelerometer

PCB Piezotronics, Inc.'s (Depew, NY) family of miniature triaxial ICP accelerometers, Models 356A43, 356A44 and 356A45, are small (0.4 x 0.4 x 0.75 in/10.2 x 10.2 x 19.05 mm), lightweight (4.2 g/0.15 oz) and TEDS (Transducer Electronic Data Sheets) IEEE 1451.4 enabled. The TEDS feature self identifies the accelerometer and describes type, operation and attributes, which, according to the company, makes it extremely easy for an operator to track. Data contained in the TEDS programming include manufacturer, model number, serial number, calibration date, sensitivity, frequency response and measurement ID—all in compliance with IEEE 1451.4 standard. Packaged in a hermetically sealed titanium cube, models are available with three sensitivities: 10 mV/g, 50 mV/g or 100 mV/g. The most common applications for this family of miniature triaxial ICP accelerometers are modal and structural analysis, automotive NVH and package testing.

For more information, visit http://info.hotims.com/65852-400

Laminated metal

Laminated metal designed to reduce vibrations and noise transmission in metal constructions, internal combustion engines, vehicle bodies, washing machines and office machines, **dB Engineering** Inc.'s (Mansfield, TX) Noiseless Metal consists of two sheets of metal bonded together by a thin viscoelastic damping layer. Noiseless Metal can be made using any commercial quality steel or aluminum. The structure-borne sound damping qualities of the viscoelastic core are temperature dependent. For this reason, Noiseless Metal panels are supplied with cores optimized for different temperature ranges, depending on the applications in which they are to be used. Standard products have viscoelastic cores optimized for room temperature, 50°C, 80°C and 100°C (122°F, 176°F and 212°F).

For more information, visit http://info.hotims.com/65852-401

DEUTSCH connector

The newly redesigned 2-pole DEUTSCH connector (MDC06-2S) from **Murrelektronik**, Inc. (Suwanee, GA) is an extremely compact connector—18 mm (0.71 in) long when plugged in—making it easier than ever to make connections, even in confined spaces. Pre-wired and 100% electrically tested, the DEUTSCH connector requires no work in the field, saving time and reducing the risk of wiring errors. It comes equipped with a PUR jacket and molded connection to protect the internal wiring from UV light, oil, water and dirt. The connector also includes strain relief, reducing the risk of failure caused by a wire break, as well as a connection for attaching a conduit retainer. The DEUTSCH connectors can be tailor-made to fit a customer's needs, available with a choice of 2, 3, 4 or 6-poles with open-ended wires or as a connection cable with a DEUTSCH connector, Junior Timer, M12 or valve connector on the other end.

For more information, visit http://info.hotims.com/65852-402

Open integration and test platforms

IPG Automotive's (Karlsruhe, Germany) CarMaker, TruckMaker and MotorcycleMaker simulation software provides solutions that allow systems to be developed and tested in the whole vehicle using realistic virtual scenarios. Designed as open integration and testing platforms, the simulation solutions enable customers to save time and costs through the continuous development process from model-, software- and hardware-in-the-loop, all the way to vehicle-in-the-loop. With the Scenario Editor, the CarMaker product family release 6.0 now includes a high-performance tool for quickly and efficiently generating detailed traffic scenarios. According to IPG, this makes it easier to manually create and configure such scenarios, as well as to edit imported existing streets from real-world map or measuring data. In addition to this, CarMaker 6.0 features an extensive collection of sensor models to suit users' individual requirements, ranging from the ideal sensor model for concept studies and general functional tests, to physical models for developing sensor components and algorithms.

For more information, visit http://info.hotims.com/65852-403

Electrically conductive adhesive

The EO-98HT from **EpoxySet** (Lincoln, RI) is electrically conductive epoxy for electrical circuits, LED attachment, die attach and grounding applications. With a volume resistivity of approximately 10-4 ohm-cm, the EO-98HT is suited for solder replacement or circuit/wire bonding where high conductivity and reliability are required. Being a silver-filled adhesive, the EO-98HT produces a very high thermal conductivity, a glass transition temperature of 136°C (277°F) and is rated for continuous use up to 250°C (482°F), making it suitable for demanding, high-temperature needs. This one-part system has a creamy consistency with a 30-day work time at room temperature and can be stored frozen for up to a year. According to the company, it can be cured as fast as 5 minutes at 150°C (302°F).

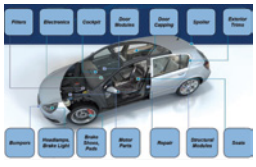
For more information, visit http://info.hotims.com/65852-404

Standalone vision system

The In-Sight 7000 series from **Cognex** Corp. (Natick, MA) is a suite of ultra-rugged, highly modular standalone vision systems. The second-generation In-Sight 7000 series represents what the company says is a breakthrough in performance, flexibility and ease of integration. This powerful new vision system performs fast and precise inspections that keep pace with increasing line speeds, while its compact form factor easily fits into space-constrained production lines. The In-Sight 7000's unique, modular design offers more than 400 different field configurations, making it the most flexible vision system available, according to Cognex. The rugged In-Sight 7000 is IP67-rated and includes Flexible Image Technology. This complete vision system features a patent-pending LED ring light that produces even, diffused illumination across the entire image, eliminating the need for costly external lighting.

For more information, visit http://info.hotims.com/65852-406

Adhesives market report



Global strategic consulting and market research firm **Lucintel** (Chhattisgarh, India) has analyzed growth opportunities for adhesives in the Indian automotive industry and has compiled a comprehensive research report titled "Growth Opportunities for Adhesives in the Indian Automotive Industry 2016-2021: Trends, Forecast, and Opportunity Analysis." The study includes a forecast for the growth opportunities for adhesives in the Indian automotive industry by product type (epoxy adhesives, polyurethane adhesives, acrylic adhesives, or other adhesives), vehicle type (passenger car and light commercial vehicles), application type (structural components and non-structural components), and region.

For more information, visit http://info.hotims.com/65852-408

PolyJet 3D technology

Now offered as part of **Proto Labs**' (Maple Plain, MN) industrial 3D printing services, PolyJet technology provides product designers and engineers with the ability to manufacture elastomeric and overmolded prototypes without investing in tooling. Product developers can leverage PolyJet to create 3D-printed parts comprised of both elastomeric and rigid materials as well as multiple colors. Its material selection includes multiple Shore A hardnesses of tear-resistant Agilus 30 for increased durability. PolyJet parts exhibit smooth surface finishes and can support complex geometries with flexible features. Like other 3D printing processes, PolyJet builds parts layer-by-layer. The machine jets out droplets of liquid photopolymers onto the build platform where they are immediately UV cured. Once the build is complete, support structures are removed, and the parts are ready without the need for additional finishing.

For more information, visit http://info.hotims.com/65852-405

Rod ends

QA1 (Lakeville, MN) offers a variety of rod ends to fit every need, including applications for motorsports, off-road, construction, agriculture and other industrial markets. The company delivers the strength, durability and consistency needed in a rod end. With more than 6500 part numbers, many different sizes, materials, configurations, coatings and options are available to fit the application's needs. Offered in Endura loader slot, 3-piece, 2-piece, bronze race, and injection-molded construction styles, the company claims QA1's rod ends feature precise tolerances to ensure quality and consistency. Choose from metric and inch, male and female, and aluminum, chromoly, stainless steel, and carbon steel options.

For more information, visit http://info.hotims.com/65852-407

Aluminum electrolytic capacitor

A new line of axial-lead aluminum electrolytic capacitors from **Cornell Dubilier Electronics**, Inc. (Liberty, SC) is available for applications that require very high-performance under all operating conditions. The AXLH is a uniquely designed axial-lead electrolytic that has the performance characteristics required for mission-critical circuitry. Continuous ripple current is rated at up to 28 amps RMS (root mean square). The AXLH features a load life rating of 2000 hours at full-rated voltage and 150°C (302°F), and a shelf life of 10 years. Targeted application fields include military, aerospace, off-road vehicles, and infrastructure system electronics. Nine values are available from 470 µF to 4700 µF, with ratings from 25-V dc to 63-V dc. Maximum ESR (equivalent series resistance) ranges are from 13 to 32 mΩ at 100 kHz.

For more information, visit http://info.hotims.com/65852-409

UPCOMING WEBINARS

VIRTUAL HARDWARE ECU: HOW TO SIGNIFICANTLY INCREASE TESTING THROUGHPUT

Wednesday, June 7, 2017 at 1:00 pm U.S. EDT

The complexity and software content of automotive electronic systems are increasing while the demand for more software and system testing is growing. This need is being driven by requirements from the ISO 26262 standard and the necessity to reduce software-driven recalls. This 60-minute Webinar focuses on the use of Virtual Hardware ECUs to enable automotive Tier 1 and OEM companies to achieve higher testing throughput to reach their software testing and quality objectives.

Speaker:

Marc Serughetti
Director of Business Development, Synopsys

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

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THE EVOLUTION OF ADAS: TESTING SYSTEMS THAT INCLUDE CAMERAS, RADAR, AND SENSOR FUSION

Tuesday, June 13, 2017 at 2:00 pm U.S. EDT

Test requirements for camera and radar technology are rapidly changing as they become more safety critical. Because these systems are increasingly reliant on sensor fusion techniques, the test requirements are growing more complex. A test system built on a scalable, flexible architecture is the only way to make sure you can adapt as quickly as ADAS technologies and autonomous vehicle systems are evolving. This 60-minute Webinar discusses test methodologies used to address these requirements, including scene generation, synchronization between camera and radar simulation, and video bit stream manipulation, and explains how to truly put cameras to the test.

Speaker:

Douglas Farrell
Senior Solutions Marketing Manager, HIL and Test Cell Systems, National Instruments

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

UPCOMING WEBINARS

FAST-TRACKING ADAS AND AUTONOMOUS VEHICLE DEVELOPMENT WITH SIMULATION

Thursday, June 15, 2017 at 10:00 a.m. U.S. EDT

Developing Advanced Driver Assistance Systems (ADAS) and autonomous vehicles is a challenge without precedent. Estimates indicate that billions of miles of road testing will be necessary to ensure safety and reliability, a task that can only be accomplished with the help of engineering simulation. This 60-minute Webinar will describe six specific areas where simulation is essential in the development of autonomous vehicles and ADAS.

Speakers:

Sandeep Sovani, Ph.D.
Director, Global Automotive Industry, ANSYS Inc.

Lee Johnson
Lead Product Manager, Systems Business Unit, ANSYS Inc.

Bernard Dion, Ph.D.
Chief Technology Officer, System Business Unit, ANSYS Inc.

Larry Williams, Ph.D.
Director of Product Management, Electronics Business Unit, ANSYS Inc.

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FROM THE EDITORS OF SAE: CONNECTED VEHICLES & JOBSITES

Thursday, June 22, 2017 at Noon U.S. EDT

Connectivity is providing more owners and operators a broad range of benefits, prompting a surge of developments by OEMs and suppliers. Chief among those benefits are safer, more efficient, and productive vehicles and worksites, both on- and off-highway. Yet technical challenges remain with development and testing of V2X communication, cybersecurity, and how to best utilize Big Data.

Speakers:

Joe Cassar
Engineering Group Manager, dSPACE

Kjeld Jespersen
Global Product Manager, Digital Services, Construction Industries, Caterpillar

Brett McNalley
Product Manager, Software and Wireless, HED

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READER FEEDBACK

Magna-Ford CFRP subframe program

It appears that carbon-fiber structural assemblies may be farther along than was predicted a few years ago, if Magna's progress is an accurate indicator. [May *AE*, cover story] The interesting point your article makes obliquely is this: if Magna can accelerate its CFRP processes so that in-plant cycle times are close to those of a steel subassembly, perhaps carbon fiber may someday replace hydroformed steel truck chassis. This would be well into the future of course.

Tom Kayser

We've been reading about carbon fiber this and carbon fiber that for 25 years, in the SAE magazine and others. There's no way CFRP will ever compete with steel on a cost basis. I don't think it will even compete with aluminum. Then there's the cycle rate which will never beat the metals.

R. C. Ioni

Carbon fiber is for race cars, aircraft and small-lot production vehicles where the manufacturer can charge a premium for the material. This was true 20 years ago and remains true in 2017. As the composites industry finds ways to make the product faster and cheaper, so do their steel and aluminum competitors.

James Freeland
Mound, MN

Low-Temperature combustion

I read your article on Delphi's research and development into GDCI/low-temp combustion not long after reading that Delphi plans to divest its Powertrain business. Do you know if the business is acquired, will the new owner get this technology?

Rennspeed290

We won't know until the Delphi Powertrain unit becomes separate in spring 2018.—Ed.

A Quantum leap

Your article on the new American Axle Quantum axles was interesting. A 30% mass reduction is significant if they can make that happen and the OEMs should be pleased with this development. I wonder, however, if live axles with an aluminum housing will be accepted by truck owners, particularly those who use their F-350s and Ram 3500s for work. Hope you publish more about this AAM product.

Dave Amm
Southgate, MI

GM's new diesel Equinox

GM is bringing more light-duty diesels into North America, as your Q&A with chief engineer Mark Cieslak explained in the May issue. It's a great idea and I'm sure the vehicle will be well suited for the diesel. It'll get outstanding fuel mileage. But the engine option will be $4000 or more and the diesel fuel price in the U.S. can be 50 cents or more higher per gallon. So, who will buy a diesel Equinox?

DaveNC

Go ask Allis

I enjoyed the April 2017 *Automotive Engineering*. Allis-Chalmers tractor company had a driveable fuel-cell tractor in the late 1950s. It's on display in the Smithsonian Museum.

Armand Wixson
Marcellus, NY

Mr. Wixson is correct: In 1951 Allis-Chalmers began research on fuel cells under the company's R&D VP, Harry Karl Ihrig. His engineers developed an alkaline-type fuel cell stack incorporating 1,008 cells comprising 112 modules of 9 cells each, arranged in four rows. The stack produced a claimed 15 kW. Installed in one of the company's tractor chassis, the fuel cell powered a DC motor. The machine had a 3,000-lb (1361-kg) drawbar rating. It was first demonstrated in October 1959 near West Allis, WI, tilling an alfalfa field with a double-bottom plow. This was six years before GM tested its famous Electrovan which used liquid hydrogen. The Allis FC tractor (shown) is now displayed in the Smithsonian Museum.—Ed.

The pioneering Allis-Chalmers fuel cell tractor in the Smithsonian.

READERS: Let us know what you think about *Automotive Engineering* magazine. Email the Editor at Lindsay.Brooke@sae.org. We appreciate your comments and reserve the right to edit for brevity.

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— Thomas Stover, Executive Chair

WHAT'S ONLINE

WHAT'S NEW

U.S. sues FiatChrysler over diesel emissions

The **U.S. Justice Department** announced on May 23, 2017, that it filed a civil lawsuit against **FiatChrysler Automobiles** alleging that FCA used "software functions that were not disclosed to regulators during the (emissions) certification process and that the vehicles contain defeat devices" for some 104,000 diesel-engine **Jeep** Grand Cherokee and **Dodge** Ram pickup trucks sold during the 2014-16 model year.

The lawsuit, filed by the Justice Department's Environment and Natural Resources Division on behalf of the **U.S. Environmental Protection Agency**, came just days after FCA announced it was seeking emissions certification for 2017 model-year vehicles fitted with the same 3.0-L diesel V6—but with updated software the automaker claimed would achieve the regulatory compliance at issue with the previous model-year diesel vehicles.

The company said in a release it "believes that these actions should help facilitate a prompt resolution to ongoing discussions with the Environment and Natural Resources Division of the U.S. Department of Justice and other governmental agencies" regarding the months of talks that so far had failed to produce a resolution to the allegation that FCA—similar to the now-infamous situation that cost **Volkswagen** tens of billions of dollars to resolve—could have employed a software-based emissions "defeat device" that allowed excess emissions under certain operating conditions.

Read the full article at **articles.sae.org/15461/**.

VIDEO

SAE Eye on Engineering: New Corvette rumors

In early May, **General Motors** sent out a notice that the 'Vette plant is halting its regular public tours for 18 months due to extensive plant upgrades. Could this be for the next-generation Corvette? In this episode of SAE *Eye on Engineering*, Editor-in-Chief Lindsay Brooke looks at the C-8, the first mid-engined Corvette. SAE *Eye on Engineering* can be viewed at **video.sae.org/12276**. It also airs in audio-only form Monday mornings on WJR 760 AM Detroit's Paul W. Smith Show. Access archived episodes of SAE *Eye on Engineering* at **sae.org/magazines/podcasts**.

WHAT'S NEW

Honda to build new wind tunnel in U.S.

Honda will spend $124 million to build a state-of-the-art, multifunctional acoustic wind tunnel in East Liberty, OH, on the grounds of the Honda-owned **Transportation Research Center** and close to the company's U.S. manufacturing hub in nearby East Liberty.

The company said it will break ground on the new wind tunnel in summer 2017 but did not state a completion date.

The company said the new wind tunnel will feature an interchangeable belt system "capable of testing both production vehicles and racecars"; it will have a five-belt rolling-road system designed for the development of production vehicles and a second, single/wide belt system to test high-performance models and purpose-built race vehicles.

The new tunnel can generate wind speeds of up to 192 mph—and will feature four secure bays for confidential testing of vehicles by contracted customers.

"This innovative and industry-leading asset provides us with another distinct reason for our customers to take advantage of the world-class testing facilities we have in Ohio at TRC," said Mark-Tami Hotta, president and CEO of the Transportation Research Center.

Read the full article at **articles.sae.org/15387/**.

COMPANIES MENTIONED

UPCOMING FROM THE EDITORS

June 2: Electronics & Connectivity Technology eNewsletter

June 7: Automotive Engineering Technology eNewsletter

June 14: Truck & Off-Highway Engineering Technology eNewsletter

June 19: Vehicle Engineering Technology eNewsletter (all markets)

June 21: Heavy-Duty Technology eNewsletter

June 26: Automotive Engineering Technology eNewsletter

July 13: Automotive Engineering (Autonomous Vehicles special edition) Technology eNewsletter

July 17: Truck & Off-Highway Engineering Technology eNewsletter

July 27: Automotive Engineering Technology eNewsletter

August: Truck & Off-Highway Engineering Print Magazine
- Advanced Emissions Strategies for Off-Highway (Webinar Feature)
- SAE COMVEC Preview
- Intelligent Machine Control
- Tractor-Trailer Aerodynamics
- Hydraulic Components product spotlight

August: Automotive Engineering Print Magazine
- Composites & Plastics
- Vehicle Structural Composites
- Sensors product spotlight

August 9: Automotive Engineering Technology eNewsletter

August 14: Truck & Off-Highway Engineering Technology eNewsletter

August 21: Vehicle Engineering Technology eNewsletter (all markets)

August 28: Automotive Engineering Technology eNewsletter

AD INDEX

Q&A

With nearly three decades of experience at Nissan, Alfonso Albaisa took over in 2017 as the company's new global design director (image: Nissan).

New Nissan design chief: One foot in design, one foot in engineering

Earlier this year, **Nissan** surprised the industry by announcing that design director Shiro Nakamura was retiring after nearly two decades with the company, with Alfonso Albaisa, since 2014 the design chief at the brand's **Infiniti** upscale division, to take his place.

Cuban-American Albaisa, 52, is Nissan's first non-Japanese design director. He started his career with Nissan Design in 1988 and as head of Nissan's global design will oversee a staff of approximately 700 responsible for the styling of the company's full model range, including commercial vehicles.

Automotive Engineering editorial director Bill Visnic spoke with Albaisa at the 2017 New York auto show, not long after he assumed his new role.

We used to hear a lot about "design language." Is it your intention to introduce a new design language at Nissan?
I think naturally, because of what's going to happen, that we are starting, especially with issues of electrification. In Japan, we have something called 'e-Power,' which are cars that have an engine, but they're mostly to charge the battery—electric motors drive the car. All of these new platforms of electrification, including e-Power, are making new 'language' appropriate. Electrification and autonomous and intelligent mobility is going to bring a new aesthetic.

It is not required, of course. We can always put the icing over a different cake. As artists, though, we react. So when our engineers are coming with the next generation of EVs, you naturally are like, 'Oh, well, that's curious. It is different. It is different than an ICE (internal-combustion engine) car.

So we might still see the fundamental proportions that we understand now, is it possible you can work with that?
The spirit we have right now with engineering is quite close. Obviously, Shiro (Nakamura) was very close to them. But I have an opportunity a little bit different than him—because I kind of grew up with our engineers. Not because of my age, necessarily. When you're not the big boss—in any organization, the big boss has to be somewhat distant from the 'genba' (Japanese for "working-level" employee). I'm a genba guy, so my relationship with platform engineers, drivetrain engineers, is that I love these guys. My sister's an engineer and my father was an architect in Cuba. So I always gravitate to engineering. My work at Infiniti was bringing shape to the things engineering wanted to do.

The same is happening as we move into electrification—to get in shoulder-to-shoulder with engineering and really find the potential of all of this.

Do you worry about losing that "genba" connection?
A little bit! I go from not having a private office to having one. So that's a fundamental change right away. I don't know how much I'll use it, to be honest. Luckily, the heads of engineering are also my friends. I'm the luckiest man in the world not because of anything vital or a (particular) car I worked on, it's just that I can walk freely in engineering as much as I can in design.

Do you find engineers now are more willing to work with design, that they understand they have to work with design? That engineers are more cross-functional in that way?
I have heard that even in other companies it's changing. That engineering knows a beautiful skin only makes things better—and you get more budget for the next time and all this domino-effect, you know?

Engineering has a tough job. On one hand, they're thinking like this. But then, they're responsible for money. The inherent beauty of metal is not their only concern. So I find that they are extremely generous, because they all 'play' with me and my team while knowing that they have this immense (fiscal) responsibility.

When you're (proposing) a $5-per-car loss in (the design of new) metal, it's absurd to the company. There's no 'value' in that. The Nissan alliance now makes 10 million cars. That's $50 million dollars! For *what*?

You have immense respect for engineering. Will your coming designs reflect that by being more of a more "technical" nature—particularly as the industry progresses toward electrification and autonomy?
The best way to say it is that I feel humans make cars, not machines. The fingerprint of the artist *and* the innovator—which is engineering—I want that seen in the car. So a purely technical expression, I don't feel is honest to those people I work with. When an engineer is busting his **beep** to make panels that are deep, that struggle is emotional. There's a humanity I want expressed. ■

LAST CHANCE! Entry deadline: July 1, 2017

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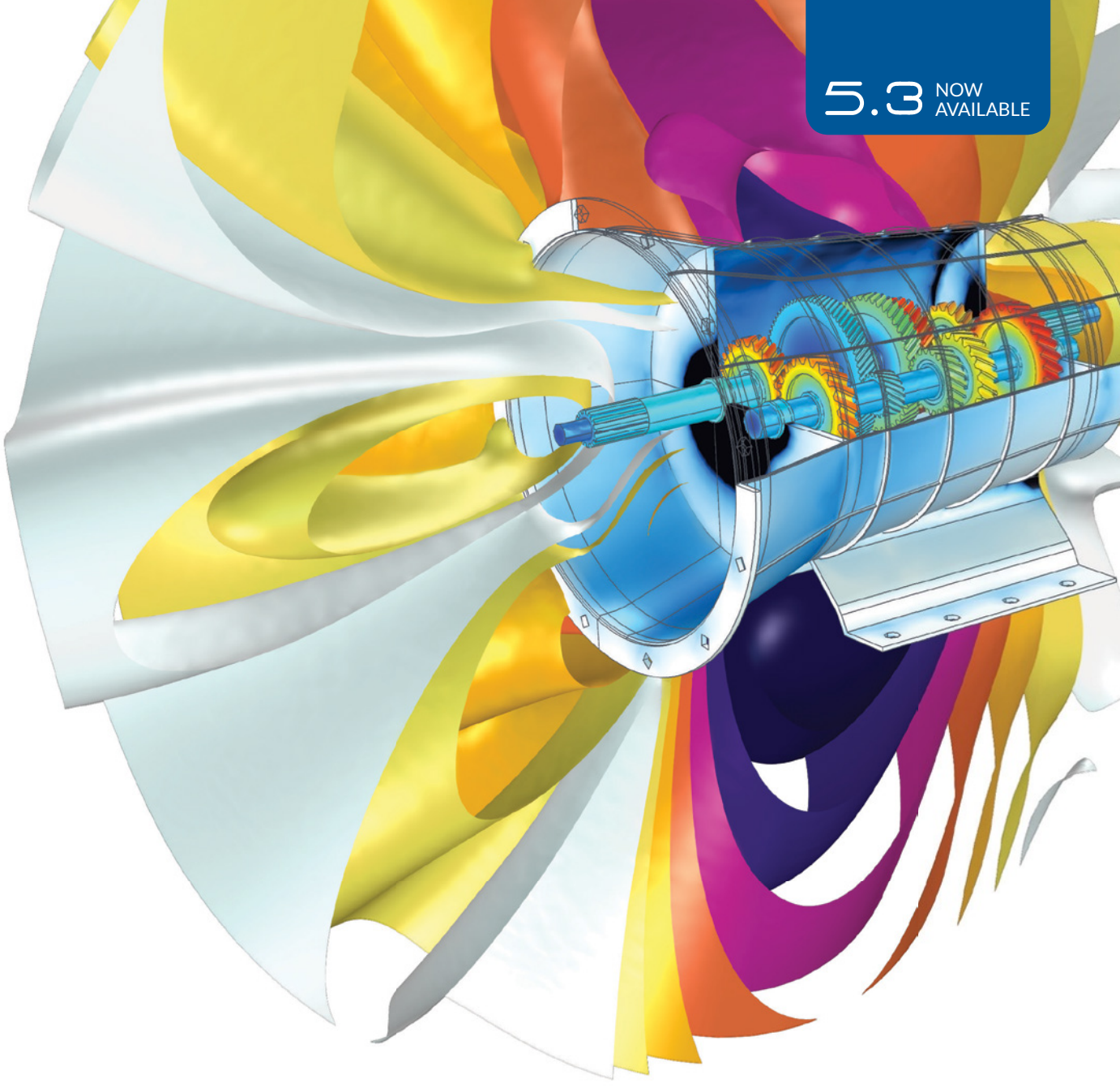

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