With the electric revolution underway, we investigate what must be done to prevent battery fires and other dangers.

Phil Glyn-Davies
Jaguar Land Rover’s head of safety on personalized ADAS, V2I and bringing down sensor costs

Driver monitoring
How health and emotions can be monitored and even improved to help drivers be at the top of their game

Flawless sensing
The latest efforts to expand the capabilities of sensors and software to deal with all weather and light conditions
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COVER STORY: ELECTRIC VEHICLES
Are electric cars less safe than their IC and hybrid counterparts? Max Mueller collates expert opinion on some of the safety considerations unique to these vehicles.

SAFETY CHECK
The principal transportation planner for the City of Bellevue, Washington, explains how an in-development video analytics tool could increase safety.

DRIVER MONITORING
As well as efforts to refine driver monitoring systems’ response to fading alertness, work is underway to expand the technology to pick up on key health indicators, finds David Smith.

LOOSE OBJECTS
Unsecured objects or animals in the car pose a big threat to occupants. John Evans asks why the issue does not receive the attention it merits.

JAGUAR LAND ROVER
The car maker’s head of safety, Phil Glyn-Davies, tells Guy Bird he is working to make safety systems as unobtrusive and personalized – and therefore more widely accepted by drivers – as possible.

SENSORS
Cat Dow uncovers recent and imminent developments expanding the capabilities of sensors and associated software to cope with operational limitations.

AUTOMATED DRIVING
Robert Bosch outlines how HD maps can provide the missing intuition needed to enable the safe roll-out of automated vehicles.

BIOMETRIC AUTHENTICATION
The driver’s eyes are key to securing and customizing the in-vehicle, connected car experience, says Gentex.

REAR-SEAT SAFETY
IEE explains how advanced seatbelt reminder systems, combining occupant detection and buckle monitoring, are coming to the rear seat.

TESTING
Open-road testing conditions for ADAS and autonomous systems require a robust localization system to cope with GNSS interruptions, explains Oxford Technical Solutions.
Contributors to this issue...

David Smith
Cat Dow
John Evans

Izzy Kington, editor

Izzy Kington

In researching the latest advances in vehicle sensing for the article on page 40, Cat was struck by the focus on trying to replicate the capabilities of humans, and even discovered an openness to learn from other species. “It seems an overwhelming task, yet with the help of machine learning, I truly believe cars will begin to learn faster, have better senses, and save lives,” she says.

More than 750,000 electric cars (including battery-electric, plug-in hybrid electric and fuel cell electric models) were sold in 2016, taking the global fleet above the two million mark, according to the International Energy Agency. The organization predicts that this fleet could rise to between nine and 20 million by 2020, and between 40 and 70 million by 2025.

While electric cars only account for 0.2% of the current passenger light-duty vehicle stock, clearly we are going to see a lot more of them on the road. Therefore, it is crucial to separate the fact from the fiction and truly understand the specific safety issues involved with these vehicles. As the experts explain in the cover feature on page 6, electric vehicles may also offer the potential to increase safety in certain areas.

Another big investigation in this issue delves into the topic of loose items in passenger cars. It’s scary when you start to think how many of us have driven around with bulky items in the passenger cabin, without a thought to what damage they might do to us in a crash. The students who’ve left for university with as many belongings as they can cram into the car. The kids kept entertained with tablets and MP3 players. The owners who don’t think to restrain their pets. We draw attention to the issue on page 24.

There’s also plenty to read about ADAS developments. On page 16 we track trends in driver monitoring technologies – which seem to be heading from simply providing attention assistance toward building and responding to a more holistic picture of driver health and well-being. Then, on page 40, we explore the latest advances in vehicle sensing; a particularly pertinent topic as car makers are being challenged to expand the functionality of their ADAS technologies to work across a wider gamut of weather and lighting conditions. For example, Euro NCAP is adding a low-light scenario to its pedestrian AEB testing in 2018.

For more on the direction of consumer testing, turn to page 68, where Global NCAP’s new chairman, Lauchlan McIntosh, rounds out the issue with his vision for the exciting road ahead.

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Are electric cars less safe than their IC and hybrid counterparts? Experts give their verdict on popular perceptions and shed light on some of the safety considerations unique to these vehicles.

AUTHOR: MAX MUELLER
IMAGES: THATCHAM RESEARCH, MILLBROOK, DR ERIC WACHSMAN, SEYMOUR POWELL
The electric Opel Vauxhall Ampera-e scored four stars in Euro NCAP testing in September 2017.
With more and more electric vehicles (EVs) on the roads, it is pertinent to ask if they pose new risks not seen with IC or hybrid vehicles.

“Looking at our accident analysis data, we’re not seeing any issues for EVs per se,” says Richard Cuerden, technical director for vehicle safety at the UK’s Transport Research Laboratory (TRL). “You can look at risk in different ways. EVs have a different type of acceleration and usage pattern, which might conceivably cause more collisions, but we’re not seeing any evidence of that. When they are involved in a collision, they are not behaving any differently from IC or hybrid vehicles.”

One commonly held worry is that battery compartments might be compromised in a crash. However, Matthew Avery, director of insurance research at the UK’s automotive research center, Thatcham Research, dispels this perception. “None of the electric cars we have tested under Euro NCAP have been compromised,” he says. “Battery compartments are very well protected. We’ve had no battery breaches or fires, even in the pole crash, which is extremely exacting on the vehicle’s structure.”

Crash test engineers note advances in design from earlier generations of EVs. “One of the more noticeable improvements is how the battery is integrated and housed in the vehicle,” says Matt Hillam, chief engineer for safety at UK-based test and validation provider Millbrook. “That’s supported by an increased consideration for the routing of high-voltage cables, which helps to protect them in an impact. Pure EVs tend to be built from a bespoke platform where the battery and associated motors, invertors and so on are integrated into the structure from the start. The battery and associated components can therefore form part of the crash load path, so there are considerations regarding how force is distributed during an impact.”

Lithium-ion chemistry
Another perception is that lithium-ion chemistry continues to pose a fire hazard. Lithium-ion cells have been associated with an effect called thermal runaway, where rising temperatures can produce ever more heat in an uncontrolled feedback loop.

“The failure of a single cell, causing thermal runaway in that cell, has the potential to propagate to adjacent cells,” says Dr Daniel Doughty, an independent battery safety expert.
Independent battery safety expert and former advanced power resources researcher at the US government’s Sandia National Laboratories. “In the extreme, the failure of a single cell could cause thermal runaway of every cell in the battery pack and a small failure could become catastrophic.”

Doughty recommends the systems engineering approach for battery design. “If we presume that one battery cell can enter thermal runaway – regardless of the cause – it will produce heat and gas, sometimes violently,” he continues. “These effects have been quantified at the cell level in some applications and, using understanding of heat transfer and the effect of hot material ejected from the cell, battery pack design has been improved. Packs that exhibited propagation of single-cell failure to the entire pack have been made propagation resistant. The automotive industry should embrace this approach.”

**Solid-state technology**

Another promising strategy is to eliminate flammable components altogether. At the University of Maryland, researchers are working on cells that use solid-state technology, which is claimed to be safer, as the ceramic electrolyte is non-flammable.

As a bonus, the cells are said to operate with higher-capacity lithium metal electrodes, thus obtaining a higher energy density. “In terms of cost, they’re competitive – their fabrication in an ambient environment is far cheaper and there is no need for expensive dry rooms,” says Dr Eric Wachsman, director of the University of Maryland’s Maryland Energy Innovation Institute. “On the material side, the sulfur cathodes are also inexpensive. Our only issue is scaling manufacturing capacity, with the first commercial-scale production expected by spin-off company Ion Storage Systems in 1-2 years for non-automotive applications. Production for the EV sector is also a priority – several OEMs have shown interest – but this poses a bigger challenge and may take a little longer.”

**Tertiary safety**

Another concern is that EVs involved in accidents seem to pose additional problems for the emergency services. “After the crash of an EV, the control circuitry for the battery pack could be impaired,” says Doughty. “This would result in the inability to discharge battery packs, a situation referred to as ‘stranded energy’. If this energy is not released safely, first responders (emergency medical technicians) and second responders (operators of tow trucks) could be at risk.”

Thatcham Research’s Avery voices similar concerns. “EVs can compromise tertiary safety – the ability of the emergency services to cut people from a vehicle after a crash,” he explains. “Car structures these days are made from high-tensile materials such as boron steel, which already makes extracting people difficult. But if the vehicle also has live high-voltage cables, then the fire crews will have to proceed with extreme caution.”

Avery believes such potentially life-threatening delays could be avoided with the appropriate labelling of circuitry. "Via the new Euro NCAP roadmap, we’re encouraging..."
ELECTRIC VEHICLES

High voltage

One safety concern with EVs is the high voltage of some vehicle systems. “These cars use voltages in the region of 300-750V,” comments James McGeachie, Prodrive Advanced Technologies’ director of engineering.

However, McGeachie points out that aside from their physical and visual barriers, electrical architectures are also protected by an IT network earthing system, which he says offers three key safety measures.

“Firstly, these are isolated systems with live and neutral conductors,” says McGeachie. “Even if someone were to get past the physical obstacles, they would need to be in contact with both the live and neutral conductors to be in danger.”

Secondly, any metal components that could become live, motor casings for example, are grounded. “This provides a preferential path for the current,” says McGeachie. “Thirdly, cables have double insulation, which is monitored continuously for damage or penetration.”

In the event of a collision, the high-voltage system will shut down automatically. “Another consideration is the inclusion of a service disconnect, which can be used by emergency services personnel to immediately shut down the high-voltage system,” says McGeachie.

“EVs CAN COMPROMISE TERTIARY SAFETY – THAT IS THE ABILITY OF EMERGENCY SERVICES TO CUT PEOPLE FROM A VEHICLE AFTER A CRASH”

Matthew Avery, director of insurance research, Thatcham Research

manufacturers to show the location of all electric components – something like a QR code on the vehicle that rescuers could very quickly identify and read,” he says.

A further perception is that the additional weight of EVs adds some protection for occupants in a crash but makes things worse for third parties – especially pedestrians and cyclists. On the face of it, the additional weight of cars with traction batteries does seem to be a concern.

“Some people choose to drive bigger and heavier cars than others because, statistically, they will come off better in a collision with a lighter vehicle – they are going to experience a lower change in velocity and lower forces,” says TRL’s Cuerden. “EVs and hybrid vehicles are typically – but not always – heavier than IC-powered cars of a similar size. However, I’m not aware of any studies that say that EVs are more dangerous because of their weight. There are many factors involved, so I don’t think we should get caught up in any argument around the mass of an EV in a collision. Instead, by lowering the center of gravity in the chassis, and with ESC fitted as standard in most regions in the world, you move away from the risk of rollover. This is important because, although not as frequent, the chance of getting seriously hurt in a rollover is higher than in a frontal or side collision.”

Front-end design

Cuerden believes the rise of EVs could be good news for more vulnerable road users. “With appropriate design, we could really raise the game,” he says. “The desire to improve air quality will lead to more EVs being used in our dense urban environments, which is where we find higher numbers of pedestrians and cyclists. Through
Making a noise

NHTSA announced a federal safety standard in November 2016 that requires new hybrid and electric cars to have audible alerts when reversing or traveling at speeds below 30km/h (19mph). The measure is expected to prevent some 2,400 pedestrian injuries a year.

The requirement applies to hybrid and electric cars of 10,000 lb (4,500kg) or less. Half of all new vehicles in this category must comply by September 2018, and all by September 2019.

regulation or Euro NCAP, we could press for more stringent safety criteria for front-end design. Such designs are more difficult to do with an IC engine at present. As we achieve economy of scale, designers will want to change the look of EVs anyway, to make them more individual.”

It’s exactly this opportunity that excites EV designers. “Electric platforms have a simplicity that allows you to play with the architecture,” says Richard Seale, a senior automotive designer at SeymourPowell. “The absence of hard masses – for example, engine blocks and radiator – gives us scope to design the front to be safer for pedestrians and cyclists. Front-end car design has long been ruled by potential pedestrian impacts – think of Jaguar losing its bonnet mascot. Most cars now have pop-up hoods, which cushion an impact. The absence of an ICE drivetrain gives you more room for these solutions, and the front can be made softer and more impact-friendly.

More space also allows you to improve the driver’s view.”

Silent killer?

Another area pertinent to pedestrian protection is the implementation of a warning sound protocol. Europe and the USA seem to be divided on the subject, with the former favoring a car-like sound and the latter an warning system such as a series of beeps. “I’m skeptical about ideas like a ‘golden sound’ or a symphony of warning tones,” says Seale. “I think the sound should be the natural by-product of an engineered solution such as a cooling system. As the number of EVs rises and traffic becomes quieter, pedestrians will also tune in more to the overall sound of vehicles, for example tire noise, and the issue might solve itself.”

“The absence of hard masses – for example, engine blocks and radiator – gives us scope to design the front to be safer for pedestrians and cyclists”

Richard Seale, senior automotive designer, SeymourPowell
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In 2016, there were 433 traffic collisions involving injuries, 39 bicycle crashes and 47 pedestrian collisions, including one fatality, in Bellevue, Washington, USA. The city is collaborating with public and private sector partners to develop a video analytics platform to study crashes and conflicts, so it can decide where to focus infrastructural investment to prevent others from happening.

“We have an opportunity to leverage proven technologies to derive data on speed and derivatives of speed (for example, acceleration and jerk) to better understand steering and braking behaviors,” says Franz Loewenherz, principal transportation planner, City of Bellevue. “This data has the potential to identify near-collision events, such as when a car abruptly stops or swerves to avoid striking a pedestrian. These close calls are much more frequent and more useful than actual crash reports in detecting systemic safety problems.”

Other stakeholders in the Video Analytics Towards Vision Zero Partnership include Deep learning

The US city of Bellevue is crowdsourcing volunteers to help develop a video analytics system to identify problem areas.

Microsoft and the University of Washington.

“We are demonstrating the capability of vision technologies to detect cars, pedestrians and bikes and track their movements from traffic cameras,” says Loewenherz.

The partnership is now crowdsourcing volunteers to annotate pre-recorded video clips from traffic cameras. “This data will be used to train the underlying deep-learning algorithms informing the video analytics platform,” says Loewenherz. “Through crowdsourcing, we have an opportunity to teach computers to recognize when, where and why traffic crashes occur.”

Technologies including AEB, ISA and intelligent seatbelt reminders for all seats should be fitted as standard in new cars sold in Europe, the European Parliament’s Committee on Transport has said. The non-binding resolution, made in October 2017, calls for the European Commission to propose new legislation no later than the first quarter of 2018. Europe’s car safety standards were last updated in 2009, and included requirements for AEB in new trucks, and ESC and seatbelt reminders in the driver’s seat of cars.

To prevent children dying of heatstroke after being left in cars, Hyundai will offer a rear-occupant alert system from the 2019 model year. It relies on ultrasonic sensors, integrated into the headliner, to detect movement. A message on the center instrument cluster display reminds drivers to check the rear seats when leaving the car. After they have left, if movement is detected in the rear, the car will sound its horn, flash its lights and send an alert to the driver’s smartphone. “We understand only a brief lapse in judgment and inattention can have terrible consequences,” said Mike O’Brien, vice president of product, corporate and digital planning at Hyundai Motor America.
There are multiple protocols to ensure that only accurately submitted classifiers are incorporated from the crowdsourcing effort. More than 500 volunteers have come forward so far. Loewenherz says their efforts have resulted in pedestrians and bicyclists (grouped into a non-motorized object category) being recognized 90% of the time. Microsoft is targeting >90% segmentation accuracy between the categories.

“We’ve already begun to experience promising results in the form of a traffic analytics dashboard developed by Microsoft, which is operational in the City of Bellevue’s traffic management center,” says Loewenherz. “The dashboard depicts count reporting infographics based on raw video footage from Bellevue’s traffic cameras. The video analytics platform accurately classifies motor vehicles by turning movement (through, left or right) and by direction of approach.”

Loewenherz is excited about the potential of the tool to identify problem areas in need of infrastructural countermeasures. “In addition, it could be leveraged to measure how well roadway investments have improved safety, enabling cities to track their progress toward Vision Zero,” he says. “Our partnership is exciting because no city has ever developed a video analytics platform that converts raw video footage from a city-wide network of traffic cameras into useful data that can be searched, managed and used to provide detailed information on traffic flow and non-crash traffic conflicts. Together we intend to move beyond proof of concept and arrive at a common set of features that meet the needs of modern cities both large and small, in the USA and in other nations.”

The Hemicordulia dragonfly could hold the key to advances in machine vision, say researchers at the University of Adelaide and Lund University. The team recorded certain neurons that enable the dragonfly to focus on a small moving object (flying prey) against a complicated background. If the prey disappears, the dragonfly can predict where it will reappear. “These results will have practical applications, especially in the development of artificial control and vision systems, such as self-steering vehicles and bionic vision,” said Dr Steven Wiederman of the University of Adelaide.

Alix Edwards details how TRL will develop testing protocols for AEB, VRU warning systems, new mirrors and other safety measures for London buses

What is the project all about?
Transport for London (TfL) has commissioned the Transport Research Laboratory (TRL) to deliver a program of research to develop a Bus Safety Standard (BSS). The BSS will be a standard for vehicle design and system performance, with a focus on safety. The work includes evaluation of solutions, test protocol development and peer-reviewed amendments of the Bus Vehicle Specification including guidance notes.

What methods will be used?
The evaluation methods depend upon each of the 13 measures being developed. For AEB we will include track testing and on-road driving, whereas for occupant interior safety measures we will use computer simulation and physical component tests. There will also be human factors assessments, and tests to measure the effect of technologies on a representative population of volunteers, including bus drivers and other road users.

Will competing technologies be tested against each other?
Competing technologies will not be tested or rated against each other; only one technology or vehicle will be used for each trial. The purpose of the trial is firstly to demonstrate whether each technology can deliver, in a realistic environment, the potential benefits identified. Secondly, it will help to inform the development of a test procedure that will produce a pass/fail and/or performance rating. Injury and collision data will be used to derive the scenarios and/or injury mechanisms to be addressed; as such it will be an independent, performance-based assessment. Of course, it is possible that TfL will want to carry out comparative testing in the future to assess technologies/vehicles against the newly developed BSS tests, but that is not within the scope of the current project.

What is the timeline for the trial?
The results of the trials will feed into the new BSS that will be incorporated into bus operator contracts from the end of 2018. It’s unlikely that all 13 measures will be included in the 2018 requirements. A road map will be developed by TRL to provide a guide for future developments of the BSS.

This road map will become a key tool for bus manufacturers and operators in understanding TfL’s requirements, and will be updated to remain relevant, also including legislative requirements. The timescales will be challenging but realistic. Euro NCAP’s road map for passenger car safety has been used as the model for our approach.

What will justify a technology’s inclusion on the BSS?
As a minimum, each technology will need to demonstrate significant improvement in physical performance against the baseline in controlled testing in scenarios reasonably representative of real service. However, translating this into an assessment of casualty reduction is challenging. Most of the measures do not yet exist in the bus market, so a predictive analysis will be undertaken. This will predict the numbers and severities of casualties prevented, and look at how well each technology can reduce them.

A business case will be developed for each measure based on an economic valuation of the predicted casualty reduction balanced against the costs of adding the feature into the specification and any other operational costs or benefits.

• Alix Edwards is a vehicle safety and technology consultant at TRL
As well as efforts to refine driver monitoring systems’ response to fading alertness, work is underway to expand the technology to pick up on key health indicators.

Author: David Smith
Images: Daimler, Faurecia, Ford, Hyundai, GM, Honda, Transportation Research Group – University of Southampton
Mercedes-Benz’s Fit & Healthy concept monitors the driver’s physical and mental state.
As well as monitoring physical indicators of health, Mercedes-Benz’s Fit & Healthy concept could soothe stressed drivers with massage, music and intelligent climate control.

Companies including Toyota, Volkswagen, Nissan and Mercedes-Benz have introduced driver monitoring systems (DMS) in select models. Of the various technologies that could form the basis for DMS, ABI Research predicts that interior-facing cameras will ultimately prevail; it says global sales of the units will reach 6.7 million by 2019. These cameras enable facial recognition and eye tracking, whereby the system monitors gaze direction and eyelid movement. Toyota has deployed eye tracking in Lexus cars.

Other systems monitor steering inputs or use forward-facing cameras to detect when the vehicle starts to drift toward its lane boundary. Honda takes the former approach with its Driver Attention Monitor, a component of its 2017 CR-V EX (in the USA). It works with the EPS to measure the frequency and severity of the driver’s steering inputs. “This is a world-first function,” says a Honda spokesperson. “It’s different from our competitors’ systems because it uses a steering vibration function to gauge the driver’s level of awareness and can prompt the driver to take a break.”

Visual, audio and haptic
Alerts are delivered via a coffee cup icon below the speedometer. The illumination of all four white bars indicates full attention — if it drops to two bars, the icon shows a message inviting the driver to take a break. If it drops to one bar, a beeper sounds and the steering wheel vibrates.

There is also potential for DMS technology to be used in applications other than attention monitoring; some OEMs are now exploring how the technology could monitor and respond to drivers’ health and stress levels. “To date, driver monitoring has been focused on driver incapacity, especially drowsiness detection, to make driving safer,” says Götz Renner, project manager at the German Academy of Sciences and Humanities (Leibniz Academy).

Although NHTSA says drowsy-driving crashes are difficult to identify, its FARS database noted 846 people killed in this type of crash in the USA in 2014.
Faurecia’s Active Wellness seat uses medical-grade sensors to gather biometric data about a driver’s physical and mental state. The data can be used to issue warnings to drowsy drivers. The system can also analyze the driver’s size, shape, weight, biometrics and heart rate to build up a picture of their seating preferences. It can then work out what position will be most comfortable based on their physical condition, the travel conditions and the car’s status.

Meanwhile, Lear’s intelligent seat – the InTu – will be installed in a premium US sedan in 2018. A sensor mat embedded within the seat reads the driver’s anthropometric frame – back, torso and legs – and adjusts continually to their sitting position. The company says it is natural for a driver to move after they have been on the road for a while and the seat will move with them.

“ANYONE IN GOOD SHAPE, FEELING GOOD AND IN CONTROL OF ALL THEIR RESOURCES, WILL BE A MUCH BETTER DRIVER THAN WHEN THEY’RE STRESSED OUT OR EXHAUSTED”

Götz Renner, project manager, Fit & Healthy, Mercedes-Benz
“IF BRAIN ACTIVITY INDICATES A DAYDREAM OR POOR CONCENTRATION, THEN THE STEERING WHEEL OR PEDALS COULD VIBRATE TO RAISE THE DRIVER’S AWARENESS”

Wolfgang Epple, director of research and technology, JLR

we need to know about the driver’s state of mind, as well as general lifestyle. We are partnering with Philips to develop wearables that provide this information. We plan to start the integration of wearables in 2018; but we expect to have vehicle-integrated sensors not that far down the line.”

Brain waves
Meanwhile, Jaguar Land Rover is trialling Sixth Sense, which monitors the driver’s heart rate, breathing and brain activity to identify stress, fatigue and lack of concentration. The MindSense aspect of the technology uses medical-grade sensors in the steering wheel to read a driver’s brainwaves, enabling the car to determine if they are daydreaming or drowsy. JLR has involved neuroscientists in the research, which draws on NASA’s technology ideas. “If brain activity indicates a daydream or poor concentration, then the steering wheel or pedals could vibrate to raise the driver’s awareness and re-engage them with driving,” says Wolfgang Epple, director of research and technology at JLR.

Hyundai has also revealed a futuristic vision – a Health plus Mobility Cockpit that manages driver stress and tiredness. Sensors placed throughout the car will monitor the driver’s physical and mental state, detecting posture as well as breathing rate and depth. The sensors will also measure heart-rate variability for stress response, and use eye tracking and facial feature recognition to determine alertness and emotional states.

Lightening the mood
“Hyundai’s approach to driver monitoring is human-centered,” explains John Suh, head of Hyundai Ventures. “We have incorporated different actuators that can change the cabin environment, including seat massage systems, CO₂ monitoring, fresh or re-circulated venting and cabin lighting. All these things are useful and important actuators in creating mood shifts.”

Hyundai is examining two mood shift cases – from bored or sleepy to alert and refreshed, and from over-
“WHILE THERE ARE SENSORS THAT MONITOR PHYSICAL CONDITION, WE NEED OTHER SENSORS TO MAKE THOSE BIO-SIGNALS RELIABLE ACROSS A WIDER RANGE OF USERS AND SITUATIONS”

John Suh, vice president, Hyundai Ventures

NHTSA says drowsy-driving crashes most commonly happen between 12:00am and 6:00am, or in the late afternoon, and that many are run-off-road crashes involving a single vehicle with no passengers

The technology is at the conceptual stage and Suh says three developments are required to make it a reality. “The first is better sensors,” he says. “While there are sensors that monitor physical condition, we need other sensors to make those bio-signals reliable across a wider range of users and situations. Another area for development is data analysis; there needs to be software that can use the sensor inputs to diagnose the driver’s condition accurately. Related to that, there needs be a deeper understanding of how individuals react to changes in the cabin.”

Autonomous applications

DMS technologies could also have a role to play during the long transitional

Car makers are investigating the potential of wearables to send more information to drivers. For example, Ford introduced new technology in 2017 allowing owners of Samsung Gear 2 and Gear 3 smartwatches to integrate their devices to a Ford SYNC-equipped vehicle. Drivers worried about their attentiveness can use the Samsung Gear smartwatch to set audible chimes and voice alerts at 3-, 5-, 10-, 15- or 20-minute intervals while on the road. Future versions of the app will vibrate the watch.

Meanwhile, Renault and Sensoria are collaborating on socks that enable racing car enthusiasts to assess their performance on the racing track. The information gathered by the connected socks is transmitted to an app that records parameters including speed, braking and acceleration.

Stimulated and tense to at-ease and relaxed.

‘Mood bursts’ are used to transform the driver’s state of mind. If the Healthcare Cockpit’s sensors detect the driver is losing concentration, an Alert Burst can be triggered to engage them. If they have elevated stress levels, a Calm Burst can boost relaxation.

“The Alert Burst and Calm Burst work because our moods change as a result of several complementary environmental changes, such as lighting (for example blue hues tend to relax us), music choices and tuning, scents (lavender can have a calming effect), air temperature and fan speed, and seatback tilt,” says Suh.

The potential of wearables

Car makers are investigating the potential of wearables to send more information to drivers. For example, Ford introduced new technology in 2017 allowing owners of Samsung Gear 2 and Gear 3 smartwatches to integrate their devices to a Ford SYNC-equipped vehicle. Drivers worried about their attentiveness can use the Samsung Gear smartwatch to set audible chimes and voice alerts at 3-, 5-, 10-, 15- or 20-minute intervals while on the road. Future versions of the app will vibrate the watch.

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Stimulated and tense to at-ease and relaxed.

‘Mood bursts’ are used to transform the driver’s state of mind. If the Healthcare Cockpit’s sensors detect the driver is losing concentration, an Alert Burst can be triggered to engage them. If they have elevated stress levels, a Calm Burst can boost relaxation.

“The Alert Burst and Calm Burst work because our moods change as a result of several complementary environmental changes, such as lighting (for example blue hues tend to relax us), music choices and tuning, scents (lavender can have a calming effect), air temperature and fan speed, and seatback tilt,” says Suh.

The technology is at the conceptual stage and Suh says three developments are required to make it a reality. “The first is better sensors,” he says. “While there are sensors that monitor physical condition, we need other sensors to make those bio-signals reliable across a wider range of users and situations. Another area for development is data analysis; there needs to be software that can use the sensor inputs to diagnose the driver’s condition accurately. Related to that, there needs be a deeper understanding of how individuals react to changes in the cabin.”

Autonomous applications

DMS technologies could also have a role to play during the long transitional

NHTSA says drowsy-driving crashes most commonly happen between 12:00am and 6:00am, or in the late afternoon, and that many are run-off-road crashes involving a single vehicle with no passengers

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Autonomous applications

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“WE ARE GOING TO NEED DRIVER MONITORING FOR A LONG TIME, EVEN WHEN WE ACHIEVE LEVEL 4 AUTOMATION”

Neville Stanton, professor of human factors in transport, University of Southampton
We all have our morning routines – and a distraction, misunderstanding, or change in the routine can easily have tragic consequences if you forget your child in the car. In the US alone, at least 739 children have died from vehicular heatstroke between 1998 and 2017.

IEE’s VitaSense is the first vehicle-based system that detects the presence of children on the rear seat, even sleeping infants, the most frequent victims. This allows the vehicle to make a warning - or take other countermeasures - so the number of heat-related tragedies can be reduced.

The Euro NCAP Roadmap 2025 plans to award this type of functionality as part of their rating scheme starting in 2022.

More information is available at www.iee.lu
Lethal loads

Unsecured objects or animals in the car pose a big threat to occupants – but the issue does not receive the attention it merits.

Author: John Evans
Images: Shutterstock, The Center for Pet Safety, Horiba Mira
According to the American Pet Products Association, 42.9 million homes in the USA, own a cat and 54.4 million a dog. Only 16% of owners restrain their pets in the car. The Center for Pet Safety, which tests pet restraint systems, recommends that properly restrained pets should travel in the back seat of the vehicle or the cargo area. It publishes advice on the load limitations of vehicle restraints and connections, and says pet owners should be aware of these to understand the risks. In addition, it documents formal test standards for harnesses, crates and carriers, rating products on measurable performance indicators.

Lindsey Wolko, founder of the Center for Pet Safety, a US-based organization that crash tests pet restraint systems and promotes pet safety in vehicles, recalls a horrifying story involving a car driver seriously injured in a crash by their unrestrained dog. “The man had to be airlifted out of the crash when his terrier hit him on the head and neck,” she says. “Happily, he survived, but the treatment for his dog cost US$15,000.”

The 7kg (15.4 lb) terrier, traveling at, for example, 50km/h (31mph) prior to the crash, would have exerted a force of 350kg (771.6 lb) on the driver’s head. But even had the pet been restrained, there’s no guarantee the outcome would have been any better, at least for the dog. Veterinary surgeons at the Institute of Forensic Medicine at Brno, in the Czech Republic, describe how a dog traveling in the rear seat of a car, wearing a safety harness tethered to
LOOSE OBJECTS

“THERE ARE NO PERFORMANCE STANDARDS OR TEST PROTOCOLS FOR MANY CLASSES OF PET PRODUCT”

Lindsey Wolko, founder, Center for Pet Safety

According to the DfT, 541 people died in work-related driving collisions in the UK in 2016.

No tests or standards

“There are no performance standards or test protocols for many classes of pet product, and manufacturers are not required to test them,” explains Wolko of the Center for Pet Safety. “There is no oversight agent for the pet product industry, and while some manufacturers claim to test products, with the absence of test standards, these claims cannot be substantiated.”

The issue of unrestrained or inappropriately restrained interior loads is not confined to pets, but it receives scant attention, particularly in terms of private cars. For example, Euro NCAP tests vehicles’ crashworthiness and safety systems, but not the behavior and risks associated with unrestrained objects. “While unrestrained objects in cars can definitely be dangerous, this has not been tested by Euro NCAP, nor do we have this planned for the future,” said a spokesperson.

Commercial research

By contrast, the risks posed by unsecured or unrestrained loads in commercial vehicles are widely publicized and investigated. The UK’s Health and Safety Executive says workplace transport is one of the

Flying phones

Figures relating to driver distraction shine a light on the issue of unrestrained objects inside vehicles. According to distraction.gov, a US government safety agency, at any given moment across the USA, approximately 660,000 drivers are using cell phones or electronic devices while driving. Assuming a cell phone weighs around 200g (7oz), one flying around the interior of a car in a crash could generate a force of 6kg (13 lb) at 48km/h (30mph).

Other common in-car distractions include eating and drinking, suggesting the presence, perhaps, of aluminum cans and heavy bottles. Books and road atlases are also given as examples of distractions in cars.
highest-risk work activities there is, accounting for more than half of all incidents resulting in death or injury. It says many incidents are a direct result of loads being secured poorly, leading to these loads falling over during the journey. This claim is borne out by figures released by the UK’s Driver and Vehicle Standards Agency. During the 2015/2016 financial year, it issued 1,632 prohibitions relating to unsecure loads on commercial vehicles.

Tools on the loose
Es Shepherd, head of member advice at the UK’s Freight Transport Association (FTA), says his organization is very aware of the dangers. “A few years ago, the FTA commissioned a safe van racking guide from TRL, aimed especially at drivers who use their van as a toolbox,” he says. These drivers were at risk from up to 1 ton (2,205 lb) of loose missiles – screwdrivers, spanners, electric drills, and so on – especially under hard braking. Most vehicles have racking now, and companies don’t hesitate in having their vans modified.”

Shepherd says two pieces of UK legislation have encouraged operators to consider vehicle loading more carefully – Regulation 100 of the Road Vehicles (Construction and Use) Regulations 1986 and Section 40A of the Road Traffic Act 1988. He says that while most commercial vehicle operators are aware of this legislation, the public should also know it, as it relates to all motor vehicles. “Go to any home improvement store and see how people

No-go areas
Tony Payne (pictured above), senior consultant on safety projects at Horiba Mira, says the police often approach his team to test restraints for communications and incident kit. “They like putting lots of fancy kit in their cars and ask us to assess if it’s sensible to or not,” he says. “We tell them they can’t put anything in the airbag deployment zone or attach anything to the seatbelt. We may test it, but we’ll issue a report saying it’s not the best location for that device. You shouldn’t play around with seatbelts because they’re tested and approved as they are.”

One company wanted to secure its workers’ laptops with a strap attached to the seatbelt. “We advised against it because the seatbelt is there to restrain the person and not the person plus something else,” says Payne.

(Main, above and left) The Center for Pet Safety conducted a crate and carrier study, sponsored by Subaru of America, in 2015.
A 2017 study by Fixeta found that 84% of respondents had driven with a piece of luggage in the cabin.

The Fixeta study also found that 40% of drivers would carry extra luggage unsecured in the cabin.

Aftermarket kit

In the absence of clear regulations, Tony Payne of Horiba Mira says the approaches taken by suppliers of aftermarket equipment fall into three categories. These are: negligence (those who performed no tests on the equipment); best practice (those who tested using the ECE R17 pulse); and state-of-the-art (those who also used appropriate materials in the construction).

“It’s all about liability; an OEM is going to want to see the supplier has considered everything,” says Payne. “This is because an OEM homologates a vehicle to the point of sale – it’s not responsible for anything added to it afterwards. If someone buys an option at the point of sale, the car maker will have to get it approved.”

Load their cars, he says. “It’s terrifying. Ladders, planks and heavy tools can, in an impact, burst out of the load area into the passenger compartment.”

Seatback strength

It was these concerns that, in 2003, led to a proposal to amend ECE Regulation 17 – concerned with seat anchorages and head restraints – with the aim of protecting occupants against the displacement of luggage in the back of a vehicle. Consumers International, which proposed the amendment, quoted research by TRL that revealed that weaknesses in the rear seatbacks in cars could cause serious injury. It said the ECE R17 test used a standard load weight to replicate the luggage colliding with the rear seatbacks, but did not account for the luggage capacity of the car, which could in fact be far greater.

Consumers International proposed a higher test pulse and consideration of the car’s luggage capacity.

Gray area

Today, that test pulse, defined by ECE R17 as 20g for 30ms, is a key weapon in the fight to improve vehicles’ internal safety. Tony Payne, senior consultant on safety projects at Horiba Mira, says not only does his team apply it in rear seatback tests, but also in tests of aftermarket safety equipment, such as dog guards, which is unregulated.

“It’s a very gray area,” comments Payne. “We’d love someone to produce regulations we could work to. Until they do, it comes down to product liability. That’s the stick that ensures OEMs insist their suppliers have their aftermarket products tested.”

Whether it’s pets, parcels or phones flying around your car, the issue of unsecured loads is a serious one. Perhaps it’s time regulators realized that.
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Jaguar Land Rover’s head of safety, Phil Glyn-Davies, is working to make safety systems as unobtrusive and personalized – and therefore more widely accepted by drivers – as possible.

AUTHOR GUY BIRD
IMAGES JLR

Subtle support
Features of the new Discovery SVX include a tuned Terrain Response 2 system and active roll control.
The Jaguar Land Rover Group (JLR) features brands that have clear – and diverse – market positions. Jaguar is all about “grace, space and pace” – whether the cars are coupes, saloons or crossovers, while Land Rover is associated with rugged, off-road ability, and Range Rover is positioned as the ultimate luxury go-anywhere SUV marque. Although these brands encompass a wide breadth of attributes, a strong emphasis on safety underpins them all.

This means that the work of Phil Glyn-Davies, senior manager of vehicle safety at JLR, is diverse and involves the development of some unusual features, in addition to the more traditional core safety systems.

Unusual features
For example, Jaguar’s all-wheel-drive technology features an Intelligent Driveline Dynamics (IDD) system, which can detect when the driver is about to lose traction in predominately rear-wheel-drive mode and prepare to divert more traction forward to the front ones, to keep the car on track. Meanwhile, Land Rover’s wade-sensing kit features downward-facing sensors on the side mirrors that feed

Getting to know Phil Glyn-Davies

1964: Born in Harpenden, Hertfordshire, UK
1986: Completed a general engineering degree at Cambridge University in the UK
Late 1980s: Started career as a durability engineer at General Motors, first in Luton, UK, and then at its testing facility at Millbrook, UK. Later graduated to become senior engineering manager for vehicle safety
2011: Joined Jaguar as an integration engineer
2013: Became senior manager of vehicle safety attributes at Jaguar Land Rover

Personal life
Family: Married with a son (19) and a daughter (17)
First car: Land Rover Stage 1.

“It was a second-hand, early 1980s model. I’ve always liked Land Rovers; my grandparents had a place in Wales and it got to places other cars wouldn’t. I still own it.”

Current car: A 2017 Range Rover Sport (company car)
Hobbies: “A bit of indoor climbing, independently organized holidays to India, Brazil, Peru – we climbed Machu Picchu there – and rock climbing, but not mountaineering. You need a low sense of your own personal comfort for the latter.”
Favorite book: Touching the Void by Joe Simpson
Favorite film: The Third Man
Favorite music: Mis-Shapes by Pulp, Pixies, 1980s indie
information to the interior screen, informing the driver when they’re close to the car’s maximum wading depth. By the end of the decade, JLR products will offer pothole detection, utilizing forward-facing stereo digital cameras and other sensors to pinpoint oncoming blemishes in the road and adjust the suspension accordingly. JLR also plans to share this data via the cloud to warn other drivers on the same route, and with local authorities so that they can fix them more quickly. Glyn-Davies’ experience includes more than two decades at General Motors’ UK testing facility at Millbrook – where he worked on outsourced projects as diverse as improving military vehicle blast protection and aircraft seating g-force testing. He joined JLR in 2011 as an integration engineer, before rising to the group’s top safety job in 2013.

“THE BEST ACTIVE SAFETY SYSTEM IS ONE WHERE YOU’RE NOT EVEN AWARE OF ITS PRESENCE”
In interview, the 53-year-old comes across first and foremost as a pragmatist. “We’re looking for our safety to be very driver-centric and to introduce systems at the point where they are high enough quality to not be invasive,” he says. “If people believe these devices will interfere to the point that they don’t like them, they won’t specify them or have them turned on.”

Glyn-Davies cites a US survey from a couple of years ago that found 50% of respondents who bought LKA turned it off because it beeped when they didn’t want it to. He wants JLR’s take on safety to be the opposite of nannying or annoying. “It’s about the car being more aware of what the driver is doing, and what constitutes normal driving behavior, then modifying the vehicle intervention based on how engaged the driver is,” he says. “We did a variant of lane-departure warning that used braking, steering and throttle input to identify the level of driver engagement, then adjusted the system’s sensitivity accordingly. It’s a difficult balance to make with marketing and other departments, because you could have a system that doesn’t appear to work quite a lot of the time – but the best active safety system is one where you’re not even aware of its presence.”

**Personal safety**

Glyn-Davies thinks machine learning will be key to achieving a higher level of personalization, and that such technology is not far away. “Cars now have so many systems that could be tuned to the style of the driver, but to set that up individually is a very laborious process,” he says. “A system that can identify you – whether by recognizing the phone you’re carrying or by you keying details into the car – will allow the vehicle to understand your behavioral traits and adapt its systems accordingly.”

Of the challenges ahead, Glyn-Davies says an important question will be how to interpret the vast amounts of new data generated. “By 2020 or possibly a bit earlier, JLR production cars will have all the external sensors we need to manage and observe the environment from all angles – including lidar, radar, stereo cameras, corner radar and far infrared,” he says. “The challenge will be combining all those things in such a way that the car makes the right decisions. If you want an analogy, a baby has the same sensing capabilities as an adult, but it hasn’t yet learned how to make correct decisions about the world around it.”

**Wish list**

All these sensors come at a price – Glyn-Davies reckons about £4,000-£5,000 (US$5,285-US$6,600) per car – so he’s keen to see suppliers be more inventive to bring the cost down while maintaining the quality required. He’d also like to see those in charge of infrastructure take a more active role in safety planning, so V2I discussions can take place sooner. “Up until now, a lot of safety legislation has focused on the manufacturer, particularly regarding technology,” says Glyn-Davies. “Going forward, safety has to be much more of a shared venture, with legislative and government organizations involved. The car makers can get there by themselves, but it will take much longer and be more expensive.”

One problem he gives that could be solved by infrastructural means is drivers proceeding through red lights. “There’s a set at a junction to the M1 motorway where people regularly go through a red light because the angle of one of the lights in the cluster is still visible to drivers in the other lanes,” says Glyn-Davies. “When drivers in these other lanes see the light go green, sometimes they drive through. If humans can mistake such a signal, then a car’s camera – which still misses some driving nuances – could do too, at least until we can get to an AI level of programming. If a traffic light could communicate its status to the car, the car wouldn’t get it wrong; that signal has to come from the infrastructure.”
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From the publisher of Vision Zero International
Welcome sight

Developments in individual sensor capabilities, processing software and AI are expanding the operational scope of safety systems

Author: Cat Dow
Images: Volvo, Toyota, Ford, Shutterstock
Volvo’s City Safety VRU detection and Pilot Assist technologies are based on a combination of sensors.
With the electric revolution underway, we investigate what must be done to prevent battery fires and other dangers

Phil Glyn-Davies
Jaguar Land Rover's head of safety on personalized ADAS, V2I and bringing down sensor costs

Flawless sensing
The latest efforts to expand the capabilities of sensors and software to deal with all weather and light conditions

Driver monitoring
How health and emotions can be monitored and even improved to help drivers be at the top of their game

Visit www.ukimediaevents.com/info/vzi to request exclusive and rapid information about the latest technologies and services featured in this issue
The key to autonomous vehicles is getting them to behave as well as humans – but we are complex creatures. We can see, hear, feel and subsequently predict and plan in nanoseconds, often not consciously. Yet human capacity for concentration is both variable and restricted – which is where intelligent machines come into their own. But ensuring computers have the same sensing capabilities is no easy feat.

**Sensor fusion**

Current camera, radar, laser and sonar sensors are combined to try to mimic human capabilities. No single sensor type can achieve this in isolation. “It is crucial to have two or more sensors, since there are advantages and disadvantages to each type,” comments Tjark Kreuzinger, senior manager of safety research and technical affairs at Toyota Motor Europe. “For example, sensors with a wide field-of-vision are good for short distances. Conversely, the field-of-vision on a long-range sensor is less than 20°.”

These different sensor types are suited to detecting different things. “For example, in a situation where an e-bike is traveling at 40km/h (25mph) and a car is traveling at 20km/h (12.5mph), a camera might pick up on the e-bike, but the long-range sensor won’t have a wide enough field-of-vision,” says Kreuzinger.

Cameras are deemed to be the best all-rounder, because with adequate processing power they can detect almost anything. However, in low light or poor weather conditions, a vehicle cannot rely solely on the camera. In such situations radar is king; it is unaffected by light, temperature or weather conditions. However, the equipment size, radar’s lack of accuracy with lateral measurements and inability to classify objects are key challenges. Other solutions include laser (lidar) and sound sensors, but these have limitations of their own.

**Low light**

Ford says it has overcome the camera’s traditional low-light limitations through the use of sophisticated computer mapping. “When we introduced Pre-Collision Assist on the Mondeo, it only worked in the daylight; the feature deactivated in low light,” explains Thomas Łukaszewicz, manager at Ford Automated Driving Europe. “In the 2017 Fiesta we have a next-generation camera with better resolution and an algorithm with higher computational power, which means we can run different exposures in parallel. That means we can activate the feature even at night.”

**Current capabilities**

In general, sophisticated cameras have improved from a VGA resolution of 640 x 480 pixels to 1,920 x 1,080 pixels, enabling greater clarity at greater range – going from 50-60m (164-197ft) to 100m (328ft), meaning that dirty road signs are not as much of a problem as they were. However, improvements still depend on light conditions, so buddy sensors are needed.

Ultrasonic range for parking sensors has extended from 2-3m (6.5-10ft) to 5-6m (16.5-20ft) and on short range has moved from 20-30cm (8-12in) down to 15cm (6in). Similarly, with radar, long range is 150-200m (500-650ft), but latest-generation radars go as far as 250m (820ft). A few years ago, radars were blind within 1m (3.3ft) but now they can see as close as 20-30cm (8-12in).
With the electric revolution underway, we investigate what must be done to prevent battery fires and other dangers.

Phil Glyn-Davies
Jaguar Land Rover’s head of safety

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A study of human behavior

Autonomous cars will need to deal with humans on an everyday basis. Dr Gill Pratt, CEO of Toyota Research Institute (TRI), says much work has been done in Europe on recognition, using deep learning.

“Perception is pretty much there,” explains Pratt. “Next we have to work on prediction. If a ball rolls into the road, what is going to happen next? Will a child follow the ball? The hard part is, it’s not about physics. It’s about the human mind and behavior. It turns out that recognition is hard, but predicting human behavior is really hard! Everyone is different. You not only need to collect a lot of data, but you must understand the variability of it. People are very complex.”

To understand driver behavior, the Toyota Research on Autonomous Cars Europe (TRACE) team has set up some global tests. “We need to be able to predict the behavior of other drivers,” says Jonas Ambeck-Madsen of Toyota Europe. “How do we do this? We analyze the context. Cars are driving in their own lanes and they respect the distance of the vehicles around them. We feed this information and examples of how people performed when overtaking and then we learn what the key elements are that will make a certain driver decide to overtake or not. We’ve tested the system in different regions with different sensor setups. The more data we gather, the better the prediction we can make. Currently our best system predicts actions within 1.6 seconds with 80% accuracy.”

The team has compared this driving sequence to manual driving. When the model predicted risk, the driver was actually releasing their foot off the accelerator. The researchers found a consensus between how people drive and the risk the system detects at the right time.

“We think that this is necessary for the acceptance of autonomous driving,” says Ambeck-Madsen. “The car will behave the way they expect it to and this will make them feel comfortable. The next step is to continue to decrease the time it takes to predict the maneuver. Occasionally the car will risk a lane change or predict one that doesn’t happen and we need to understand what the passenger is feeling at that time.”

“At Ford we have cameras in production and we are working with suppliers on the next generation, which features increased performance, resolution, field-of-view, range and sensitivity to light conditions,” says Lukaszewicz.

Ford introduced its Active City Stop AEB feature in 2011, using lidar technology. Based on a single laser beam, automatic braking applied below 15km/h (9.3mph), with crash mitigation below 30km/h (18.5mph). The lidar range has now increased.
Learning from the animal kingdom

To understand how to optimize sensor performance in every environment, researchers have been investigating other species. “We might think cameras are the only replacement for human vision, but some animals have different types of eyes,” says Luc Van Gool of KU Leuven. “One type of fish, Anableps, has divided pupils; part can look up out of the water and part can look inside the water. There are birds of prey that can see UV parts of the spectrum. Bees can use the polarization of sunlight as a way-finding tool. Then there are goats, which have horizontal pupils that allow them to focus on the part of the scene that matters. To retain that advantage when grazing, the eye rotates to keep the pupil horizontal. Hopefully we’ll be able to evolve an autonomous car and find out what kind of eyes and sensors it needs.”

Van Gool believes that in the end, autonomous cars will have a combination of sensors, probably with very non-human capabilities such as near-infrared.

“It is challenging to endow them with the same knowledge about the world that people have. You can train a system – using good drivers, of course. Alternatively we could do a lot of deep learning and build rules on top of that, but that approach didn’t do well in the real world previously.”

Jonas Ambeck-Madsen and the team will start real-world testing in the next year or two. “The model must be validated in the real world – so far it’s only seen videos, not real life,” says Ambeck-Madsen. “We’ve also talked about how we can go further, from the attention span to what our mental state is linked to, how we feel, and applying the same logic to the car.”
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The human brain does an astonishing job when confronted with the task of driving a car. It processes all the data sensed by the body, accounts for previous driving experiences and knowledge about the local environment, and immediately generates motor input on the steering wheel and pedals. It does all this very well: even on roads they have never seen before, most drivers reach their destinations without an accident.

Developers working on automated driving systems at Bosch are now facing the challenge of emulating this impressive performance using technology. In fact, they want to go further, to reduce the number of collisions to zero by exploiting the fact that an automated system never gets tired, is always focused on its task and can control the vehicle more precisely than a human driver can.

**Bridging the gap**

Still, automated vehicles are not yet always able to cope with situations they have never seen before. While many developers are working on machine learning approaches that aim to imitate the human brain, it will take years before these solutions are robust enough for series system implementation. In the meantime, another component must stand in for the intuition, experience and localization of the human brain: an up-to-date, high-definition map.

HD maps go far beyond the classic navigation maps sold now, and are commonly organized in layers that contain specific information for planning the next maneuver (for example, detailed lane geometry) and for localizing the vehicle.

**Localization**

To use a map, the vehicle’s precise location must be ascertained. Once the exact vehicle location is found inside the map’s localization layer, the vehicle is localized in the complete map, as the layers are precisely aligned with each other. The vehicle is localized in relation to landmarks that are observed by the vehicle’s sensors and matched to landmarks in the map’s localization layer. This localization process can be repeated repeatedly to obtain a stream of locations.

The landmarks typically used for localization at Bosch are features detectable by camera (including lane markings and road signs) or radar. Both types of sensor are widely used today for ADAS functions and are thus able to provide frequent map updates. One challenge the map engineers are
The Bosch Road Signature

The Road Signature is a localization service being developed at Bosch. It allows localization with radar or video sensors. The Bosch Radar Road Signature, relying on radar signals, is reliable in situations where the camera faces limitations, for example in snow, heavy rain, blinding sunlight or fog.

It is a fully independent localization system, but can also be combined with video-based localization (the Bosch Video Road Signature) to exploit the advantages of both technologies and to make localization even more robust.

The system uses data from radar and video sensors fitted to connected vehicles. The data is transmitted to the OEM’s cloud and forwarded to Bosch’s. The Road Signature layers are created in the cloud and can be forwarded to the map provider. The map provider can then offer the integrated HD map for the OEM’s vehicles.

Facing is balancing the trade-off between the map’s memory consumption and providing enough landmarks for robust localization.

Forward planning
To plan the next maneuver, the precise location is not the only requirement; a specific layer containing semantic information about the road network is also needed. This includes information such as how many and what type of lanes are present around the vehicle, and the speed limitation for each lane. Knowledge about upcoming lane geometries is needed in deciding whether the vehicle should perform a complex lane change or stay in its current lane; information that can be extracted from this layer. The course of the lane ahead, beyond the reach of the vehicle sensors, is relevant for the comfortable planning of many driving maneuvers. This information can be read from the map.

To realize these map-based functions, the information provided must be highly accurate and fresh. The required accuracy can be achieved using mapping vehicles equipped with highly precise measurement technology, including laser scanners, highly precise inertial measurement units and differential GPS.

Crowdsourcing data
Unfortunately, this method of data collection is time-consuming and expensive, because the vehicles must be moved regularly along all required roads and the huge amount of data must be processed afterward in combined automated and manual processes. Thus, it is difficult to create maps with this method in the frequency required for sufficient freshness. Instead, many companies are now following a complementary approach to reflect changes in the world as swiftly as possible. The approach is based on crowdsourcing the data from a fleet of vehicles equipped with the appropriate sensors. The vehicles transmit their observations to a cloud system, where the map is created and updated. Afterward, the map can be downloaded to the vehicles.

HD maps support automated driving by introducing information about the environment that the human driver would take from their experiences. HD maps provide the element of intuition to automated vehicles, thus playing an important role on the road to full automation and a huge reduction in collisions.

• Peter Abeling is the product specialist responsible for Robert Bosch’s road signature cloud system

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We’ve all heard stories of how thieves can use US$50 worth of electronics to build a device capable of hacking into a vehicle’s keyless entry system. In fact, in 2016, Germany’s national motoring body, ADAC, released a list of vehicles vulnerable to exactly such an attack. Additionally, the internet is flush with articles from other research teams showing how easy it is to take a car by simply stealing its keyless entry signal.

But preventing vehicle theft is not the only reason the automotive industry is interested in new security measures. With the advent of the connected car, securing personal data is a preeminent concern, and knowing who is behind the wheel is essential to the safe delivery of cloud-based features and services. To help meet these requirements, the industry is increasingly turning to biometrics.

Within the automotive industry, biometrics can be defined as a security mechanism that measures and analyzes certain physical attributes to identify and authenticate the driver prior to granting vehicle and/or information access. Common forms of biometric solutions include fingerprint, facial and voice recognition.

To help auto makers provide security for the connected car, Gentex recently launched a vehicle-based biometric identification system that authenticates the driver and delivers customized security, comfort and convenience features. It can be used to secure and enhance vehicle-to-home automation services and vehicle-to-infrastructure transactions, too.

The Gentex biometric solution stems from a strategic partnership with...
Iris recognition

Biometric identification is used to identify an individual accurately by analyzing one or more of their unique biological characteristics, for example fingerprints, facial geometry, voice waves, iris patterns or DNA. Each has pros and cons when it comes to accuracy and implementation. For example, fingerprint scans can be affected by skin contaminants and other environmental factors. Facial recognition systems struggle when the subject’s facial hair or body weight alters dramatically. Voice recognition becomes troublesome with excess ambient noise.

Biometric authentication is also critical for alternative mobility solutions such as ride sharing, where an iris scan could authenticate the ride-share member and allocate payment for vehicle usage. In the autonomous age, an iris scan would confirm identities, personalize the cabin, authorize users’ cloud-based services and assign payments.

Biometric identification, iris scan systems in particular, stands to become a vital vehicle security measure for safeguarding and personalizing the in-vehicle, connected-car experience.

• Neil Boehm is vice president of engineering at Gentex

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In recent years several NCAPs have started to perform crash tests with adult dummies in the rear seats. One aim is to motivate vehicle manufacturers to make restraint technology such as belt tensioners and load limiters more widely available for rear seats. However, rear-seat occupants can only benefit from improved belt systems if they are buckled up.

Seatbelt wearing rates for the rear seats are known to be lower than for front seats – dramatically so in some countries (see table). What can be done to ensure that rear-seat passengers benefit from advanced restraint systems? The IIHS recently investigated what would motivate part-time belt users and non-users to buckle up in the rear. Visual belt reminders were mentioned by 50% of respondents, and 62% said audible reminders would make them wear the seatbelt. Only a direct request from another occupant was said to be more effective (75%).

**Current solutions**

Advanced seatbelt reminder (SBR) systems with audiovisual warnings have proved highly effective in increasing seatbelt use. The number of drivers and front-seat passengers that don’t buckle up is reduced by 80% in vehicles with advanced SBR systems that meet Euro NCAP requirements.

Simpler SBR systems for the rear seat have become common lately, especially in Europe. Through buckle monitoring, visual seatbelt information can be provided to the driver at the start of the journey. Should a rear passenger unbuckle during the trip, an audiovisual alert is triggered.

**Recent rulemaking**

On the regulatory side, a recent update of the UN R16 regulation has paved the way for mandating these basic rear-seat SBR systems in countries applying that UN regulation. For the EU, the effective date for new vehicle types is expected to be September 2019 or 2020. In the USA, the MAP21 bill called for rulemaking on a rear-seat safety belt warning system, and has been overdue since 2015.

<table>
<thead>
<tr>
<th>Country</th>
<th>Front seatbelt use</th>
<th>Rear seatbelt use</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>42% driver 13% passenger</td>
<td>2% 4%</td>
</tr>
<tr>
<td>France</td>
<td>98% passenger 98% driver</td>
<td>84% 35%</td>
</tr>
<tr>
<td>Italy</td>
<td>60% passenger 98% driver</td>
<td>50% 35%</td>
</tr>
<tr>
<td>Japan</td>
<td>98% passenger 94% driver</td>
<td>35% 35%</td>
</tr>
<tr>
<td>Poland</td>
<td>80% passenger 80% driver</td>
<td>43% 25%</td>
</tr>
<tr>
<td>Spain</td>
<td>91% passenger 91% driver</td>
<td>81% 81%</td>
</tr>
<tr>
<td>South Korea</td>
<td>84% passenger 84% driver</td>
<td>19% 19%</td>
</tr>
<tr>
<td>UK</td>
<td>95% passenger 95% driver</td>
<td>89% 89%</td>
</tr>
<tr>
<td>USA</td>
<td>86% passenger 86% driver</td>
<td>75% 75%</td>
</tr>
</tbody>
</table>

Source: IEE based on data from ETSC, UN, NHTSA and JAF

Advanced SBR systems, well known for the front seats, are now coming to the rear seats. By adding occupant detection sensors, the basic buckle-monitoring SBR systems can be upgraded to deliver the same audiovisual warning strategies as those given for the front seats.

Subaru has introduced two vehicle models with advanced rear-seat SBR to the Japanese market – the Levorg (2014) and the Impreza (2016). Both were awarded additional points by Japan NCAP. Starting in 2018, Euro NCAP and Australia NCAP will also introduce additional incentives for such advanced rear-seat SBR systems. Out of two points available for rear-seat SBR, one and a half points will be available for the buckle-monitoring function and half a point will be allocated to additional occupant detection, enabling an advanced reminder function.

We can therefore expect vehicles with advanced SBR for all seating positions to appear on the European and Australian markets. The upcoming regulatory requirement for the basic systems would allow the NCAPs to focus their incentives more on the advanced SBR systems.

**Technical challenges**

Occupant detection for the front passenger seat has been on the market for more than 20 years, and for the rear
Child detection

In the January 2017 issue of Vision Zero International, IEE highlighted the issue of children dying of hyperthermia after being left alone in vehicles – sometimes because the driver forgets they are there. IEE’s VitaSense radio-frequency sensor detects children in the rear seat after the ignition is turned off. The sensor can be integrated with onboard systems to activate alerts and other countermeasures.

In its recently released Roadmap 2025, Euro NCAP stated that child presence detection would be rewarded in its testing from 2022.

For vehicles with highly flexible seat configurations or removable seats, a wired system layout could be considered limiting. A wireless prototype concept has been developed to address those concerns. It is based on the same communication technology as currently used by tire pressure monitoring or keyless-go systems.

Camera-based concept
IEE is also investigating other occupant detection technologies that could be used for front- and rear-seat passenger detection. A camera-based interior sensing concept was presented at IAA Cars in September 2017. IEE’s radio-frequency based VitaSense sensor, developed to detect children that have been left unattended in a vehicle, also has the potential to be upgraded to monitor individual rear-seat occupancy.

Occupancy information is not only useful for SBR, but also has the potential to support systems including eCall. By achieving higher belt wearing rates and improved restraint systems, we can expect additional road safety benefits in the near future.

Test matrix
In addition, the occupant often has more freedom of movement in a rear seat, because of absent or less distinct side bolsters. Sensor design and size are therefore adapted to specific rear bench needs. A dedicated test matrix ensures robust sensor performance for occupant detection and object non-detection.

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Occupancy information is not only useful for SBR, but also has the potential to support systems including eCall. By achieving higher belt wearing rates and improved restraint systems, we can expect additional road safety benefits in the near future.
The development of ADAS and automated driving systems is increasingly moving away from the confines of proving grounds and laboratory conditions, and onto open roads, with all the complexities and challenges that real-world testing brings.

To validate the host of sensors and systems vehicles are equipped with, they need a robust and reliable ground-truth reference. This is most commonly supplied by an inertial navigation system (INS) combining a global navigation satellite system (GNSS) and an inertial measurement unit (IMU).

In the ideal open-sky conditions of a proving ground, GNSS can provide precise positioning down to the centimeter. Unfortunately, as you move away from the track and onto open roads, you encounter obstacles including tall buildings, trees and bridges. These cause multipath errors, obstruct satellite visibility, or block the signals completely. In these conditions, the sensor fusion of an INS helps aid the GNSS to keep the outputs on track. However, with traditional, loosely coupled systems, whenever the number of satellites in view drops below four, the performance is completely reliant on the IMU. For longer periods of outage, a high-performance IMU based on fiber-optic or ring laser gyros would be necessary, but these are expensive and cumbersome.

**Tight coupling**

One method to make use of more economical sensors in these environments is a tightly coupled integration between the GNSS and IMU. This type of integration, as
Minimizing RTK interruptions

No sensor can maintain RTK lock when satellite signals are interrupted, even momentarily as often happens in open-road testing, and with each interruption, the RTK search algorithm must search for a solution from scratch. While RTK loss can’t be prevented, its impact can be mitigated if the time to achieve relock can be significantly reduced – something an extension of the gx/ix algorithm called gxRTK inertial relock is designed to achieve.

It works by feeding the RTK search algorithm with a more accurate seed (starting point), which reduces the search area volume from cubic meters to cubic decimeters. This reduces the number of candidate solutions and means RTK relock should be achieved in under 10 seconds. Typically, it is achieved in about five seconds.
Since the airbag inflator scandal, car makers have imposed even more stringent measures to reinforce quality control. But despite the additional investment and complexity involved, suppliers still have the same cost targets.

Many manufacturers are resorting to less expensive fabrics and coatings for one-piece woven (OPW) airbags, cushions that are especially well-suited to applications such as side-impact protection. While cheaper materials meet the same quality requirements, the finished fabrics often have a high level of distortion.

When combined with process and resource optimization, advanced airbag design and laser cutting techniques make it possible to meet these exacting new requirements while achieving an end quality approaching zero defects, even when using cheaper materials.

Fabric distortion
OPW airbags are woven in three dimensions, enabling their seamless shapes to take form on the loom. Multiple cushions are woven into a single piece of OPW fabric, which must be cut to separate the individual bags.

OPW material is subject to many treatments before cutting. Despite the controlled production environment, once the fabric has been woven, scoured, washed, dried and either coated or laminated, the size and shape of the woven pieces present some degree of distortion. Typically the size of the pieces varies by as much as 2% from one roll of fabric to another.

To minimize risks stemming from this variation, OPW airbags are typically woven with adequate spacing between pieces. The cutting process must therefore guarantee that all the pieces meet the required dimensional specifications, whether fabric distortion results in a tighter or looser weave than was intended.

Design unification
Because industrial design departments define OPW airbag cut parts in a variety of formats, it is essential to unify scales and units. Points and segments unrelated to the outline to be cut are eliminated, even those invisible to the naked eye. Powerful software can detect and flag them, preventing unintended incisions that would compromise airbag integrity.

For OPW airbags, the next step is to build a grid, prepare for SmartCutting and assemble the parts from the industrial loom layout. SmartCutting was developed by Lectra for use with its FocusQuantum OPW laser airbag solution. Before the first cut is even made, the geometric data is extracted quickly. SmartCutting enables OPW airbag programs to be managed free of the restrictions typically associated with other cutting modes (for example, mainframe, scaled and hybrid). The result is a marked increase in material savings and cutter capability.

Fewer restrictions
Before SmartCutting was introduced, connection zones between deformable and non-deformable parts of OPW airbags cut in hybrid mode needed to be designed manually. Designing these complex zones was time-consuming and the cutting sometimes left
Lectra has developed software and laser cutting equipment to optimize OPW airbag cutting. OPW material can be distorted through bowing or skewing, or have a tighter or looser weave than required. These issues can now be handled with ease using advanced cutting preparation software. By delimiting specific areas of the OPW bag design that may not be altered, the laser cutter can instantly adapt to the fabric’s real contours while adhering to positioning and spacing rules. It is this dynamic interaction between the cutting preparation software and the cutter itself that results in cut pieces identical to the verification template.

Ensuring regularity

In theory, all it takes to cut an OPW airbag is a starting point and the outline of the cutting path for consistency with the verification template. Although this would be the only operation if the material were completely regular, cost-efficient materials generally present some degree of distortion, due to their elasticity. The cutting path must therefore accommodate variation, while eliminating the risk of making unintended incisions. Certain features – for example, mounting holes – must also be positioned with precise spacing, maintaining center-to-center distance. These issues can now be handled with ease using advanced cutting preparation software. By delimiting specific areas of the OPW bag design that may not be altered, the laser cutter can instantly adapt to the fabric’s real contours while adhering to positioning and spacing rules. It is this dynamic interaction between the cutting preparation software and the cutter itself that results in cut pieces identical to the verification template.

Greater efficiency

SmartCutting’s laser cutting technology makes it possible to combine non-deformable zones (where dimensions are reproduced just as faithfully as with the mainframe method) and deformable zones (where the cut piece is scaled and resized to conform to the true contours of the OPW material). The ability to manage two deformable zones directly opposite one another enables a dramatic reduction in the spacing between parts without the risk of any overlap.

Pierre-Michel Richer is airbag cutting room product manager at Lectra.
On the road to automated driving, vehicles are being equipped with numerous ADAS functions. The legal requirements for these are still being established, as illustrated by the plan recently presented by the German Federal Ministry of Transport. The technologies must be robust, so special emphasis is placed on their validation.

Euro NCAP has been testing city and interurban AEB since 2014, and VRU pedestrian AEB since 2016, to increase their market penetration. The system is evaluated in rear-end crash situations emulating everyday traffic and in a collision with a pedestrian crossing the road. Both deceleration and collision avoidance are evaluated.

**Euro NCAP changes**

In detail, the changes include the addition of a new category (AEB VRU bicyclist), the expansion of the three existing AEB tests, and the introduction of a new target vehicle, the Global Vehicle Target (GVT).

Current AEB City testing involves nine tests, performed against a stationary obstacle within a 10-50km/h (6-31mph) range with 100% overlap. Tests will now also be evaluated in the range of ±50% and ±75% overlap.

Euro NCAP’s AEB Interurban tests are conducted using the scenarios of a stationary vehicle (CCR), a moving vehicle (CCRm) and a braking vehicle (CCRB), within a speed range of 30-80km/h (19-50mph) with 100% overlap. The new GVT will also be used for these tests, and vehicle overlaps will be evaluated in the range of ±50% and ±75%.

There will be equally marked expansion in the tests to validate AEB scenarios involving pedestrians. The current tests examine pedestrian recognition in three crossing scenarios within the speed range of 20-60km/h (12-37mph) in daylight. These will be expanded in 2018 to include scenarios at night and in a longitudinal direction.

The whole AEB test procedure will be supplemented with the addition of a scenario involving a bicyclist. The AEB VRU Bicyclist test will examine the scenario of a cyclist crossing the road within the speed range of 25-60km/h (16-37mph) and riding in a longitudinal direction within the speed range of 25-80km/h (16-50mph).

Clearly, a 2018 Euro NCAP test campaign will be hugely more complex than before, with the additional influence of a further environmental condition – night-time.

**Need for speed**

Testers must master a broad range of tests efficiently and safely. These tests must take place at defined times and in certain conditions – factors that necessitate testers to act with high efficiency and swiftness.

To meet these requirements, the x-track project combines a mobile approach with a complete chain of testing tools, thus ensuring a high level of flexibility and agility. The test van has been specially equipped for the
“TESTERS MUST MASTER A BROAD RANGE OF TESTS EFFICIENTLY AND SAFELY; TESTS THAT MUST TAKE PLACE AT DEFINED TIMES AND IN CERTAIN CONDITIONS”
The character of a car is defined by the way it handles on the road, which is down to the chassis. The steering, wheel guidance, damping and suspension are key to the car’s identity and ability to please. A good chassis can also reduce noise, vibration and harshness, helping to reduce or remove the rattles and knocks that occupants find annoying, in turn reducing the requirement for additional, weighty materials to reduce this unwanted noise.

“Going forward, mobility will be all about improved driving comfort and safety as well as local zero-emission drives,” says Dr Holger Klein, head of the Car Chassis Technology division at ZF Friedrichshafen.

As well as offering safety benefits, developments in chassis technology will aid the acceptance of autonomous vehicles by delivering a comfortable experience.

As one of the most complex systems in a vehicle – and one of the most important when it comes to enabling driving safety and comfort, the chassis will play a growing role in the progression of vehicle design as we move through assisted driving features to fully autonomous vehicles. ZF’s active chassis systems are already playing a major role in improving vehicle safety; part of the company’s active contribution to support its vision of accident-free driving.

New chassis functions
Integral Chassis Control (ICC) connected to mechatronic systems takes this a step further. It enables new chassis functions, preparing the way for autonomous driving features and increasing safety and comfort with excellent longitudinal, lateral and vertical driving dynamics. The ICC connects individual chassis systems and enables functionality in the control network. “We’ve put a lot of forward thinking into our new active systems to make vehicles ready for autonomous driving features, because if you’re not actually driving, it may be easy to blame autopilot features for every noticeable pothole or bump in the road,” says Klein.

Roll control
ZF’s Electromechanical Roll Control (ERC) active roll stabilization system improves cornering performance and provides a more comfortable ride on uneven road surfaces, while helping to put an end to unwelcome chassis movement that would otherwise affect the car body on these surfaces. The 48V electric motor installed on the axle equalizes vehicle roll motion in under 300ms at torques of up to 1,400Nm. Further benefits come from ERC’s

Smooth moves
AV roll-out

The launch of automated vehicle functions is transforming the way in which cars are designed and marketed and could also enable drivers to disengage from driving tasks for periods of time. Vehicle architectures will change the way people can use interiors; manufacturers are likely to place greater emphasis on interiors that can transform cars into mobile living spaces.

Hefty steering maneuvers can feel, at best, unpleasant, but if the occupant’s attention is focused on other things, these can become impossible to counter. The integration of ZF’s ICC with frontal electric power steering and AKC rear-axle steering system can improve fast-lane changes and make avoiding potholes feel almost like a smooth straight drive.

Active damping
Improvements in body stability help to make driving safer and far more comfortable. The new sMotion active damping system builds on the proven Continuous Damping Control technology from ZF. A motor pump unit is integrated into each wheel suspension, helping to enhance the performance of shock absorbers. These bidirectional actuators enable the system to generate forces at a higher speed against the piston rod movement. Consequently, while conventional or semi-active damping systems are sensitive to vibration, sMotion actively counteracts roadway surface excitation, including potholes or bumps, with scalable force. This virtually eliminates rolling, pitching, tipping and bounce in the vehicle body.

Autonomous driving will enable the driver to hand over driving functions so they can focus on other activities. If the vehicle becomes a mobile office, for example, the need for comfort becomes even more important. “sMotion makes you feel as if you’re on a flying carpet,” says Klein. Combined with ZF sensors, control electronics and lidar or radar sensors, sMotion will support autonomous driving functions.

Level best
Using four actuators to realign the vehicle’s spring plate, ZF’s Electro Hydraulic Leveling (eLevel) technology adjusts the height of the car body smoothly. This enables improved aerodynamics, which in turn reduces CO₂ emissions; optimized ground clearance; contact-free loading of e-vehicles; balancing of the level of loaded vehicles; and increased efficiency while driving uphill and crossing raised obstacles; as well as simply making it easier to get in and out of the vehicle.

Thanks to its actuators and interfaces to ADAS, defined according to the plug-and-play principle, ZF’s ICC can be used in a scalable manner across platforms and can play a key role in highly automated driving. ICC connects advanced systems such as the EPS on the front axle to the Active Kinematics Control (AKC) rear-wheel steer system, active damping and the vehicle’s electronic braking system. Networking the individual actuators gives rise to completely new functions, including emergency steering and trailer stabilization. The latter balances out unwanted trailer movement and reduces the vehicle’s turning circle and vertical motions. ICC also shifts the dynamic driving limit range outward to assist the vehicle to stay in its own lane, even on icy surfaces, and if the situation arises, perform evasive maneuvers more efficiently.

• Louise Colledge is head of regional communications at ZF

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Radar sensors are becoming key sensing elements in many ADAS and automated driving systems. The number of radar sensors used in cars is expected to grow rapidly in the next decade. During the development process of radar for ADAS and other automotive systems, simulation tooling is crucial to reduce costs and time to market, and to increase efficiency and accuracy. The PreScan physics-based radar model (PBRM), developed by Tass International, offers the flexibility of a simulation tool while providing physics-based radar end-to-end channel and signal modeling.

The PreScan simulation platform is used for the development of ADAS functions and automated driving systems based on radar, lidar, camera and GPS sensor technologies. PreScan can be used for everything from model-based controller design to real-time tests with software-in-the-loop and hardware-in-the-loop systems.

**Radar advantages**

Radar sensors are an attractive solution for the automotive industry because of their capability to sense both moving and stationary objects over a wide range of distances. Radar sensors are much less susceptible to lighting and weather conditions than camera sensors are. Modern radar developments aim to use radar as an imaging device, much like a camera. However, because of the complex nature of radio wave propagation, and possible interference between different radar sets, there is a need for a tool that allows the user to better understand what the radar under development saw and reacted to.

Traditionally, electromagnetic problems are solved by full wave methods. These methods are very computationally expensive, and virtually infeasible for large-scale problems, such as the simulation of cars driving in an urban environment. With recent advances in GPU computing, and an approach based on forward ray tracing, Tass International can simulate a physically correct radar channel model. The simulation chain includes not only the calculation of received power from the ray tracing, but also realistic modeling of the received temporal signal as it would appear at the radar receiver. In the development of radar front-end hardware and signal processing algorithms, the simulation tool allows the user to quickly update the scenario, traffic participants and modulation scheme, or perform beamforming, etc. This reduces
THE NUMBER OF RADAR SENSORS USED IN CARS IS EXPECTED TO GROW RAPIDLY IN THE NEXT DECADE

reliance on extensive measurement campaigns, saving time and money.

**Fully configurable**
The user is free to choose the number and location of transmitter and receiver elements, and to import the patterns for each antenna and the waveform signal for each transmitter. Rays are tagged with a transmitter and receiver ID, so the signal at each receiver is a sum of the contributions of the signal form, with corrected phase and delay based on the target’s speed and distance. This gives the freedom to develop multiple input, multiple output systems, where each transmitter sends a different waveform, and systems involving digital beamforming, which enables improved detection and classification. Tass International’s framework enables the modeling of virtually all types of radar systems – including frequency modulated continuous wave and Pulse Doppler systems. Interference effects between different user-defined radar sets can also be simulated.

It is possible to incorporate system and hardware effects including system quantization, phase and thermal noise, and receiver non-linearity effects, which results in an accurate end-to-end automotive radar system simulation. Users can also incorporate their own components, or even signal processing modules containing proprietary info.

**Quick adaptation**
The model’s flexibility enables fast, cost-effective development, testing and evaluation of signal processing algorithms. Radar system parameters, hardware specifications and processing software can be adapted quickly, without gathering measurement data.

The PreScan PBRM is unique in its simulation of accurate raw radar data for a realistic scenario in a reasonable time. Simulating raw radar data enables Tass International to incorporate all the influences from the radar hardware, the processing pipeline, and any artifacts or spurious signals accurately. This makes it suitable not only for testing ADAS, but also for testing the setup and processing pipeline of the radar sensor.

Last but not least, the raw synthetic radar signals generated by the PBRM, together with the corresponding ground truth segmentation data from PreScan, can be used in training deep neural networks. This includes training based on the fusion of raw data from radar, camera and lidar sensors, for example. This shows that PreScan is ready for the next stage in the development of automated vehicles.

• Christos Ismyrloglou is a project manager at Tass International

**Contact**

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Autonomous vehicle ground-truth solution

GNSS-only sensors
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Nowadays, Euro NCAP protocols assess ADAS technologies that can detect cars, pedestrians and bicyclists, but they don’t consider powered two wheelers (PTWs). UTAC CERAM has initiated the Motorcycle Users Safety Enhancement (MUSE) consortium, bringing together 14 industry partners, including several OEMs and Tier 1 companies, to address the issue. Despite representing a small portion of road users, PTW users account for the highest percentage of road deaths in the vulnerable road users group. Testing equipment that could enable the industry to develop and evaluate an emergency braking system involving a motorcycle doesn’t yet exist, nor is there a test protocol defining the main scenarios and their characteristics. The aim of the MUSE project is to address these gaps and provide OEMs and Tier 1 companies with the tools to test and optimize their systems.

Collision statistics
While the number of car occupant deaths decreased by 50% between 2005 and 2014 in Europe, the motorcyclist death rate fell by just 30%, according to a 2016 report by the European Commission’s Directorate-General for Transport. PTW deaths represent around 20% of road deaths in Europe. In Germany and France, around 50% of motorcyclist deaths involve another vehicle. In France, the responsibility is evenly distributed; in Germany most cases happen because of other vehicles. To ascertain which systems would protect riders well, and to define the technical characteristics that test equipment must meet, we first need to understand the collisions in which motorcyclists are involved. Therefore various national and European databases are being studied.

PTW dummy
4activeSystems is developing a new and fully 3D PTW dummy, focusing on ensuring a realistic response to all automotive sensor technologies, including camera, radar, infrared and lidar. The typical structures of a PTW – including wheels, reflectors, active lights and license plates – must be displayed to camera and lidar systems in a realistic manner, for example with detailed and specific surface properties, and by ensuring the ‘wheels’ touch the ground. To test the car’s radar response, the dummy must mimic the typically very uneven ride characteristics of a motorcycle. The dummy must also represent rotating wheels, so that the radar can gather differential speed information, which is used for better classification. The structure must be stable for traveling speeds up to 80km/h and it must be possible to crash into the dummy from any direction without damaging it or the vehicle under test.

While the PTW dummy should respond in a realistic manner, the equipment that moves it should be invisible to sensor systems. The existing 4activeFB is an extremely flat GNSS/IMU-controlled platform powered by a high-performance driving unit. It has a very low radar cross-section and is designed for testing small road users such as pedestrians and bicyclists, as well as motorcyclists at higher speeds. 

• Rodrigo Nuñez Miguel is an active safety test engineer at UTAC CERAM.
• Martin Fritz is COO at 4activeSystems

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Global vision

Lauchlan McIntosh, Global NCAP’s new chairman, shares his ideas for the organization

What achievements are you most proud of?
I have been fortunate to have had a few different careers, from scientific and operational management in mining, to management and political advocacy with national and international membership and professional organizations. One long-term achievement has been with Australasian New Car Assessment Program (ANCAP), where, as chairman for more than 20 years, I was able to oversee its continued growth and acceptance.

Extending the lessons learned at ANCAP to the broader road safety agenda, firstly at the Australian Automobile Association, and with international colleagues as part of initiatives such as the International Road Assessment Program (iRAP) has been very rewarding for me. Another highlight was helping to establish the Australasian College of Road Safety (ACRS) as president.

What is your vision for Global NCAP?
I am keen to continue the work we have undertaken so far under Max Mosley’s leadership. That is, actively providing a forum for existing NCAPs and related bodies to collaborate, assisting the newer NCAPs to develop and grow, and encouraging the formation of new NCAPs in areas including the Indian subcontinent and Africa. Global NCAP must continue to facilitate the rapid improvement of international vehicle safety standards. We need to demonstrate that there are real life-saving benefits to the latest safety features and general vehicle performance.

How can the organization help in the democratization of road safety?
I have always been surprised and disappointed that in many markets, safety has been seen as a luxury. Even today, convenience features such as the distracting communication devices promoted by telecoms and vehicle manufacturers are seen to be more important than crash avoidance and even some crashworthiness. Why do manufacturers sell products that they know have a different risk? No one expects to fly in an unsafe airliner, or use an unsafe telephone, in any country. It is our role to make private or fleet buyers aware of the latest safety benefits, so they can demand them, wherever they are. It is also our role to inform government regulators of the benefits of safer systems and to reward manufacturers who introduce the safest vehicles into all their markets.

Which ADAS technologies should be prioritized by lawmakers?
We are leading the Stop the Crash partnership, which demonstrates the safety benefits of ESC, AEB, tire safety and ABS for motorcycles. These relatively new technologies have already reduced death and injury rates. However, regulatory processes and policies need to be equally disrupted to ensure they keep up with the pace of change, not stifle or delay their introduction.

ANCAP insisted on ESC for a 5-star rating almost five years before regulations caught up. By then, most manufacturers had installed ESC in their popular cars. NHTSA, IIHS and 20 manufacturers in the USA jointly announced a voluntary commitment to install AEB by 2022, and since then one manufacturer has said it will extend that to almost all its fleet by the end of 2017. Recently, nine manufacturers, covering 85% of Chinese production, committed to installing ESC. We will keep looking for ways to encourage the early introduction of safety technologies.

What is your view on autonomous vehicles?
Their development is rapid and certainly gaining a lot of attention. They have the potential to reduce crash rates, but the world has a massive fleet of non-autonomous vehicles, which will take decades to replace. I doubt they will be ubiquitous for quite a while, but the potential for semi-autonomous technologies is even more fascinating and immediately available. Equally those who enjoy driving, including me, will be able to do so – but much more safely.
How can you find the best path if you can’t see everything?

Ant: insects of the family Formicidae, belonging to the order Hymenoptera (from the Greek μύρμηξ mýrmēx). Ants come equipped with multi-faceted eyes which enable them to use landmarks and the position of the sun to evaluate the movement and direction of objects in their visual field and to integrate this information to find the shortest route back to their nest.

TASS International provides a wide set of integrated tool suites and services to support the automotive industry with the development of automated driving and V2X communication.
Zero Accidents. Well – almost!

In future, increased connectivity between vehicles and their environment will be able to protect all road users – almost all.

But even today, ZF’s safety technologies are helping to prevent accidents or at least lower their severity. For ZF, Vision Zero is not just a concept. With high-performance sensors and cameras, we are pursuing our goal of a world without road accidents.

zf.com/safety