The tire of the future

Intelligence, connectivity and materials that react chameleon-like to the conditions: industry experts reveal the tire technologies that will prevail in the age of driverless vehicles
10 great reasons to visit Tire Technology Expo!

1. The floor space has been increased to 20,000m² (215,280ft²) – the biggest Tire Technology Expo ever!

2. The Conference is also unprecedented in its size and scope. This year there will be some 180 speakers across 15 streams, including polymer science, business strategy, tire testing, manufacturing, and more.

3. A presentation from Prof. Eric Amis of the University of Akron’s School of Polymer Science and Polymer Engineering (see page 20 for more). The title is Advanced Manufacturing: the 21st Century Opportunity. Full Conference program: p106.

4. There are always numerous new exhibitors joining those who return to the show year after year. This year’s newcomers include Budde Fördertechnik, NHV Corporation, EZ Metrology, Festo and Mycronex.

5. The opportunity to hear from some of the industry’s most senior R&D experts, including SRI technical manager, Hiroaki Kawasaki and Bridgestone’s Dr Katsuhiko Tsunoda.

6. Information on an unrivaled array of test and analysis systems – from NTRC’s asphalt-like flat-track belt (see p75) to LMI’s new sensors for 3D inspection.

7. Awards for the industry’s outstanding innovations and achievements! The ceremony has become the highlight of the tire industry year.

8. Developments in tire simulation and modeling, including contributions from Michelin, Pirelli and Jaguar Land Rover.

9. More groundbreaking new technology for tire development and manufacturing than you’ll find at any other show (p86).

10. The best networking opportunity for tire design, research and production professionals. Don’t miss it!
Force of nature

Polymer research at the University of Akron could lead to a new generation of smart materials that take the inspiration for their adaptive behavior from natural phenomena

by Graham Heeps

Imagine a tire with a tread whose pattern imitates the shape of a bird’s claw, whose texture is akin to a snake’s underbelly and whose compound can automatically change its performance according to the road surface conditions. Sounds like science fiction? Not necessarily, according to Prof. Eric Amis, dean of the College of Polymer Science and Polymer Engineering at the University of Akron in Ohio, USA.

The College was established in 1988 but few universities have as long or as distinguished a history with polymers as Akron. Students were working with the local rubber companies as early as the 1890s and, as Amis notes, the synthetic rubber program centered on the University of Akron during World War II and “was second only to the Manhattan Project in its importance to the US war effort.”

With post-war consolidation in the tire and rubber industry and the decline in tire manufacturing in the city as companies closed or relocated production, the university’s polymer focus is broader nowadays.

“We work on biomaterials, electronic materials, plastic processing, rheology – the full a range of modern polymer science,” says Amis, who took over from Stephen Cheng as dean in 2014. “That fits for Ohio, which in the US polymer industry is number-one by a factor of almost two ahead of the next state. Many of our graduates end up working in Ohio, or for companies headquartered here. We take our cue from where the industry and science in polymers is going.”

Tire and rubber chemistry, science and processing is still part of the picture at the graduate-only college, with research funded in some cases by tire companies and with numerous alumni employed by the likes of Bridgestone and Goodyear, which both have R&D operations in the city.

One area in which new materials are being applied is in sealing new elements, such as sensors, into the body of the tire.
“Encapsulating and protecting systems with polymers is a critical issue. The fact is that we still don’t know how to seal things very well; having the right material to protect something in its environment is important”

Prof. Eric Amis, dean of the College of Polymer Science and Polymer Engineering, University of Akron
“As advanced technologies emerge from tire companies, they’re all paying attention to their manufacturing processes,” says Amis, who will speak at the 2018 Tire Technology Conference on the subject of Advanced Manufacturing: the 21st Century Opportunity. “Encapsulating and protecting systems with polymers is a critical issue. The fact is that we still don’t know how to seal things very well, so whether it’s in automotive, electronics or medical devices, having the right material to protect something in its environment is important.

“We also have new avenues in strong materials that disappear over time. There is a need to enclose things in polymers but then have the material disappear after it has done its job.”

The latter concept has applications in fields such as medicine – enclosing a pain-relief drug, for example – but also in other coatings and materials.

**Smart monitoring**

Amis’s vision for embedded intelligence goes far beyond sealing a pressure sensor inside a tire, however.

“It would be great to monitor temperature, wear, slip and how traction is controlled,” he offers. “It would be wonderful to have a feedback loop that enabled you to adjust for the road. Embedding a sensor is a great start, but what if the material itself were the sensor? What if you could get the feedback direct from the material that’s part of the tire reinforcement structure?

“We’re currently in the mindset of having a sensor that would feed back a signal to be acted on, but why not have a material that would, on its own, sense the environment that it’s in, sense the need, and then respond to that need?”

In this emerging area of smart materials, the college is working on shape-memory and shape-responsive materials.

“There’s a lot of interest in materials that can be formed into a particular useful shape and then deformed, but when needed can go back to the original useful shape,” he explains. “Perhaps you can develop that in such a way that the material can change from one use into another – a material that actively controls itself, for example, responding to the road surface conditions it experiences. Instead of using an external controller to prompt a change, we could perhaps sense the presence of slip through heat created, prompting a change in the material to provide better grip. That would in turn reduce the heat and the material would revert to its original state.”

Amis says that biomimetic systems – copying the physics of a biological system – is a rich source of inspiration for the development of smart materials at Akron.
"Think about creatures that can camouflage themselves – it seems unlikely that their brains are controlling the camouflage and more likely that the camouflage is in response to the surroundings," he continues. “This is the nature of doing interdisciplinary science, having people who are working with geckos that can control their interaction, friction and adhesion, and people who are working on surfaces for electronics, where you also need to control surface interactions. When you combine those things you can end up with entirely new concepts.

“In another example, one of our faculty members understands the locomotion of snakes. This knowledge could result in a new generation of devices that could take you into areas where a normal vehicle couldn’t go. We’re not trying to make an animal – we’re trying to use those techniques to design effective technology.”

As exotic as this sounds, Amis adds that having many faculty members connected to industrial funding helps to keep the focus on solving practical problems. Indeed, technology that has emerged from biomimetic research is already on the market, such as a soap dispenser that saves energy by mimicking the way that animals spit. Nevertheless, he says it’s important keep students focused on the future.

"I hope we’re not solving next month’s problem, nor firefighting a production problem that somebody has right now. I hope we’re working on things that will have an impact three, five or 10 years down the line. That’s what we, as an educational institution training the next generation of scientists, need to be doing. Just as companies have their DNA, we have ours. When you try to blur the boundaries, I don’t think either organization does a good job."

Sandia partnership
An important partnership was announced in September 2016, when the college and Sandia National Laboratories approved a Master Research Agreement. It is hoped that novel materials will arise from collaborations in the areas of carbon nanomaterials and conjugated polymer developments, as well as investigations into the roles that adhesion, friction and wear play in coatings, lubricants and adhesives. Biomimicry studies are on the agenda here, too.

“it’s a fantastic connection because Sandia has unique needs for polymers and we can bring a lot of skills in that area, particularly in manufacturing,” says Amis.

There’s no reason why the products of the partnership couldn’t be applicable to tires, too. One focus for the partnership will be additive manufacturing, a technique that is already finding use in tire R&D and mold making. In addition, Amis notes that Goodyear has had a very productive engagement with Sandia over the past 25 years in areas of computational materials science and manufacturing technology.
The future is here

TTI speaks to tire manufacturers and specialists about the myriad challenges that lie ahead as the industry prepares for the introduction of a new generation of connected and autonomous vehicles

by Rachel Evans

The Ball Pin Tire concept from Hankook, which gives an insight into the types of future technologies being explored by tire makers, is capable of moving in a full 360° circle, giving the vehicle more freedom to maneuver, which could, for example, be useful in avoiding hazardous situations.
The tire landscape is undergoing a period of transition. Autonomous driving is just around the corner and the industry faces a raft of challenges, with many questions likely to remain unanswered for years to come. As the requirements and expectations of connected and autonomous vehicles evolve, there will be a change in the way these cars – including their tires – are set up. What will be the impact of the movement on tires, and how will the performance requirements for an autonomous vehicle’s tires differ from traditional products?

Andreas Pürschel, head engineer at the Hankook Tire European Technical Center, comments, “There will be an increase in shared mobility as the car will be able to drive numerous people to a destination and then come back to pick up more passengers. This means the tires will have to provide very good mileage. At the same time, there might not be a passenger on board to change a tire if it becomes damaged, so self-sealing technologies like Hankook’s Sealguard will become more popular. The connectivity of tires and the amount of information that is shared between them and the car will escalate from just tire pressure to include many more things. Tread wear, road conditions, etc, will have to be taken into account to ensure the car can react to its surroundings as a driver would.”

Meanwhile Jake Ronsholt, MD for products and solutions strategy at Bridgestone EMEA, says it will be about learning from experience and establishing the reality versus theory, in defining which performance properties will be needed. “In the next two to three years I think we will see a lot more connected tires. There are a number of basic functions we will have in the beginning, such as monitoring the tire to pre-empt and warn people if there is a problem approaching, but I expect the day they will be fully integrated, communicating interactively and adapting with the vehicle, to be in about 15 years.”

Close collaboration between tire makers and automotive manufacturers will be important if they are to agree on common platforms. “There are discussions around how we will integrate the tires with the vehicle as a system,” adds Ronsholt. “That requires standardization because if every manufacturer needs its own solution in terms of tires, data and sensors, it will be difficult for us.”

Reaction time
To understand better how the performance criteria for autonomous vehicles could evolve, it is useful to distinguish between levels of automation, as Mattias Hjort, head of research in tire-road interaction at the Swedish National Road and Transport Research Institute (VTI), notes.
Tire makers including Toyo are investigating the application of airless tires, which offer a maintenance-free alternative to conventional pneumatic designs.

**PROCEED WITH CAUTION**

A revolutionary system rolled out earlier this year in Sweden continuously monitors road friction in real time. The Road Surface Information (RSI) feature introduced by Nira Dynamics, indirect TPMS pioneer and a developer of signal processing and control systems for the automotive industry, provides drivers with slip warnings and could in future be applied in self-driving and autonomous vehicles to inform the controller of traction levels, enabling it to gauge braking distances.

“We have developed a friction estimator, a road roughness estimator and also a function that detects speed bumps, potholes and loose wheels – all based on monitoring either wheel speed signals or other signals from the car,” says David Askenteg, project manager for RSI. “For future connected and autonomous vehicles, these functions are also very valuable and can be extremely powerful if we connect vehicles via the cloud.”

Askenteg notes that almost all functions of the tire can be monitored without application of a sensor, and therefore predicts that in the future there will not be intelligent tires, but intelligent tire monitoring.

“We are currently working on the development of a friction map for the whole of Europe. It is updated every few minutes and has a resolution down to 25m (82ft),” Askenteg says of the new system, which is expected to greatly increase road safety.

Sae has defined a five-degree scale on which Level 1 represents assistance to a human driver, and Level 5 full automation. At Level 3, the car is driven by an automated driving system that expects the human driver to respond appropriately to a request to intervene.

“It could be argued that fully automated vehicles will be driven in a predictable way, with safe distances between vehicles that will impose lower demands on acceleration compared to today’s driving,” says Hjort.

“Fully autonomous vehicles will, however, most probably not be a reality for a long time, and to get there, handling performance will be of great importance to allow a vehicle to cope with unexpected, sudden incidents. For the lower levels of automation, driver assistance systems may intervene in a situation when an accident is unavoidable and in situations where the collision impact can be mitigated [by reducing the speed, or altering the angle of impact]. In those situations, increased braking and handling performance will be beneficial.”

Other areas that need to be addressed will be how to avoid motion sickness, though most likely vehicle movement needs to be soft and smooth with low levels of acceleration, which would be less stressful to the tires. For Levels 3 to 5, it is thought that comfort will be the primary focus, though good grip and handling in potentially critical situations.
Michelin’s Visionary Concept showcases R&D themes including airless tires, recyclability and reuse, and connected technologies.

PERFECT SENSE

On the path to ensuring safe and reliable autonomous driving in all situations, Andreas Pürschel at Hankook identifies several challenges that must be addressed with regard to the implementation of sensors within the tire.

Adherence to the stable transmission of data within the tire even at high mileage and top speeds, is one important consideration. "It must be guaranteed that the material strength of the tire is consistent and of course that the sensor does not become damaged in any way during use in extreme conditions," he says. “We also have to make sure that the sensors are durable and will not melt at high temperatures caused by friction. The rechargeable battery that powers the sensor has to be resistant to all outer influences as well.

"In addition, autonomous driving requires the capacity to cope with a large volume of data. An excessive load must not be placed on power consumption by the sheer mass of data transmitted."

The power supply has to be well thought out, too. Pürschel continues, "The rechargeable battery and the energy storage, both sources of energy for the sensor, should work perfectly together. All functional areas in the vehicle, including the sensor in the tire, will have to be activated by a power supply until the vehicle has reached the required top speed."

Could also be of value. "It may require Level 5 autonomous vehicles to be proved successful and accident-free before customers feel safe," Hjort says.

In the long run, ride will be important, as well as acoustics, while aerodynamics and rolling resistance will be more heavily emphasized than before.

All in the details

According to Hankook’s Pürschel, the development of tires for autonomous cars can be approached from multiple angles and broken down into three key areas: compounding, construction and connectivity.

He explains, "In terms of compounding, the rubber must be robust overall, since the tire has to perform even better in use and has to acquire data independently. The compound must therefore be structured in a way that guarantees consistent performance and a broader limit range.

"In addition, the tire’s performance must be even more consistent, because if the vehicle starts skidding it will need to counter-steer. With the aid of the sensor, the tire should detect when the ground contact area changes, so that it recognizes when the car is getting into danger."

On the chassis front, vehicle ABS and ESC systems will be greatly improved, which means that the car will react more sensitively and faster. A tire’s tread must be able to work in harmony with these enhanced vehicle systems.

With regard to connectivity, Pürschel comments, "The tire maker has to guarantee that the sensor communicates effectively with the vehicle’s onboard computer and the control unit in the wheel housing. Manufacturers must work closely with car makers to ensure that transmission is fast, short and energy efficient."

Covering all eventualities

To guarantee predictable performance in all potential conditions, our experts believe that testing will be even more important than it is now. In addition, the demands of intelligent functions such as tire friction limit estimation will lead to an increase in the amount of testing. Additional evaluation of tire limits on wet and dry surfaces will need to be performed so that the vehicle controller can adjust its action based on the available traction. Analysis on snow and ice will also be critical to ensure reliable operation of sensors in situations where road markings might be covered. Furthermore, parameters such as cornering and braking stiffness will need to be measured to ensure appropriate steering and braking input from the vehicle controller.

According to Hankook’s Pürschel, the biggest change will be in the second phase of the testing process. “The first phase, when a product is tested for all performance criteria by a tire maker, will remain the same,” he explains. “The second is incorporation with the car maker’s first prototypes to evaluate autonomous vehicle reactions. What we don’t know
A notable feature of Goodyear’s Eagle 360 Urban concept is the bionic skin with a sensor network that enables the tire to monitor and gather information on the environment. Made from 3D printing and powered by artificial intelligence, it also features a morphing tread that transforms and adapts.

FIVE FOR THE FUTURE

At the 2017 Tokyo Motor Show, SRI revealed some of its fundamental R&D focuses, categorized into three topics – safety technologies, Enasave technologies, and core technologies – and branded the Smart Tyre Concept. Within it, SRI has identified five areas of development. Elements of the Smart Tyre Concept have already been incorporated into products and processes. There are plans to introduce further aspects in the future.

“We are working on feeding more information into the system, so that the vehicle can adapt its driving style to the environmental conditions. In addition to that, as there will no longer be intuitive interaction (a driver reacts based on what he has seen before climbing into the vehicle, consciously or subconsciously), we have to make sure that the tire knows which vehicle is in use, and vice versa,” notes Jaap Leendertse, manager for PCR and SUV tires, Sumitomo Rubber Europe. SRI’s concept consists of the Sensing Core, which transforms tires into sensors by installing a propriety algorithm in the ECU for a vehicle’s brake system; an Active Tread that can change its functionality according to the road conditions (above); Performance Sustaining Technology, which suppresses the degradation of tire performance due to wear and rubber deterioration; airless tires; and Life Cycle Assessment, aimed at engineering the most environmentally friendly tires.

Leendertse comments, “In future, the sensor might also inform the vehicle in order to adapt tire inflation pressures and adapt vehicle speed to the road and tire conditions. In terms of our Active Tread, to describe how it works, think of the elements of the polymers, which could be activated from the outside based on information that is available from sensors. It will take a long time for complete implementation; first and foremost, autonomous vehicles need information that only sensors can provide.”

To give an idea of timescales, according to the tire maker, in 2020 it will begin mass production of a tire incorporating the Performance Sustaining Technology. A new concept tire engineered with new materials, developed through the application of the Life Cycle Assessment technology, will also be launched in 2020. The Active Tread, meanwhile, will be displayed on a concept that is scheduled for debut in 2023.

Meanwhile, some industry experts have predicted that in the future the role of traditional tire testers may diminish and be taken over by control system engineers who will simply test the complete vehicle to ensure it does what it is supposed to do.

VTI’s Hjort argues that the more predictable the tire behavior is, the greater the control of the automated vehicle, “so at least in the pre-production phase there should still be a need for traditional tire testers.” He believes that with the vast number of tires and dimensions on the market, this will have a negative effect on the number of manufacturers, particularly the smaller ones.

With a combination of self-driving and autonomous vehicles expected to exist side-by-side for many years to come, it is unclear when the fitment of intelligent tires that operate as part of an intelligent transportation system will become the norm. Development and testing is already taking place in the OE sector, with the replacement market expected to follow in a few years.

Rønsholt at Bridgestone comments, “Everything revolves around getting more information than we can currently get from sensors. This takes us to another important area, which is that a tire always brings a compromise – if it performs well on snow, for example, it won’t be as good in the dry. In the future we’ll need to be able to sense and measure road conditions. Taking that a step further, I would guess many manufacturers are looking to develop a tire that can flex and adapt to different conditions. There are many theories on how it could adapt – in the width of the tread for instance, or via chemistry. “It’s a fast-evolving world and everyone wants a slice, so in a sense we can’t afford to be slow, but going too fast means there is potential to make mistakes.”

at the moment is if we will be involved in this or not. Ultimately we have to design the tire to work.”
Get connected

How will tire requirements evolve to suit the car of the future?
David O’Donnell, Continental’s head of R&D for passenger car and light truck tires, gives us his thoughts

by Chris Pickering

Automated driving, electrification and connectivity are prompting the biggest shake-up of automotive technology in decades. And it’s not just a chassis or powertrain issue. As the only physical link between the vehicle and the road, almost any change will have an impact on the tires.

Some of these are more obvious than others. It’s fairly well accepted, for instance, that near-silent electric drivetrains place more emphasis on other aspects of NVH, such as road noise. In other respects, however, the situation is harder to predict.

Regarding rolling resistance, one hypothesis is that there will be a continuous need for improvement. On the other hand, some OEMs have questioned whether this will still be required in the future, as David O’Donnell, head of R&D for passenger car and light truck tires at Continental, explains: “At the moment, range is critical for electric vehicles, but once the battery capacity is there, that need reduces. Then, perhaps the question becomes more about comfort and refinement. Drivers are typically more sensitive to road noise in an electric car and potentially more aware of the ride quality in an autonomous vehicle, where they no longer have to focus on the road.”

This poses some interesting ramifications for the dynamics. Could we perhaps end up in a situation where grip and performance are less critical? O’Donnell admits it’s something he was pondering himself.

“Clearly, we’re still at a stage where all cars spend a majority of their time under manual control, so that hasn’t changed yet,” he says. “Until recently, my personal opinion was that we might see a change of attitude in the future, but we’ve had some interesting feedback from the OEMs. One opinion there was that the handling precision will have to be maintained. If the car is constantly making small adjustments to keep itself on course, it could become disconcerting. There’s already a debate about travel sickness in automated vehicles and that could become a factor.”

There’s also the other side of the dynamic equation to consider. Even the most ham-fisted driver is harnessing millions of years of sensory evolution when they take the wheel. Without that feedback, the car is entirely dependent on its electronic sensors. It’s an area where tires have yet to match the advances made elsewhere, but that could be about to change.

“With the tire being the only point of contact between the vehicle and the road, we feel we need to cover the area of direct sensing, which is little-used at the moment,” comments O’Donnell. Indeed, one of the star attractions on Continental’s stand at the 2017 IAA in Frankfurt was the company’s ContiSense tire concept. This aims to bring the tire more fully into the loop, providing data on temperature, pressure, tread depth and puncture detection.

Sensing changes

Like Continental’s existing Electronic Tire Information System (eTIS), ContiSense is embedded into the tire itself (as opposed to the wheel rim). It consists of two main features – a series of electrically conductive rubber compounds in the tire, which serve as the sensing elements, and a small unit that monitors the data and transmits it to the outside world via Bluetooth or RF.

The RF portion of the system is already industrialized and available today, O’Donnell points out. At present, the system transmits temperature and pressure data, but ContiSense aims to take this further with puncture detection and tread depth measurement.

“There’s unlikely to be one big bang where suddenly all these functions become available. What we can see – depending on customer interest – is a series of features that could be made available, depending on technical capability and customer requirements, from 2020 onward,” he says.

The puncture detection system is provided by three layers in the innerliner of the tire. The two outer layers are conductive rubber, while the middle layer...
ContiSense uses a combination of electrically conductive rubber compounds and rubber-mounted sensors to collect and send information from the tire to the vehicle control system.
provides an insulating barrier. If a foreign object pierces the liner, it connects the inner and outer layers, completing the circuit that feeds back into the sensor.

Going a step further, there are various ways of approaching the tread depth measurement. Continental already has a model-based system, drawing data from the vehicle’s sensors to predict the change in tread depth over time. As part of the ContiSense concept, however, the company has unveiled a direct measurement system that analyzes changes in the tire’s electrical resistance to determine the degree of tread loss.

The temperature sensing system works on a very similar basis, tracking the resistance change in the rubber on the shoulder section of the tire as it gets hotter or colder.

We’re told a lightweight temperature sensing system would potentially have a negligible impact on the mass of the tire. Puncture detection, however, adds extra layers, which could be more complex.

“There we have to see what is the minimum we could do while maintaining the same degree of air permeation,” comments O’Donnell. “That will require a degree of experimentation, but we don’t expect significant weight changes overall. We’ve already got ContiSeal and ContiSilent where some weight is added to the tire, but it’s inside the carcass so it has less impact on rolling resistance. This is the area that we’re zoning in on for puncture detection, so we don’t see anything beyond what we already have in terms of mass change. It could be weight-neutral relative to something like ContiSeal.”

Connectivity is another aspect. The technology required to get the data out of the tire is already established, but the connection between the eTIS unit and the sensing elements elsewhere in the tire is harder to engineer. One option is to do this wirelessly (“We’re looking into several ideas there,” notes O’Donnell), while the other is to use a physical link.

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**INTERVIEW**

**ELECTRIFIED RUBBER**

The decision to electrify the rubber in the ContiSense system came down to necessity, explains David O’Donnell. Bringing wires or other foreign matter into the tire construction is always a challenge and the engineers were mindful to avoid compromising the tire’s general performance attributes.

“The basic concept comes down to an understanding of the conductivity, resistance capability and electrification of rubber. That enables us to follow this approach of using the rubber to sense certain characteristics within the tire,” he says. “We will have to look at the other performance characteristics [before it could be brought to market] but this is something we’ve already simulated extensively.”

Continental already had a good understanding of the electrical properties through the work that’s gone into channeling static electricity away from the tire, but this latest project is a step into the unknown to a certain extent.

“When you look at the characteristics required for electrification, you go into a new arena. We’ve been able to leverage the knowledge of our colleagues in other divisions to find out what type of electrical signal is required to influence the various responses in the electronics,” says O’Donnell.
Either will have to be robust enough to withstand long-term use in a series production environment.

**Adaptive tires**

The idea of embedded tire electronics has been gathering pace recently, and systems such as eTIS could open the doors to a whole range of other options. It’s possible that this real-time monitoring could even lead to tires that actively respond to the conditions.

Continental explored this idea with the ContiAdapt concept that was revealed at the Frankfurt show. This could adjust the rim width and the tire pressure while the vehicle is moving to alter its footprint – for instance, to mitigate hydroplaning. Both ideas have both been around for a while, but advances in micromechanics (see sidebar, above) mean they’re now more realistic. In fact, by the time you read this it’s likely the company will have working prototypes for both the pressure and rim width adjustment systems.

Again, the intention is to demonstrate the technology to prospective OEM customers rather than to preview a specific product. “We’re looking to get into a dialog around these principles,” says O’Donnell. “It doesn’t mean we will have a rim that adjusts itself in two years’ time, but we’re interested to see whether the adaptive behavior that’s now common in other parts of the car could be applied to the rim.”

It’s perhaps unlikely that we will see this technology on mainstream passenger cars any time soon. However, Continental is understood to already be in discussions with manufacturers who have specialist vehicle requirements, such as off-roading.

Whether or not any of these concepts reaches production, it’s clear that the automotive industry is taking an active interest in the role of tire technology on future models. The dependence on embedded technology could also see tires becoming more model-specific and perhaps strengthening brand associations in the aftermarket.

**ADAPTIVE MICROMECHANICS**

The ContiAdapt prototype varies the tire pressure using a microcompressor that sits in a disc between the rim and the hub. The company evaluated various options for the compressor architecture and the current prototype is said to bear some similarities to those used in the company’s sealant kits. In this instance, it uses an inductive power transfer system to overcome the challenge posed by a rotating component.

It’s likely any subsequent production variant would be integrated into the wheel itself, but the current layout has provided a platform to demonstrate the concept. The company’s R&D department is also in the process of building a similar prototype for the variable rim width concept.

**Above right:** As part of the ContiSense setup, rubber-based sensors continuously monitor tread depth and temperature