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tire TECHNOLOGY INTERNATIONAL

INTERVIEWS

Dick Cormack
managing director,
DMACK Tyres

André Louis
process development engineer,
Apollo Tyres

Industry 4.0

Robotics, automation, big data and the Internet of Things: how the tire industry will make the next leap forward in production efficiency and quality

APOLLO EXCLUSIVE
Inside Apollo Tyres' new greenfield plant in Hungary. Could this be a template for the tire factory of the future?

LIGHTWEIGHT TIRES
Experts advise on the best way to shave mass from new tire designs without sacrificing performance

TREAD DEPTH DEBATE
Michelin thinks that tires should be used right down to the legal minimum tread depth – and label tested accordingly

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Editor's note

In 2006 I interviewed Gary Benninger, then COO of Amerityre, about the prospects for his company's molded tires. He expected a urethane tire to be OE-fit on a mass-production car well within a decade.

Amerityre is still in business, producing flat-free tires from closed-cell polyurethane foam and a polyurethane elastomer at its facility in Boulder City, Nevada. Applications include bicycles, golf carts, mowers and wheelbarrows.

But as Joe Walter's column on p14 observes, we're still waiting for a one-piece, molded urethane tire in a passenger car or truck application. Nor have we seen our late columnist LJK Setright's vision of tires "made by the mile, cut off by the foot" come to pass.

The competing demands on a PCR or TBR tire are driving materials development to new heights – and seemingly making the prospect of a single-material molded solution remoter than ever. But never say never.

Our current assumptions for what makes a high-performing tire revolve around it coping with any one of the many scenarios that the driver can throw at it. But what if there were no driver? What if an autonomous vehicle always operated at comparatively low speeds in a city? What if the software driving the car never sent it around corners at high lateral loads? What if vehicle-to-vehicle communications made emergency stops from high speed a thing of the past?

Now we might not need a complex, multimaterial toroid working hard to excel at conflicting performance requirements. If most sales were to rideshare fleets rather than individual consumers, maybe an established, high-tech brand image or motorsport pedigree is no longer important. Maybe a durable, easy to make, easy to recycle, one-piece molded tire from a company with no history in the business, might do the trick. Now wouldn't that be something?

Graham Heeps, editor

COVER STORY

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100% guayule tire

A major milestone has been achieved by Cooper Tire on the Biomass Research and Development Initiative (BRDI), a five-year US$6.9m grant from the US Department of Agriculture (USDA) to develop guayule as an alternative natural rubber source.

Having successfully built and tested tires made with several guayule components, Cooper is now in the final stages of analyzing a 100% guayule-based tire – and has reported extremely positive results.

Chuck Yurkovich, senior VP of global R&D at Cooper Tire, says, "We have found that with the correct formulation, guayule rubber performs the same as Hevea-based rubber. We have also found that it processes as well or even better."

Evaluation of the prototypes, which began in mid-2016, consisted of the usual tests. In total, around 1.7 million miles have been covered in the lab and on roads. That includes durability testing on a rig and analysis on tracks, such as high-speed handling, wet and dry braking, and acceleration tests.

One particular challenge on the project, however, was to devise the right formulation for every part of the tire using guayule, which contains types of resins that are different from Hevea and are undesirable in tires. Guayule resin contains a wide array of components, most of which are terpenes, terpenoids, and fatty acids derivatives. Examples of components include alpha- and beta-Pinene, guayulins, and argentatins.

"We had to first remove those components from the rubber and then establish the right purity level of guayule to be able to use it," Yurkovich explains. "It was a difficult process, but to my knowledge, my team is the first that's been able to accomplish that in nearly 100 years of industry efforts."

The next hurdle will be how to achieve mass-scale production for widespread incorporation of the material in tires. "It's going to take a lot more than just a tire company to do this – we will need increased support and collaboration between governments, academia and industry. Farmers will have to agree to grow and harvest the crops, while governments and industry will need to work together to establish factories.

Above: The 100% guayule prototype tire

Below: There are several by-products of guayule – around 10% of the content of the plant, which is a resin, can be used to treat lumber and in perfumes for example, and the remaining 80%, the bagasse, can be used as a biofuel

"The other challenge – and I don't see this as great – is to find suitable markets for the by-products," adds Yurkovich.

Elsewhere, work conducted under the BRDI by Cooper's project partners has seen a number of other remarkable triumphs. For example, in 2016 the USDA Agricultural Research Service completed the most extensive irrigation study of guayule ever conducted and has developed a web-based application that will enable farmers to use the data to maximize their yields.

As the BRDI is due to conclude in 2017, Yurkovich comments, "This project has been challenging, exciting and rewarding. There are several benefits long term: firstly, we have an opportunity to reduce dependence worldwide on imports from a very narrow band round the equator. Secondly, it will convert desert wasteland into viable farmland. Thirdly, it will produce thousands of jobs, which will be needed to raise the plants, harvest and transport the material. It's beneficial for the environment and economies." **tire**

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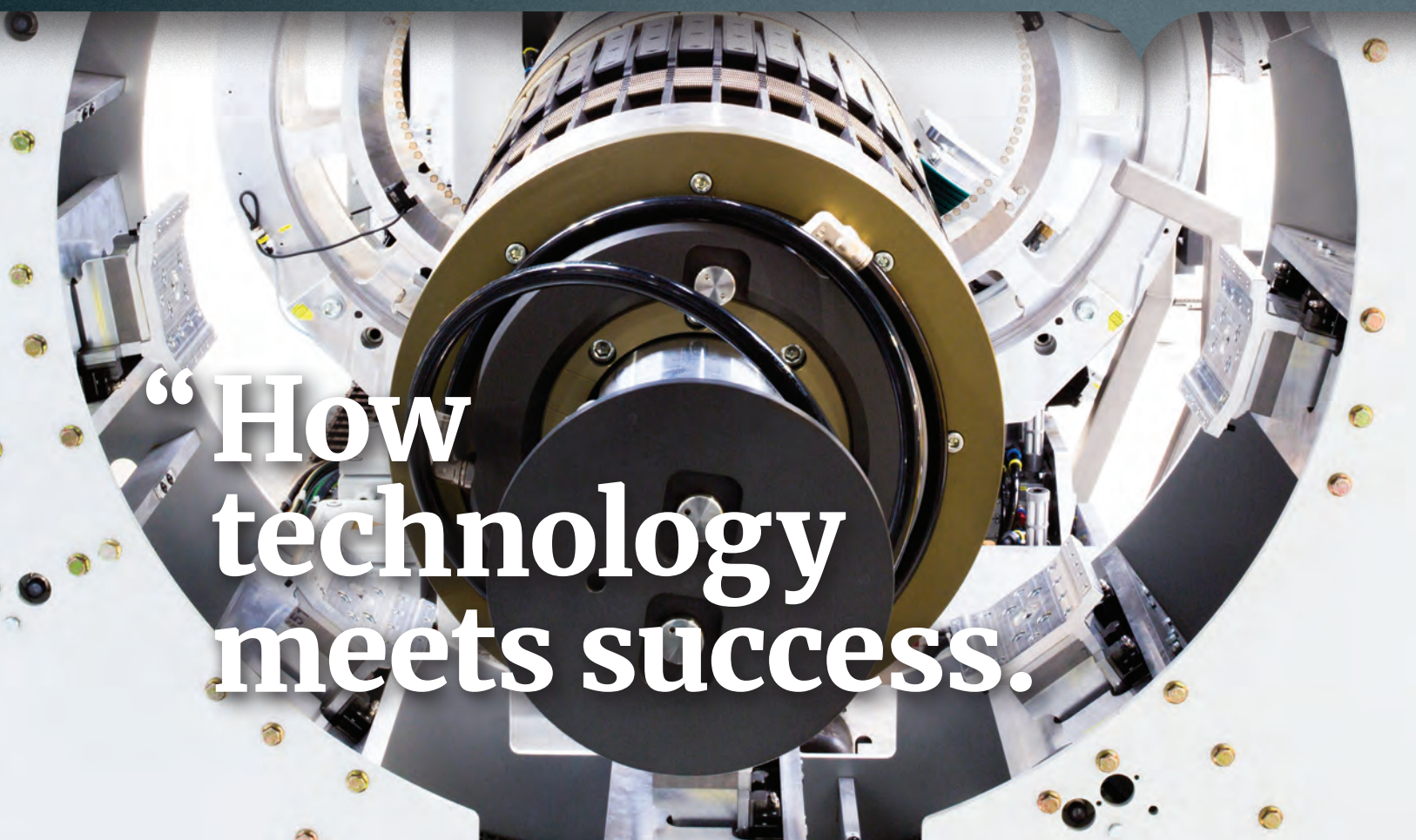

Flat-Trac partnership

A new MTS Flat-Trac CT Plus Tire Test System is to be installed at the Smithers Tire and Wheel Test Center in Ravenna, Ohio – commissioned in partnership with Bridgestone Americas, Continental, Cooper Tire, Goodyear, Hankook, and Michelin North America.

Equipped with electric motors, the new rig will provide three times more wheel torque than the current system, increased longitudinal capabilities (from 2,000Nm to 6,000Nm) and lateral load limits. The enhanced capabilities will provide more flexibility to test a wider range of tire sizes – passenger car and light truck rubber – and will enable it to be adapted more easily to new testing requirements.

Dr James A Popio, VP of operations for North America, Smithers Rapra, notes, "The new machine provides the ability to respond to complex vehicle control algorithms. Enhanced characterization of the tire's contribution to advanced stability control systems differentiates the new system from the old."

The decision to purchase the MTS Flat-Trac was made following discussions between Smithers and its customers. "Larger-size tires and tire models require an increasing amount of spindle torque on the Flat-Trac to provide the best data on forces and moments in tires under higher loads," says Popio.

"This common need across tire companies sparked conversation between Smithers and its partners.

Right: An MTS Flat-Trac CT Plus of the type being installed at Smithers in Ravenna

Below: The project partners broke ground on the extension in June 2017, with completion scheduled for July 2018

Everyone was asking for the same requirements at the same time and capacity in the industry is at a premium. Recommendations on specifications were made from all parties and Smithers worked with suppliers to find the best match from a technology standpoint."

Bridgestone, for example, which had already identified a need for a new system, was investigating options when approached by Smithers. "Our request was that the new system be able to handle the test conditions and sizes that we need to satisfy our customers' requirements for testing and tire models," explains Nicole Squire, director of tire testing technology at Bridgestone Americas.

"As vehicle development continues to increase component modeling, the new system will provide increased capability for a wider range of sizes. This will enable Bridgestone to meet its customers' needs going into the future."

To accommodate the rig, a 10,000ft^2 extension is being built onto the Ravenna lab, which will provide space for the Flat-Trac and offices, and room for future expansion, with additional technology partnerships and testing capabilities a possibility. It is expected that between five and 10 new members of staff will be required – including engineering and technical experts and lab technicians.

In order to ensure each company can efficiently manage their tire testing costs associated with the new machine, a partnership model has been developed.

Rig time will be shared between the tire makers, while excess capacity could potentially be sold to other companies outside of the partnership. **tire**

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Giti Tire GitiSport S1

The result of an ambitious two-year development schedule, Giti Tire has unveiled three all-new halo tire lines – GitiSport S1, GitiPremium H1 and GitiSynergy E1 – on the European market.

"We already have well-established products for Asia – our home market – and Europe with the GT Radial brand, but we wanted to create some high-performance ranges. That has required evolution across the business including in R&D and manufacturing," explains Matthias Hartwig, chief engineer for tire technology at Giti Tire.

The program's unusually tight timeframe presented an immense challenge and was led by the team at the company's European technical center in Hannover, Germany, in collaboration with experts at Giti Tire's R&D facility in Hefei, China, and its base in Akron, Ohio (see *Made in America*, November 2016, pp46-50; http://bit.ly/2r8AGxx).

Hartwig notes, "Typically development of a completely new line takes around six years. For these we had only two years and it had to be right first time. I think this was the most efficient tire development program ever – working on three lines simultaneously – plus we achieved TÜV certification for all products first time around."

The Giti Sport S1, designed for C-segment passenger cars, is said to provide high levels of performance in wet and dry handling and braking, low rolling resistance and high durability.

One particular technology used across all three ranges, including the Giti Sport S1, is the company's newly developed SmartBelt concept, which enhances wet and dry handling and ensures even wear.

Above: Benchmarking was done against mid-range and premium competitors

Below: GitiSport S1. Giti Tire has tripled its test capacity in Europe in the past three years

"The stiffness of the tread is adapted to the pattern and profile shape of the tire, which is extremely important because in the design of a new model you cannot simply use an existing tire and just apply a new pattern, a new profile or a new tread," says Hartwig.

"Although this belt reinforcement is not necessarily new to the industry, it is the first time we have used the technology in our tires," he adds.

The tread formulation contains new, more expensive raw materials. "This has had a great impact on the cost of the product, however if we want to be competitive we know it is necessary." A better interaction between the polymer and the silica has been achieved.

A completely new carcass material has also been used.

Simulation of factors such as rolling resistance, noise and tire footprint helped the team to reduce the pool of chosen compounds by around 80%. Frequent discussions with colleagues in China and the USA accelerated the pace of development.

Throughout the regime, process checks were performed every three months in the factory to ensure the tires could be manufactured on a mass scale. "This is a particular challenge in compound development because on the one hand you need to be able to transfer the performance from the lab to the tire, and on the other hand, ensure it can be produced in the factory," comments senior compound engineer Antonio Cascio.

For the GitiSport S1 for example, around 100 compounds were analyzed in the lab and 15 in the factory. Indoor testing also took place in China using equipment such as an MTS Flat-Trac machine and an in-house developed friction test rig.

On-road evaluation was conducted at Giti Tire's UK test base at MIRA, with visits to IDIADA, in Spain and ATP Papenburg in Germany for the labeling tests. The tire maker's fleet of test cars includes the Volkswagen Up, Golf and Passat, an Audi A7 and a BMW 3 Series.

All three new tires lines – aimed at both the replacement and OE markets – will be produced at Giti Tire's factories in China. **tire**

Production update



Above left to right: Wanli plant confirmed at China (Guangdong)-US Investment Cooperation Conference; design of Nokian's new US plant; Bandag celebrates 45 years in Texas; and the Ringbuilder Saturn retreader installed in Lourosa, Portugal

US expansion for China firm

Guangzhou Vanlead Group – parent company to Wanli Tire – is to build a US$1bn plant in Orangeburg County, South Carolina, USA. The project will involve two phases – the first focusing on production of passenger car rubber and the second on truck tires. Phase one will cost approximately US$600m and is expected to create around 1,200 jobs. Construction is scheduled to begin in early 2018. Upon completion, phase one of the factory will have an annual capacity of six million tires.

Although labor and construction costs in the USA are higher, land, electricity and gas are cheaper, which will result in less company expenditure overall, compared with production costs in China.

"With this plant in the USA, Vanlead will be able to get closer to its consumers, better understand market demand and enhance its product quality," stated Xu Wenying, secretary general of the China Rubber Industry Association.

"The US factory can also help safeguard the company from high anti-dumping duties, which have been levied on Chinese tire companies in recent years.

"For Chinese tire makers, severe competition in the domestic market has created a need to invest overseas. That has become a trend. A number of projects have come up or are coming up in some Southeast Asian countries."

Manufacturing milestone

A production milestone at Toyo Tyre's Malaysia plant has been reached with the manufacture of its 10,000,000th unit.

The factory in Perak State was first established in May 2013 and is equipped with the tire maker's Advanced Tire Operation Module production technology. It supplies regions all over the world, including Southeast Asia, Europe, Japan, and North America, and has a production capacity of five million units per year.

There is enough land surrounding the current building to build a similar-sized plant in future, if required, to meet increasing demand.

Investment in North America

Nokian Tyres is to construct its first facility in North America at a cost of US$350m. The plant in Tennessee, which will produce passenger car and light truck all-season tires, will have an annual capacity of approximately four million units. Space for expansion could enable a ramp-up in future. The site will also house a distribution facility with a storage capacity of 600,000 tires.

"In addition to increased capacity, the Dayton, Tennessee, site's proximity to North American customers will shorten lead and delivery times," said Tommi Heinonen, head of Nokian Tyres North America.

"It's our goal that the new plant will help us better serve our growing customer base throughout the USA and Canada by improving customer service and efficiencies."

Up to 400 new jobs could be created in Rhea County, thanks to the new facility, with around half of the total investment flowing into the local economy.

Retread anniversary

In May this year, Bridgestone officially celebrated the 45th anniversary of its Bandag Retread Plant in Abilene, Texas, which employs more than 170 people today.

"Bridgestone's roots in Abilene run deep, and it has been our privilege to call this community home for the last 45 years," said Jeremy Gray, manager of the Abilene factory. "We'd like to thank the Abilene community for its support over the past 45 years. The team is excited to begin this next chapter in our plant's history."

The facility has received numerous awards and certifications for its stringent levels of health and safety and its community involvement.

Equipment installation

A cutting-edge Marangoni retreading system has been installed at the Lusitania Paulino e Gomes retreading plant in Lourosa, Portugal.

The newly introduced Ringbuilder Saturn is said to be the company's most cost-effective retreader, capable of producing up to 80 tires per eight-hour shift using Marangoni's Ringtread cold retreading technology.

Its easy-to-use operating system enables the user to apply a thin overlapping strip of extruded cushion gum during multiple rotations on to the crown and shoulder of a tire casing. This strip size cushion, while it does not totally eliminate the need to fill larger craters, enables reduced and precise application of the right quantity of cushion gum. The Ringbuilder Saturn then applies a pre-cured tread ring on the casing – all during the same build cycle, and without any need to shift the tire during the process.

Antonio Cruz, director of Lusitania Paulino e Gomes, said, "I am very happy about the productivity of this machine; today with only one operator, we produce the same quantity as before with two. The technical quality of the retreads is excellent, the HMI is intuitive and the footprint of the machine is compact." **tire**

OE-fitment roundup

FCA/YOKOHAMA

Company: Yokohama
Tire model and size: Geolandar G055, 225/55 R18 98H
Car: Jeep Compass
Where sold: North America
Notes: The tire, which was selected following an extensive test and validation process with FCA, features a combination of technologies such as an integrated shoulder and full nylon cover that improves stability while resisting irregular wear, and minimizes noise.

JUNO RACING CARS/QINGDAO SENTURY TIRE

Company: Qingdao Sentury Tire
Tire model and size: Landsail formula racing tires (eight variants), 13in
Race cars: Juno Racing Car's F1000; CN16; F4; SSE; and twin seat formula training car
Where sold: Europe
Notes: It's hoped that the contract to supply the Portuguese race car constructor with a number of different models for formula and endurance races will enable the tire maker to achieve greater globalization of its road tires.

IVECO/PROMETEON TIRE GROUP

Company: Prometeon Tire Group
Tire model and size: Pirelli MG:01, 265/70 R19.5
Trucks: Iveco Defence Vehicles new generation defense vehicles
Where sold: Worldwide
Notes: Pirelli's R&D team in Milan, Italy, worked in close cooperation with experts at Iveco to develop a special tread compound designed for both on- and off-road and use in snowy conditions, for both the steer and drive axles.

André Louis

Process development engineer, Apollo Tyres

Tell us about the newly developed plasma treatment for promotion of cord-rubber adhesion in tires.
The project was initiated by VMI and the University of Twente because there is the need for an alternative adhesion promotion system between reinforcement cords and rubber, in addition to the traditional resorcinol/formaldehyde/latex (RFL) dipping solutions. With my materials science background I found this an interesting topic for a PhD project, and in particular I was curious about the potential to use plasma as an alternative cord-rubber adhesion system.

How does the plasma treatment work?
Plasma can be considered as the fourth state of matter, as it is in fact a highly energized gas phase. It has enough energy to separate the gas molecules and to even split atoms into electrons and ions. Therefore, plasma contains radicals that can be used to modify a substrate's surface. In addition to that, a vaporized chemical (precursor) can be exposed to the plasma and then deposited on the substrate. This creates a plasma coating.

What are the properties of the resulting cord-rubber interface?
With plasma treatment, a nano-coating is deposited on the cord surface. This causes a rapid transition from the highly elastic rubber to the stiff cord. While a nano-coating is good for achieving a very effective coating process, the force distribution to the cord is more critical than with the usual chemical dipping process. It is therefore important to incorporate as many cord filaments as possible into the force distribution process.

What are the advantages and disadvantages of using a plasma treatment?
The RFL technique requires a heat treatment to cure the dip onto the cord surface. This heat treatment is crucial as it defines the cord properties of the final product. We were able to simulate this effect with plasma. We also found that the atmosphere that the freshly treated plasma coating is exposed to is important for the level of adhesion achieved. If that is controlled tightly, a delay in curing the rubber has a very minor effect on the adhesion.

Could it be scaled up for use in mass production?
I am confident that mass production can be established. However, in my work we used an unmodified atmospheric pressure plasma jet, which is suitable for a broad range of applications. To successfully upscale the process to mass production, a specialized plasma device would be required. In the next steps of the project, the University of Twente is working on a follow-up process that uses entirely environmentally friendly precursors. These are also less sensitive to the actual treatment atmosphere. That combination will further strengthen the advantages of plasma treatment. The work so far has proved very promising. **tire**

"In the next steps of the project, the University of Twente is working on a follow-up process that uses entirely environmentally friendly precursors"

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Joe Walter

"Disadvantages of an all-urethane structure are many, including wet grip, dry braking, service growth, and rapid air loss that can result from cuts or punctures"

The image of pouring chemically reactive liquids into a mold and extracting a cordless pneumatic tire of any color is compelling, but pursuit of this objective has proved to be a fool's errand. Multiple quests in search of a simplified tire manufacturing process were apparently spawned by Goodyear in 1961. The cover of a popular US magazine, *Life*, featured translucent polyurethane (PU) tires illuminated internally with incandescent light bulbs blinking individually or in unison.

Urethane was a logical choice as the casting material. First synthesized by Otto Bayer at IG Farben in 1937, it had been used in roller skate wheels since 1949 and in shoe soles shortly thereafter. Goodyear, after a decade of unsuccessful urethane experimentation, lost interest in furthering its research – but its competitors had other ideas. For example, in 1970 Firestone was proclaiming the commercialization of cordless cast automobile tires within five years. After two decades of futile activity in search of a workable urethane, this project was finally terminated in the early 1980s.

At best, Firestone demonstrated it could produce a cast car tire with the performance characteristics of bias-ply constructions. In hindsight, the company should have invested more heavily in its nascent radial technology to avert the disastrous recall of more than seven million Firestone 500 steel-belted tires during 1977-78 due to tread separations.

However, even with the acknowledged setbacks of tire giants Goodyear and Firestone, the search for a simplified tire manufacturing process continued. During the 1980s, Polyair (Kitsee, Austria), with know-how in fabricating urethane shoes, produced liquid injection molded (LIM) passenger car tires – which failed German Automobile Club tests; a limited number of tractor tires were placed in service with unremarkable results. During the early 2000s, Amerityre (Boulder City, Nevada), a producer of flat-free, urethane foam-filled bicycle and mower tires, embraced the venture with enthusiasm (see *Tire*, March 2006 issue), but exited without success after a decade of self-promotion.

The advantages of cordless automobile tires are superficially plausible: only one polymeric material and two steel beads are required; no ply endings or splices mean more uniform tires; zero ply steer and conicity forces are achievable; manufacturing complexity, plant size and overall product cost can be reduced; and decentralized factories co-located with vehicle production sites are possible.

Disadvantages of an all-urethane structure are many, including wet grip, dry braking, service growth and rapid air loss that can result from cuts or punctures. These drawbacks are principally due to the inadequate physical properties of urethane and the lack of cord reinforcement.

Three stages of cast tire development tend to occur: the first stage is straightforward, a monolithic polyurethane structure (which proves inadequate); secondly, an all-urethane casing plus a conventional rubber tread; and lastly, the addition of belt plies.

Urethane alone in the tread is quickly determined to be deficient due to its relatively low coefficient of friction and low melting point. On wet surfaces, urethane is rather slippery, while in locked wheel braking, the tread can be worn to a flat surface – and perhaps melted in the contact patch. These problems are addressed with the addition of a rubber tread requiring proprietary adhesives to adequately bond rubber and urethane.

Due to urethane's stress relaxation and creep characteristics, tire diameter and section width increase unacceptably during highway service. During burst testing, even high-stiffness PU tires exhibit balloon-like behavior. Ultimately, diametrical growth is inhibited by inserting belt plies between the rubber tread and urethane casing, but sidewalls still widen under static and dynamic loadings.

Importantly, static casting, or pouring liquid polymer into a mold, produces unwanted microscopic cavities containing trapped air that act as crack initiation sites; these voids tend to propagate with each tire revolution due to the lack of crack arresting cords or crack blunting fillers. More expensive centrifugal casting does not totally remove these small voids, but does reduce their size and number – but at added cost.

The inability of PU alone to arrest fatigue crack growth in cordless tires remains a major impediment to commercial development. If the cordless tire concept ever proves successful, barriers to entering the business will be considerably reduced. Many 'low tech' rubber or plastic fabricators could easily develop the required production know-how, causing disastrous disruption to century-old tire giants. **tire**

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Four on the floor

Industry 4.0, Industrial IoT, smart manufacturing: call it what you will, but the combination of process knowledge, digital monitoring of production machines and data analytics is providing the next leap in tire manufacturing productivity and quality

by Graham Heeps | Illustration by Phil Hackett

There's no question about it: Industry 4.0 and the Industrial Internet of Things (IIoT) were the buzzwords on everyone's lips at this year's Tire Technology Expo. Five years ago the talk was of automation, but in this age of data lakes, seamless connectivity and tablet computers, that term no longer represents the scale of the transformation being implemented on the tire factory floor.

Rather than simply automating part of the production process, the major tire makers are discovering new ways for data gathered at every stage to increase the speed, efficiency and quality of their manufacturing. Showcase facilities like Continental's High Performance Technology Centre in Korbach, Germany, and Pirelli's plant in Settimo Torinese, Italy, are blazing a trail for the industry.

"We are not following a path that the tire industry is defining," says Francesco Sala, senior VP of manufacturing at Pirelli. "We are one of the front runners in this area, defining the path. We are looking more at other industries, at how they are looking at data in different ways, rather than at what the tire industry is doing."

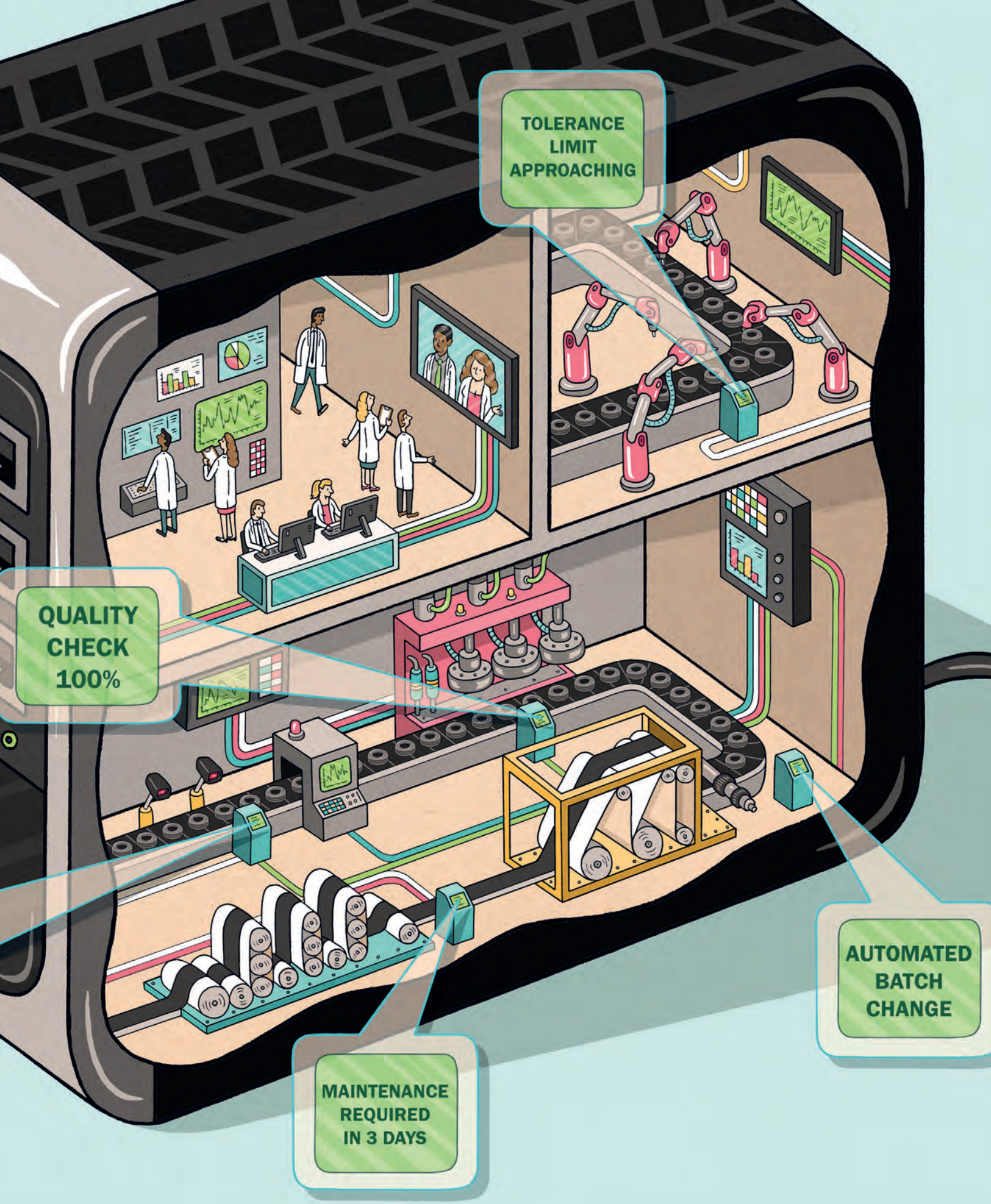
What's in a name?

Speaking to suppliers at Tire Technology Expo (see *Supplier Advances*, overleaf) offered further evidence that not all tire makers are in the vanguard of Industry 4.0 – perhaps no surprise, given that the fundamental principles of mainstream tire making haven't changed in almost 70 years. With that in mind, we spoke to Andrew Dugenske, director of the Factory Information Systems Center at Georgia Tech Manufacturing Institute, about some of the benefits of combining automation with data analytics in manufacturing.

To begin with, he says we shouldn't get too hung up on terminology. "People apply different definitions to the various names, so what people consider as Industry 4.0 and IIoT depends on the audience and context. In a nutshell, it's about making use of low-cost computational power, sensors and bandwidth to exchange data on factory floors to accomplish things you wouldn't have been able to do before these systems arrived on the scene.

"In the past, people developed automation for factories, but it was fairly expensive, challenging and proprietary," he continues. "Some people have been very successful at connecting similar types of equipment to similar software, but as they start to expand to the rest of the factory it becomes very challenging as there are so many dissimilar ways for machines and software to talk to each other. The systems that can be used now are inexpensive and as a result people are trying new things. The use of the cloud – essentially computers outside your own four walls – has accelerated the process [of data collection] because it reduces barriers to entry."

He explains that benefits of this new, connected factory start from a very basic level, simply because so little manufacturing equipment (across all industries, not just tire production) is digitally monitored – perhaps as little as 5% according to a widely accepted figure.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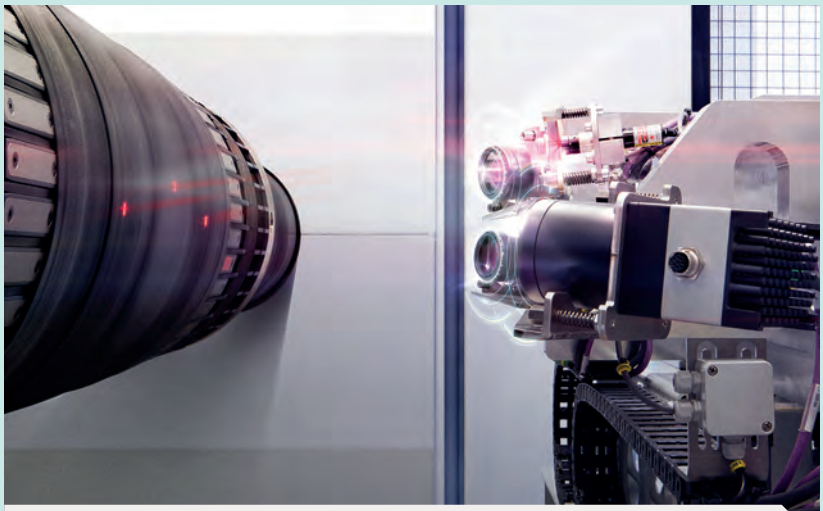
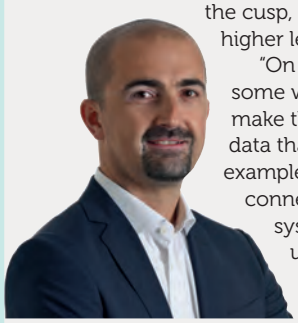


SUPPLIER ADVANCES

Pirelli's Francesco Sala (below) describes deploying IIoT as "a combination of internal and supplier knowledge. The supplier market is ready to give us machines with all the sensors we need to extract the data, at low cost."

The latest products and services from leading equipment suppliers are showing what can be achieved. In an interview in the March edition of *TTI* (https://goo.gl/TkVx7S), Comerio Ercole's Riccardo Comerio explained how data analysis and internet connectivity are enabling calender performance to be monitored and improved remotely.

Meanwhile VMI is offering systems, including the Pixxel digital monitoring system and Cortexx HMI, that meet Industry 4.0 requirements. According to VMI's VP of global R&D, Jan Grashuis, many tire makers are on the cusp, however further steps are required to achieve a higher level of automation and data exchange.



"On the logistics side in particular I see there is still some way to go, but I believe the industry is ready to make that change," he says. "Our systems create useful data that can be used in other areas of the factory, for example to steer logistics. They also provide an easy connection to an overhead production management system, so it's possible to download recipes and upload reports. That will expand in the coming years to preventive maintenance." ■

"And of that 5%, very little of the data is used," he adds. "The first opportunity is therefore to see what's going on in your factory – simple things like throughput, cycle times, types of errors and what percentage of the time the machines are doing work.

"I'm a big proponent of first-level benefits. It's helpful to collect data on your factory floor; in fact it's required to make certain improvements. Heuristics are great – talented people can listen to a machine and tell that the bearings are wearing out, for example – but there are things that go on in a factory that can't be seen. You have to obtain data, turn it into information, turn information into action and action into results. Those simple things can help solve problems, such as why a build rate was so much higher in one hour than the next."

Another level

As IIoT becomes more widely implemented, its users can start to enjoy deeper benefits such as more efficient inventory management and tracking of semi-finished goods, dynamic scheduling to minimize downtime, and predictive maintenance. Beyond that are opportunities to reconfigure the factory to improve the flow of the line, provide real-time adjustment to a machine upstream as a result of quality inspections downstream, or minimize scrap as a result of material use optimization studies.

Such efficiencies don't come without considerable work, however, and Dugenske cautions against overinflated expectations.

"It concerns me that IoT is too hyped. A lot of technology sellers imply that you snap your fingers and IoT will take care of things for you. That's not the case. IoT is a necessary – but not sufficient – condition for success and there's still a lot of work that needs to be done. It gets you the data, but if you don't understand the process, or how the data can help you, then a lot of people are going to be disappointed because there could be lots of data that doesn't correlate to manufacturing quality or improvement in any way.

"Another misconception is when people think that all they have to is plug in an Ethernet connection and turn it on! People are gravitating toward internet [communication] standards because there are so many systems and software tools available that you can glue together in this way. But there's still work to be done in the syntax and semantics of the data exchange. You need to know whether, for example, if one machine sends you GO and another says START, they mean the same thing. That's where the hard work is, and where most people have the biggest challenge."

Case study

Pirelli's Settimo factory in Turin is the testbed for its most advanced robotics – the Next MIRS production system, which builds UHP tires for Ferrari, Lamborghini and Porsche – and IIoT.

Top: VMI's Pixxel is one of an increasing number of IIoT-ready systems for tire manufacture

Right: The HPTC facility in Korbach, Germany, is at the cutting edge of Continental's adoption of Industry 4.0

Concepts developed and proved here in a cooperation between production engineers and specialists from the company's internal data analytics department are rolled out to the tire maker's plants worldwide.

"We are combining automation and robotics with data analytics and human operators to create what we call 'smart manufacturing,'" explains Pirelli's Sala. "It's a different way of understanding the production flow, in which data is available from all over the production chain, starting from the customers and going back through the factory to our suppliers.

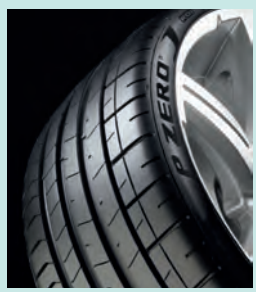
"We have examples of automation all over the world," he continues. "We've had MIRS since 2000, and Next MIRS – a fully automated and robotized production facility – since 2010. What's new is that data accelerates the process and enables us to see the near future.

"If we want to understand the performance of a machine, the quality of what it's producing, we download the data from our production systems and analyze it. The resulting data – production trends, reports and analytics – is available in real time to Pirelli employees all over the world. That way, if I have two identical machines making the same product in China and Brazil, we can make real-time comparisons."

Maintenance is another area in which data is making a difference. Sala says that maintenance programs are now digitized: stored machine data, supplier information and repair procedures are all available via a tablet to maintenance engineers, helping to accelerate processes as they investigate problems or carry out scheduled work.

"We are already shrinking our maintenance cycles from days to hours," he adds. "The vision we have for the future is to predict breakdowns based on the data we see, so that maintenance requirements will be predicted and preventive, not reactive."

Above: Pirelli's Next MIRS robotized production system builds OE UHP tires such as the P Zero for supercars **(below)**



More generally, Pirelli is working to maintain production efficiency and quality by using data from one area of the factory to look for issues in another.

"If I can understand the issue I have now in the finishing area, I might then know that there will soon be a problem in building or curing because a parameter is going out of alignment," he offers by way of example. "I can anticipate the problems and work in advance to mitigate them. That's something we'll see on a mass scale [in Pirelli] within a few years. We already have pilot schemes underway."

Good to go

Interestingly, Sala states that a major upgrade of tire-making equipment isn't necessarily needed to make the jump to IIoT-enabled manufacturing.

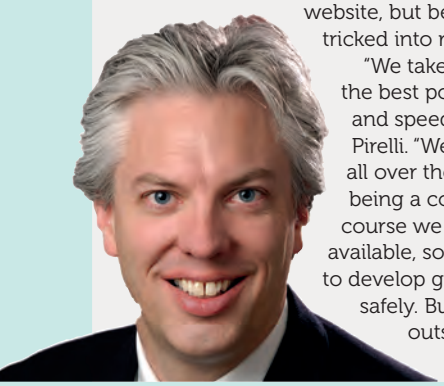
"We believe we are well equipped," Sala confirms. "We are realizing that even with the sensors we have, we are already producing a huge amount of data. The challenge of the future is to combine it in a new way to see a completely different picture of the factory.

"Let's say you want to see how materials are moving inside the plant. Twenty years ago you reported it on paper – people told you how things were going, shift by shift. Today, systems tell you that one piece of semi-finished material is here and another is there. The third step, which we're working on, will be to combine the location of the product, production planning and sensors on existing machines, to tell where the material will go in the next shift.

"To do that I don't need any new assets, just to see the data differently. The future we envisage for the coming years is therefore not necessarily to change the assets, but to exploit our factories better by analyzing data and using it to align people and processes. That will increase productivity and efficiency, and help us to manage the flexibility and variety that customers of premium tires demand." **tire**

SPEED AND SECURITY

Cybersecurity is a hot topic for companies implementing IIoT, but Georgia Tech's Andrew Dugenske (below) notes the balance to be drawn between data security and productivity. "The most secure system is one that's unplugged from the rest of the world," he laughs, "but it's not very useful! Security is important but it can kill projects and productivity. Most of the time when there's a security problem it's not from, say, somebody attacking a website, but because someone within the organization is tricked into revealing information that offers a way in."



"We take security very seriously but we want to find the best possible compromise between data security and speed of execution," agrees Francesco Sala at Pirelli. "We want to make data available in real time, all over the world, because that is a prerequisite to being a company with a data-driven culture. Of course we must be careful in how we make the data available, so a specialist internal group works with us to develop guidelines and solutions to manage the data safely. But we have no evidence of attacks from outside so far." ■

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Right: Dick Cormack at a WRC event. He is generous in his praise for the sportsmanship and competitive spirit of rally rivals Michelin

"The biggest risk was to go into the WRC in 2011. We had only been going two years, but it was an opportunity we couldn't miss"

Dick Cormack, managing director, DMACK Tyres

Rally for a cause

It's not your average tire company. Still only a decade old and having established itself at the pinnacle of motorsport, DMACK plans to take its brand into the road car market

by Graham Heeps

In April, for the second time in a year, British tire company DMACK came within a whisker of stealing a World Rally Championship (WRC) victory from Michelin. Having won multiple championships at other levels of rallying, it's surely a matter of when, not if, the startup tire company adds a WRC win to its growing CV.

DMACK is not a conventional tire company. It does not have huge factories, a multimillion-dollar R&D center, or a century of history. In fact, wind the clock back 10 years, and DMACK was only just getting started. Former Pirelli UK motorsport manager Dick Cormack founded the company when an independent assessment of the value of DMACK's first design – a 13in rally tire – and the potential product range, enabled him to raise £75,000 (US$95,000) in seed capital, which was matched by a £75,000 bank loan. In 2009, he boarded an airplane to China, formed a partnership with Yongtai, and a new tire company was born.

Paris calling

With design and marketing led from an office in Carlisle, in the UK county of Cumbria, and the products manufactured in Shandong Province, the range quickly grew to fill a niche for high-quality, reasonably priced rally tires, primarily in Europe. The leap onto the world stage came quicker than expected however, and from an unexpected source.

"The biggest risk was to go into the WRC in 2011," recalls managing director Cormack, speaking exclusively to *TTI* at Tire Technology Expo. "Pirelli had just withdrawn and gone to Formula 1. We had only been going two years, but it was an opportunity we couldn't miss.

"I put in a tender in November 2010, sent an email to the FIA with the drawings and specifications of the tires. I was invited to the offices in Paris, where I made a technical presentation. It was a big leap of faith on the part of the FIA, but they had made the decision to move away from a control tire and no one else had applied to compete with Michelin.

"They welcomed us in. It could have been a disaster, but we've progressed and it's turned out very well for everybody. It elevated the company straight away. As soon as we got the accreditation from the FIA, we started receiving telephone calls from all around the world from people wanting to be our dealers. It's quite a story."

With WRC-proven designs to its name, DMACK's sales and reputation have grown rapidly. Last year, the company made 100,000 motorsport tires and turned over £4m (US$5m). For the first time, almost all were made in the UK, by Cooper-Avon in Melksham. Production was switched away from China in September 2015, at the same time as DMACK hired Fiorenzo Brivio as motorsport technical director, who brought 35 years' experience from Pirelli.

"The timing was good," says Cormack. "We knew we had to make a step forward in terms of performance. The quality of the motorsport tires from Yongtai had always been good, but we'd been lacking some performance at the very top level in terms of compound mixing. Bringing production to the UK was a big decision. It coincided with the appointment of Fiore [Brivio] and it worked immediately as we began to lead WRC rallies – three in 2016 and more this year."

Cormack describes the company's current performance in WRC as "a measure of how far we've come". It now offers 120 different products and can supply tires for every class of rally car in the market, from the pinnacle down to grassroots.

Melksham magic

DMACK was already cooperating with Cooper on tire development even before the production switch. The Melksham facility is home to the US company's European Technical Center and was already making Avon competition radials for circuit racing, and cross-plies for rallycross. DMACK's rally radials complemented those products instead of competing with them, and filled spare capacity in a plant used to producing small batches of high-quality motorsport tires. Cormack has nothing but praise for his UK partner.

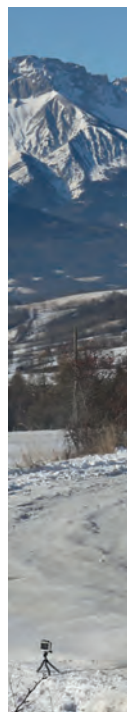
Above: More than 70% of DMACK's sales are in Europe, but it has multiple control-tire contracts in South America, and is used by leading rally teams in the USA and Canada

Right: DMACK has worked hard to improve the performance of its asphalt rally tires. On the Monte Carlo Rally this January, driver Elfyn Evans, who won the British Rally Championship for DMACK last year, clocked the tire company's first fastest times on WRC asphalt stages

"When we switched to Melksham, we had to redesign all the tires and brought out new tread patterns for 2016," he explains. "The support from the motorsport department at Cooper has been fantastic. A small group is what you need: we can do something new in a week, whereas bigger companies tend to struggle to react quickly. We had a huge database of knowledge, plus the expertise of Fiore and myself. Cooper has some great compounding people, and we have had great backing from Jeff Schumaker and now Luis Ceneviz [who succeeded Schumaker as Cooper Tire's European MD in October 2016]."

Cormack puts the increase in production cost for Melksham over China at about 7% per tire.

"It's much less than you might imagine, but minimizing scrap is a big plus," he says. "In WRC we're competing against Michelin, so we have to develop our product all the time: build small batches, test them and decide on a specification to release to the market. The minimum order from China was about 100 tires, but if we tested the specification



TESTING IN STAGES

No matter how good your test facilities are, there's no substitute for on-stage testing in rallying. "You have to have a manufacturer team on board, you have to accumulate the mileage, and test back-to-back against your competitors as often as you can, to keep at the highest level," says Dick Cormack.

That mantra was truer than ever for the latest generation of WRC cars, introduced at the start of this season. "The 2017 cars are another level up in speed and grip," he continues. "Hot gravel is especially hard on tires now because of the increased aero and power. A tire that lasted 30km (18.6 miles) on a 2016 car was only lasting 9km (5.6 miles) in testing on a 2017 car! We had to completely redesign the tires for 2017. The good thing was we did a lot of testing in the right conditions in the South of France at the end of last year, so we're very confident in the gravel tires. It was great to be able to bolt on the back of the tests with the factory M-Sport Fiesta." ■

and found it was no good, that created a lot of scrap. A good thing about the partnership with Cooper is that we can build eight or 10 tires of one spec in Melksham; the cost is a little higher per tire, but it works its way out because there's hardly any scrap."

Back on the road

In 2016, DMACK revealed plans to build its own production facility in its home county of Cumbria, where Pirelli already has a factory. "You need to be in control of your own destiny, especially with competition tires," he insists. "The dynamics changed with the Brexit vote. We had investors on board for the project in Carlisle, but once the result was announced – which was a big shock for everybody – they backed away. It might come back again but for the moment we have a strong partnership with Cooper, which has really got behind the WRC project."

The next stage of DMACK's expansion will involve a return to the road-car market from which the company quickly withdrew in 2015 after vibration, uniformity and balancing issues with the Yongtai-made tires risked compromising its hard-won brand equity.

"Retailers wanted them, they understood our story and wanted to market the tires," Cormack says. "But the quality didn't match up so we decided to pull away from it temporarily. We have opportunities to manufacture road tires again and have been in discussions with several potential partners. We want to capitalize on the brand we've built in motorsport, competing at the top level against massive manufacturers like Michelin and Pirelli, to sell road tires. That's where the gold at the end of the rainbow ought to be."

DMACK expects to announce its expansion plans later in 2017, but nothing had been confirmed by the time this issue of *TTI* went to press.

Above: DMACK came within a whisker of winning a WRC rally outright in Argentina this year. Elfyn Evans' Fiesta used DMACK's latest soft-compound DMG+2 GS62 tires and lost by less than a second

Past and future

Cormack says that production won't return to China for the foreseeable future.

"Whatever you do, there is always a stigma around producing tires there, which is often unfair because some of the factories are of a very high quality. But unfortunately you can't get a premium price for a tire made in China. We've seen in motorsport already how moving to UK production was a big boost to our reputation, even though from our first WRC rally in 2011 onward, we never had a single tire failure from a tire made in China. The quality was there, they just lacked that last 5% of performance."

He has no regrets about DMACK's experience of Chinese manufacturing, however, pointing out that western producers would have been unlikely to back a newcomer in the way that Yongtai did in 2009. He also corrects earlier press accounts of DMACK suing Yongtai: in fact, an ex-employee in China had stolen some of the trademark chops (official seal) from DMACK's wholly foreign-owned entity in the country. The ex-employee then tried to sue Yongtai, which has reportedly experienced financial difficulties, posing as DMACK.

"In reality, we were paying Yongtai's bills to try to get our chops back!" says Cormack. "Yongtai helped us a lot, right from the start, and we still have a very amicable relationship with them. They have their own problems at the moment, as many Chinese tire manufacturers do, but they still produce some 13-14in sizes for us. Who knows what will happen in the future?"

A major goal for the near future is a full supply deal with a works WRC team. DMACK already sponsors and supplies one of M-Sport's Ford Fiesta WRCs (see sidebar, *Testing in stages*), with the team's other cars running Michelins. Cormack hopes that, with the asphalt tire now closer in performance to the high-achieving gravel one, his fellow Cumbrians will choose to go all-DMACK in 2018. **tire**

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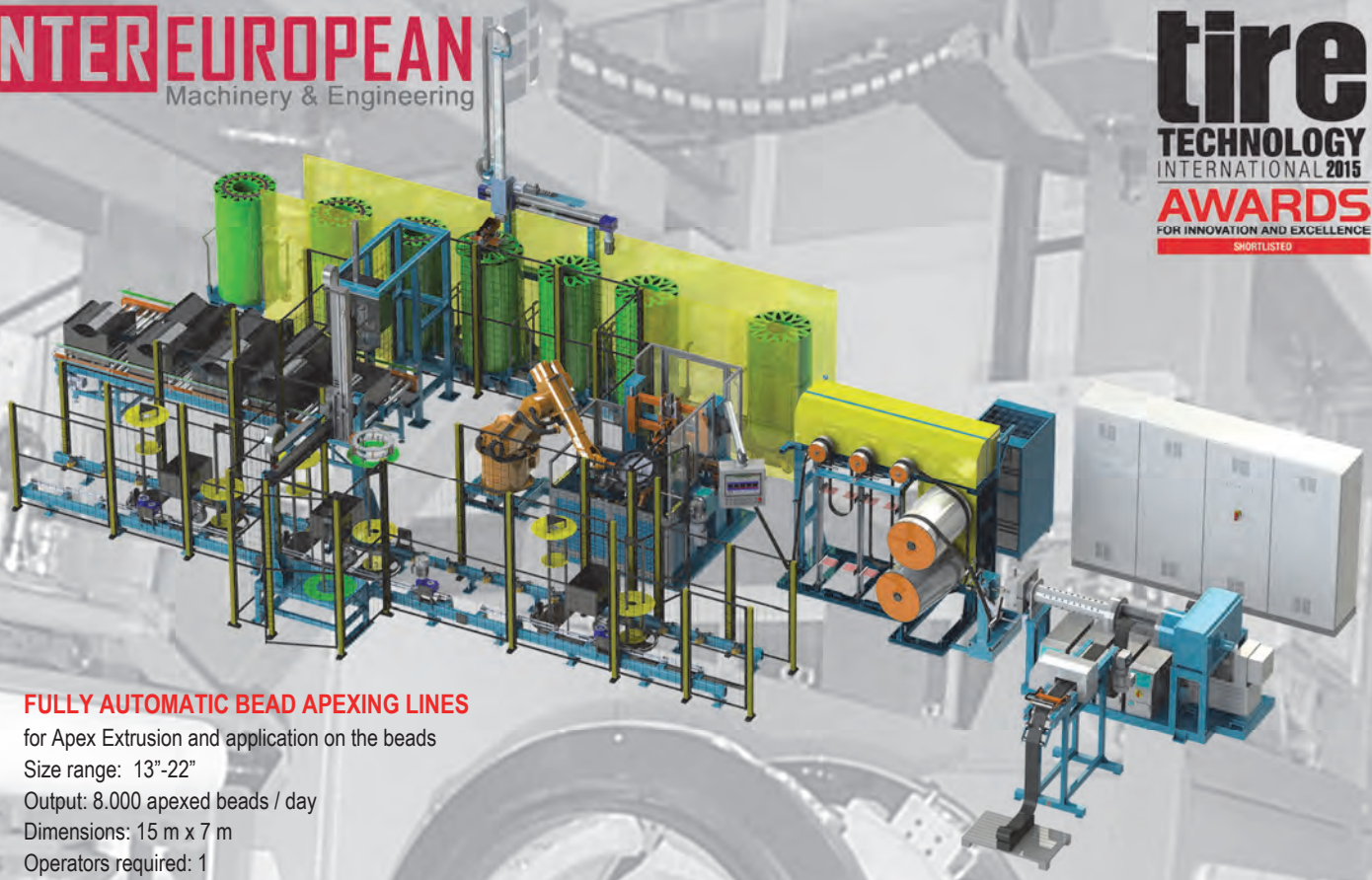

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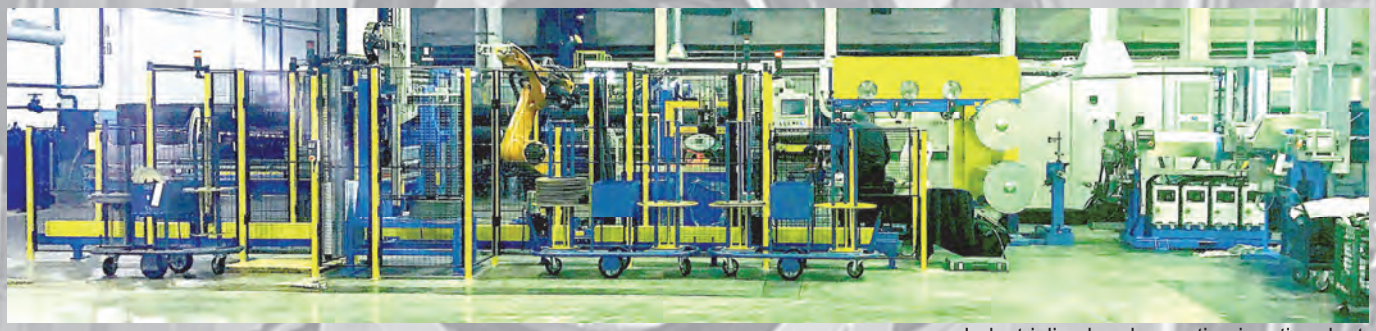
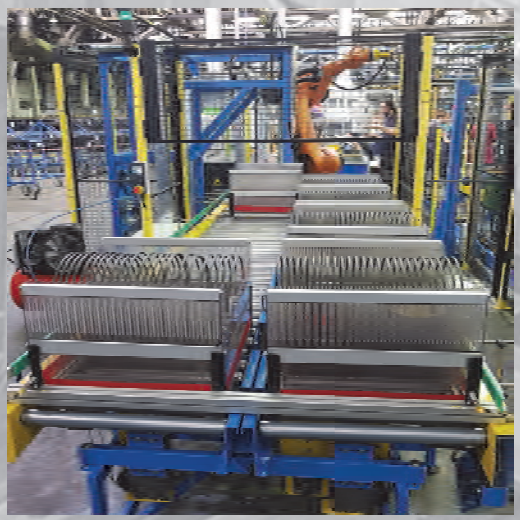


Industrialized and operating in a tire plant



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Switch to automatic

InterEuropean's CEO, Vladislav Tsoupikov, believes that tire factories today can operate with greater speed and efficiency than ever, thanks to advances in automation

by Karl Vadaszffy

Having reliable machines with as little manpower involvement as possible is a key demand in the tire industry, according to Vladislav Tsoupikov, founder and CEO of InterEuropean, which designs and manufactures tire machinery and equipment.

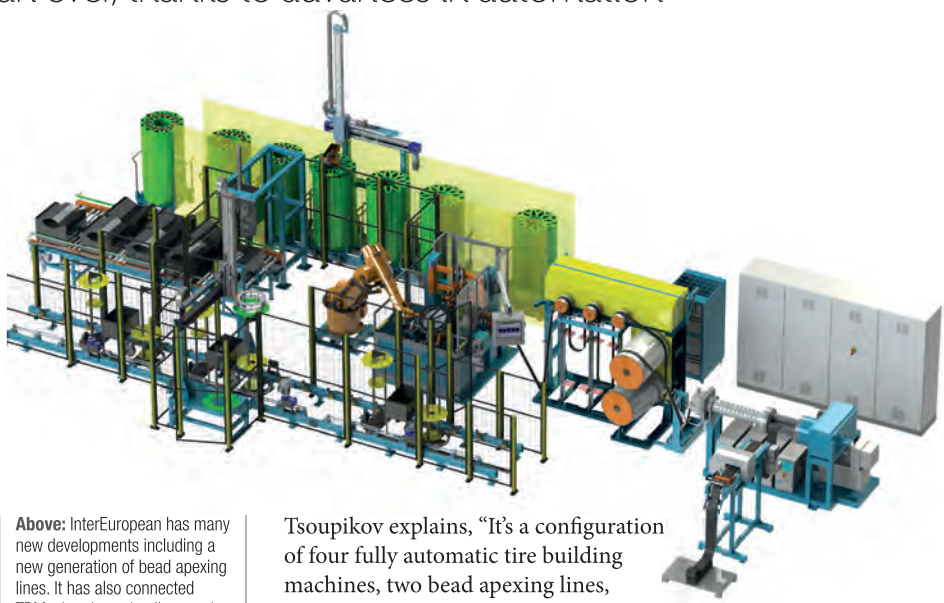
One of the aims of the Italian company's machines is, therefore, to "try to eliminate the human factor" by negating the need for an operator or reducing the role one plays in a line. "Fully automatic machines are reliable and effective," Tsoupikov comments, explaining that InterEuropean's machines "check everything consistently and guarantee that everything coming off the machine is according to specification".

Tsoupikov reveals that the company, whose global client base includes Bridgestone, Michelin and Goodyear, is currently in the process of designing a fully automatic bead apexing line for truck tires up to 24.5in. The bead handling of this system will be managed by a robot, so the concept will remain the same as with the company's other machines. With a cycle time of just 20 seconds per bead, the line should be available by the end of this year.

Addressing the challenges of developing such a solution, which has been in development for a year and a half, Tsoupikov says that a different extruder was needed to deal with two compounds instead of only one found with PCR tires, as well as catering for the extremely high size range – with truck tires, the apex size can go up to 180mm. "In addition," he says, "we need to pre-assemble the apex with two other strips in different areas, beads and apex, before it is fully assembled. And we need to ensure it can all be handled automatically."

Indeed, Tsoupikov reveals that tire building machines and bead apexing lines both for PCR and truck tires will now be the company's priority, and it aims to continue to innovate and grow so that its technology can be at the forefront of industry developments for years to come.

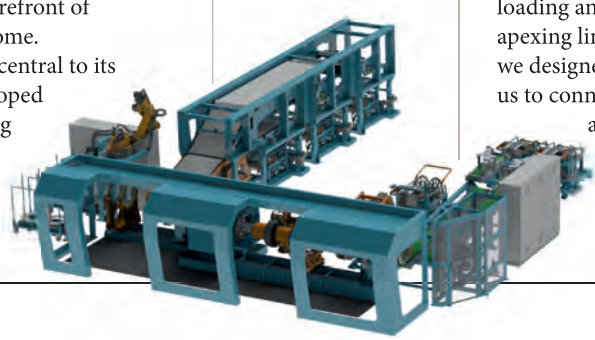
With the demand for automation central to its R&D, the company has already developed new generations of TBMs and apexing lines, combining them into a fully automated integrated tire assembling cell, or ITAC.



Above: InterEuropean has many new developments including a new generation of bead apexing lines. It has also connected TBMs, bead apexing lines and a bead winding line together in an automatic system

Below: InterEuropean's CEO, Vladislav Tsoupikov

Bottom: Unistage TBM



Tsoupikov explains, "It's a configuration of four fully automatic tire building machines, two bead apexing lines, and one bead winding line – everything connected together in a fully automatic system." This system is designed to manufacture 8,000 tires per day, which is the equivalent of 2.5 million tires per year. Laser systems and cameras control each step of the manufacturing process and guarantee that optimal quality is maintained at every level.

The new generation of bead apexing lines, with separator-placed robot, has been developed for passenger and light truck tires, from 13-22in, with a fully automated production output of approximately 8,000 beads per day. Bead loading and unloading are now fully automatic, and a key benefit is the powerful stitching of the apex to the bead from both sides, guaranteeing that the apex will not separate from the bead during the turn-up stage at the tire building machine.

Tsoupikov sees these two new generations as "the last step of the development process", which started 14 years ago with the launch of the company's first TBMs, including its industry-unique combi machines. "Following this, we proceeded with upgrades to our manufacturing lines, removing operators from loading and unloading operations on the bead apexing lines and replacing them with a robot. Then we designed bead handling cassettes, which enable us to connect the bead winding line to the bead apexing line, and from the bead apexing line transfer the beads to the tire building machines. And now we've connected all these components into one system." **tire**

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Just add lightness

With efficiency still top of the automotive agenda, could lightweight tires offer more in return for less? We explore materials and techniques involved in tire mass reduction

by Chris Pickering

You rarely get anything for free in the world of tire development. Seemingly every improvement has to be balanced against potential consequences, thanks to the complex web of interacting material and physical properties involved. Reducing the weight of a tire is about as close as you're ever likely to get, with a virtuous circle that can improve multiple aspects of the performance in a single hit.

"We've seen a pretty dramatic reduction in tire mass over the last few years," comments Kai Hauvala, CEO of consultancy firm Black Donuts Engineering. "Our target has generally been 10% over recent projects. If you look at a 205/55 R16 passenger car tire, five or 10 years ago it would have been in excess of 9kg. Now the same application could be 8kg."

The most obvious benefit is simply reducing the total mass of the vehicle, as manufacturers look to chase every last gram of CO_2 (or eke out additional range from an electric powertrain). Even in isolation, 1kg per corner is a worthwhile saving. But for a rotating component on an unsprung part of the chassis, the physics is even more compelling.

"Lightweighting of vehicles has been – and will continue to be – a major target for automotive OEMs as they strive to meet or exceed efficiency targets," comments Bruce Lambillotte, vice president of technical consulting at materials specialist Smithers Rapra.

He points to a 2015 study on lightweighting in midsize vehicles carried out by the Idaho National Laboratory, which placed wheels and tires (collectively) as the fifth-heaviest component on the vehicle, accounting for 5.45% of the total mass.

The link between rolling resistance and tire weight is more complex, but in many cases there are considerable gains to be made here too. "Reducing a tire's weight is generally a good way to lower its rolling resistance," says Hauvala. "There is a fairly direct relationship between the two. Up to a certain point it's linear – if you reduce the weight by 10% you could reduce the rolling resistance by the same amount."

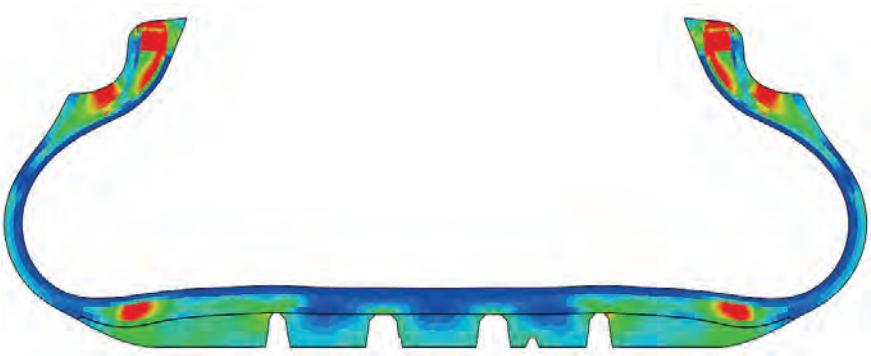
There are, however, a lot of other factors in the equation, as Nigel Hosker, manager for tire engineering at the Goodyear Innovation Center in Luxembourg, points out: "Reducing the weight of a tire will often result in changes to its performance and may also reduce tire rolling resistance. But there is no ratio for this because tire rolling resistance is not just related to tire weight. Different components, materials and rubber hysteresis levels may impact tire rolling resistance as well."

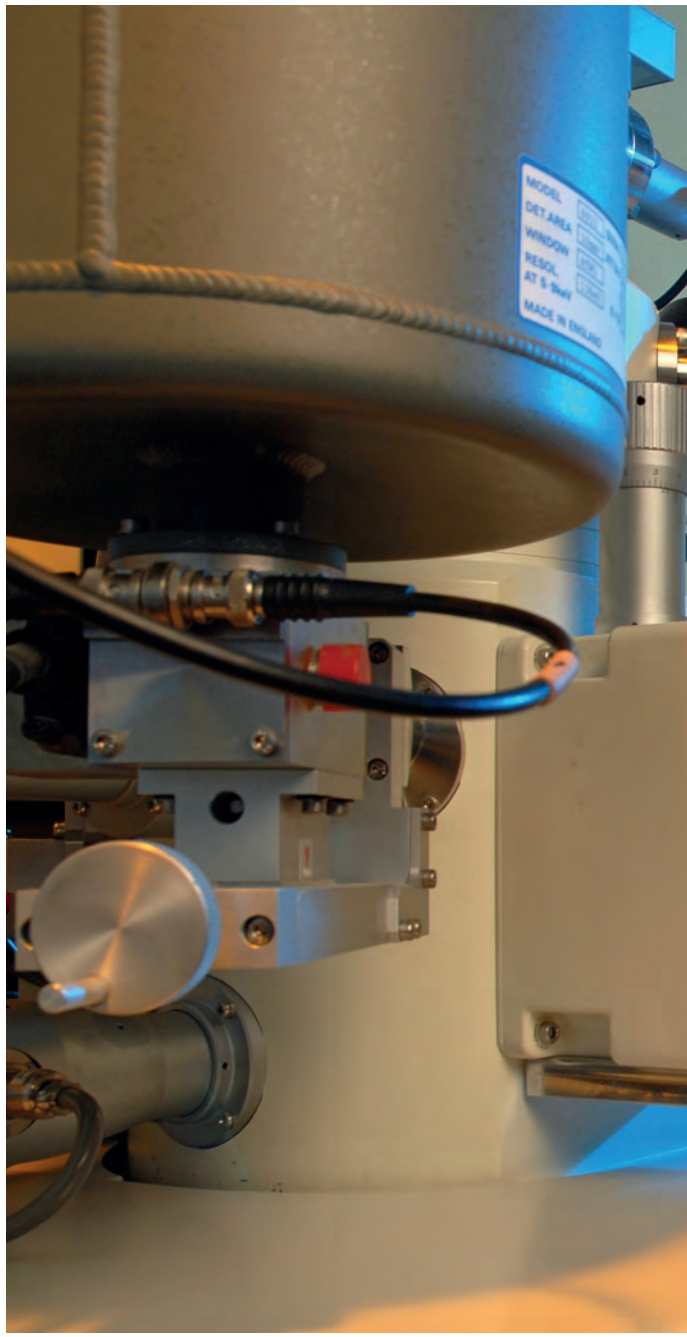
One of the biggest challenges is to maintain the ride and handling performance. The mass of the tire provides a damping effect as the carcass deforms, so there's a risk that its stability will decrease. There are other ways to address this, though, such as the groove depth and the structural design, as Hauvala points out.

Shedding weight

So there's a strong theoretical case for reducing the weight of the tire, but how exactly do you go about doing it? The easiest option – where possible – is simply to reduce the amount of rubber used in the construction. This is a case of carefully optimizing the design to remove excess material without compromising the overall integrity.

Smithers Rapra has carried out its own benchmarking and analyses to evaluate how best to achieve weight savings. On the surface, understanding how much tires weigh and the differences between brands or types is a basic exercise. However, in order to get to the meaningful details, the study of tire component lightweighting is a much more involved and challenging exercise.





Above and below: FE models from Black Donuts. FEA is one of the techniques used to tune and test lightweight concepts

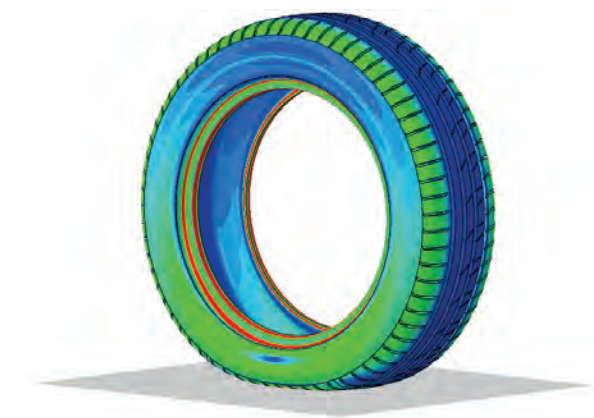
Right: Goodyear's Innovation Center in Luxembourg works on compounds that can be used in weight-saving designs

"To start, there is really no defined protocol in the industry to study this," Lambillotte says. "Truly understanding the underlying construction impacts requires extensive benchmarking data that represents a set of similar tires from various manufacturers. Tires should have equivalent size, load and speed indexes as well as similar tread design. Once the sample set has been defined, the investigation will require a wide variety of in-depth characterizations, including volume and weight data representing all major tire components. We have conducted multiple studies with these parameters to understand some of the more prevalent design tendencies relative to tire construction."

The most obvious targets would seem to be the treads and belt packages, since they are the heaviest components of the tire, but this does not necessarily match what's going on in the industry, he explains, "Our analysis of a common set of ultra-high-performance passenger tires indicated that sidewalls and bead areas were respectively the number one and two targeted areas for mass reduction in the lightest tire. However, the innerliner package in the same tire was higher than the average of the tire set."

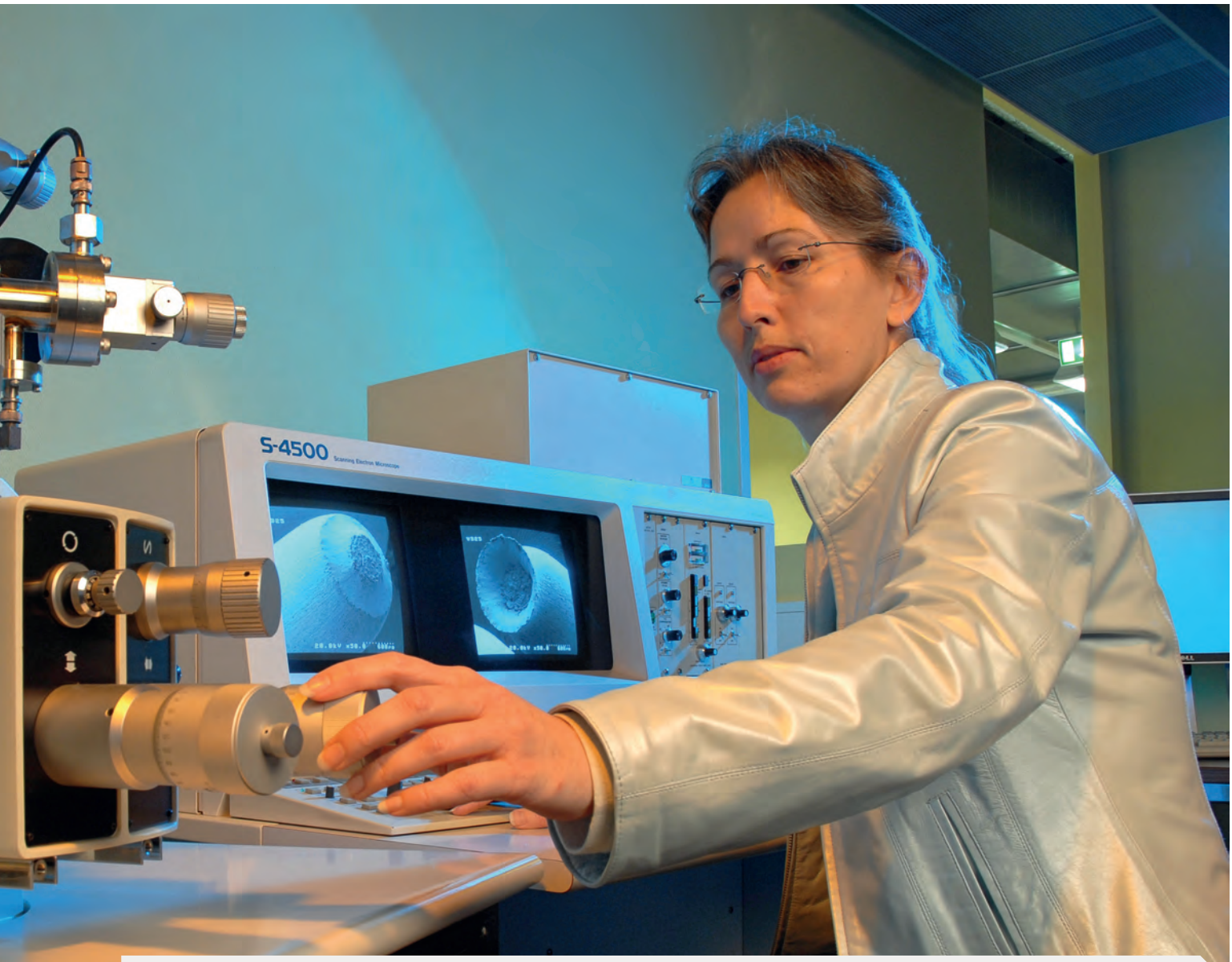
Of course, this philosophy works only up to a certain point. It's well recognized that thin sidewalls and thin belt/tread packages can increase the risk of punctures, and the consensus is that the potential to simply strip away excess rubber has been more or less exhausted over recent years. New materials could reignite the debate, however.

"The tread is largely responsible for the performance – that is to say, the wet grip and the rolling resistance – but you have a lot of rubber inside the tire that helps to hold everything together. If you can reduce the thickness of the steel belts and the textile fabrics, then you can further reduce the thickness of the rubber," notes Hauvala.



Super-high-tensile steel cords are becoming a popular option as they enable comparable stiffness to be achieved with a lighter, thinner layer. But research also extends to new silica and silane combinations in the tread.

Lambillotte also highlights the balance between design changes and material developments: "Based on our recent studies, reductions in tire mass at



MODELING MASS

Finite element models can be a powerful tool for tuning and evaluating lightweight tire designs. As well as predicting structural integrity and rolling resistance, simulation can give an insight into heat build-up in the tire and indicate areas where excess material could safely be removed.

At the heart of these models is an extensive database of material properties that can be developed for a manufacturer's own tires or competitive brands, explains Smithers Rapra's Bruce Lambillotte (right): "Tire makers continue to invest considerable resources into development of modeling processes. Alternate geometries or materials can be evaluated relatively easily, and performance compared against the summed mass of the model elements. While FEA models remain imperfect, the output of these simulations are used to guide tire design and reduce the number of experimental builds required to produce a lightweight, yet high-performance product."

However, as with any type of simulation, it's vital to correlate these findings against real-world data. That's particularly true when studying very small changes in mass, where the production tolerances of real tires start to take on a proportionally greater importance. ■

this stage of lightweighting development appear to be coming primarily from the design side versus the materials side. However, we believe that after lightweighting of key areas through dimensional changes has been broadly adopted, the focus will shift to the materials side of tire development for the next stage of reduction."

One area that has some promise is the reduction in reinforcing cord diameters by using hybrid aramid/nylon cords. "This change can contribute to an overall reduction in overlay mass while maintaining or improving performance," says Lambillotte.

Durability clearly remains key. But while there are undoubtedly challenges when it comes to lightweight tires, there are also durability benefits, as Hauvala explains: "Heat build-up is generally what kills a tire. Lighter tires tend to generate less heat, which improves both mileage and durability."

There's also work to be done to ensure that tires can be made lighter without compromising the noise and ride characteristics. Generally softer, heavier tires work best for comfort, although it's thought that clever tread design and structural tuning could help to offset the potential downsides.

Above and above right: Smithers Rapra believes that future lightweight advances will come from a mix of design and materials developments

More for less

Alongside the tire's physical performance, there's also the question of cost. Generally speaking, lightweight materials such as hybrid cord reinforcements are more expensive. That's unlikely to prove popular, but there may be ways of offsetting that increase or even achieving a net reduction.

"Material cost is less critical for the premium manufacturers, but it still accounts for 60-75% of the production cost," Hauvala observes. "That means you can improve profitability if you reduce the amount of rubber. It also means you can boost production capacity without investing in new facilities – a 10% increase in throughput could be possible in some cases with the same machinery."

Looking ahead, there may be additional challenges. While there's a concerted effort to reduce mass across the board, the rising popularity of hybrid and fully electric powertrains is actually increasing vehicle mass in some instances. Lightweight tires for these applications would have to be engineered with increased loads in mind, and that could make it harder to achieve reductions without using more exotic materials.

Ultimately, reducing the weight of the tire remains a beneficial trend. It may not be straightforward, but we can expect to see a continued effort to shed weight and improve efficiency right across the board. **tire**

ALLIANCE OF SCIENCE

According to Terry Gettys, the executive VP of R&D at Michelin, development of low-weight, high-performance tires remains a top priority to his team, *writes Rachel Evans*. He says that with a combination of design and materials, approximately 70% of mass reduction can be achieved through materials, and a further 30% thanks to their integration with different designs.

On the materials side, R&D has focused on two key areas: "Our carcasses are already optimized for mass; we've had the lead there for a number of years. Right now, weight reduction is focused largely on the crown and the tread," notes Gettys.

"We're using new, higher strength, thinner and better protected materials – such as high-strength steel belts – so that we can reduce the thickness of the treads." According to the executive, recent advancements have seen the standard strength of steel belts increase by between 10% and 30%.

He adds, "We're also using smaller cables, so less protecting rubber is required around them, which means we can achieve a higher resistance with a much thinner ply. We're also finding new materials to better protect the durability of the inner components – again so we can reduce the protective layer thickness, which means more resistance to oxidation with thinner designs."

Gettys is confident that further gains can be made without a trade-off of performance parameters. Impacts on handling and comfort in particular, he says, are "very manageable, however the main challenge is noise because as the tire gets thinner, it acts more like a drum".

Meanwhile gaining customer acceptance, which has proved difficult until now, presents another hurdle, says Gettys: "Eventually we will need to confront the industry [with the premise] that less is better, but people don't like it because it looks like they aren't getting their money's worth if the tread is not deep. We're doing this first in the truck market with the fleet managers." ■

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Strength in depth

Under a new initiative, Michelin has emphasized the influence of tire design on safety, and is calling on industry test organizations to replace the current EU labeling wet braking assessment with tests on worn tires with a 1.6mm tread depth

by Rachel Evans

In late 2016, Michelin sparked debate in the tire industry when it advocated disregarding advice given by stakeholders – including some tire manufacturers – that motorists should change their tires when 3-4mm tread depth remains, rather than at the legal limit of 1.6mm.

Now it has launched a groundbreaking initiative – The Truth about Worn Tyres – as part of which it is campaigning for test bodies and consumer organizations to compare and test both new tires and tires worn to 1.6mm of tread. Alongside the mandatory used tire tests, Michelin has also put forward proposals to introduce an eco-modulation tax scheme.

"We feel that for product safety it is no longer sufficient to just evaluate in the new condition; we need to consider the full time that the tire is in service," comments Terry Gettys, executive VP of R&D at Michelin Group. "For the regulation, we are proposing to replace wet performance tests of new tires, with worn tires, because this represents the worst conditions for the driver."

Above: Comparison tests at Michelin. The rolling resistance of a tire at the point of removal at the legal limit is said to be 80% of that of a new tire

The French tire maker claims that the current EU labeling system is unreliable as braking distances can vary greatly as tires become worn. It also states that tire performance can actually improve as the tread wears down.

Underpinning its argument, it conducted a series of tests at the R&D center in Ladoux, France, and assessed the performance of 24 different branded tires – including both premium and budget – new and worn.

"Statistically the average tread depth of a tire on the road is half worn. That's important because as the tire wears and the tread depth reduces, its characteristics will change and it will not perform as when new. For some parameters this can have a drastic effect and there can be a difference in performance at a ratio of up to 2:1," says Gettys.

Michelin says that not only did the results clearly display a wide variation in performance levels from new to worn, but in certain cases, it

was found that some worn premium tires with 1.6mm of tread depth have the same wet braking distance – or even shorter – than a new budget tire.

In terms of development, Michelin evaluates all new tire models with varying tread depths, depending on the program. Treads are buffed down to 2mm (this accounts for the variation in ETRTO measurements) using a specially developed machine, which takes around three hours per tire.

Notes Gettys, "What we want to demonstrate is that tread depth is not the only factor that influences tire performance during wear – there are many other factors. That includes the tread design, compounds and the profile, and it's these that we are working on to ensure performance down to the wear limit."

A look at accident research by independent agencies has also provided further support to the case. For example, one particular study carried out by TNO in Germany in 2009, which considered a number of influential factors, found no correlation between tread depth and the propensity for accidents.

"The performance of these tires might be less, but statistically if we look at them all, the population difference is not as big as you would think because some new tires are actually in the same performance range of worn tires, which reinforces the point that we're making."

Right: Michelin engineers at work in Ladoux, where the company last year opened an expanded technology center

A SECOND OPINION

Advice given by the European Tyre & Rubber Manufacturers Association (ETRMA) places particular importance on maintenance to ensure performance and safety throughout a tire's service life – right down to the legal wear limit. Although the organization does not recommend that tires need to be changed before then, secretary general Fazilet Cinaralp (below) states that it is impossible to specify a minimum tread depth beyond which continued use becomes dangerous, applicable for all types of tires.

She says, "A tire relies on its tread pattern to provide grip for stopping, steering and driving. If a car is driven on tires with tread that is below the 1.6mm threshold, the speed at which hydroplaning begins would be reduced by up to 40%. As important as the tread depth, tires should always be inflated to the correct pressure, according to the vehicle manufacturer's recommendations."

Cinaralp believes further changes to the label/type approval regulations are not necessary. Instead the industry should focus on monitoring and improvement of consumer awareness, she comments. "More in-depth work would be needed requiring substantial resources before demonstrating the need and the feasibility for new requirements.

"As I understand it, the phenomenon of wear is so complex and there is no one representative test condition of a worn tire, which is affected by so many parameters, such as type of asphalt and temperature. The question then becomes, 'How do you simulate a real worn tire?' Furthermore, the test cannot be simplified to one performance parameter only (wet grip) without considering all these factors – many of which are conflicting," Cinaralp concludes. ■

Meanwhile, an Ernst & Young report commissioned by Michelin has highlighted the social and environmental impacts of changing tires at 3mm instead of 1.6mm.

The analysis found that changing tires early could result in 128 million additional tires being used each year in Europe and nine million tons of additional CO_2 emissions. Raw material use and waste from tire manufacturing would increase by 35% annually; at the current level of production, that equates to one million tons of additional waste and one million tons of extra raw material use. In terms of energy consumption – both in production and during usage – that's around 32,800GWh, which is equivalent to the annual energy produced by more than two third-generation nuclear reactors.

With regard to costs, replacing tires before they are worn to 1.6mm represents an increase in annual expenditure of motorists in Europe – including purchases of new tires and more fuel – of €6bn (US$6.7bn), Michelin claims.

Worldwide, that amounts to a potential saving of 400 million tires per year and 35 million tons of CO_2.

Gettys concludes, "You might think it is better for business to encourage end users to take their tires off early. In fact in some industries, OEMs actually design for programmed obsolescence. At Michelin we encourage programmed longevity. This will lead to customer loyalty and reinforces our commitment to the environment." **tire**

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Hungary for success

Apollo Tyres has opened a state-of-the-art factory on a greenfield site in Hungary. *TTI* got an exclusive tour of a PCR and TBR facility that has huge potential for expansion

by David Shaw

Aerial view of the 72-hectare site. Some 7,000 people were involved in the construction, which took 721 days to finish

Less than an hour's drive east of Budapest, Hungary, the suburbs give way to a rural area that now hosts one of the world's most advanced tire factories.

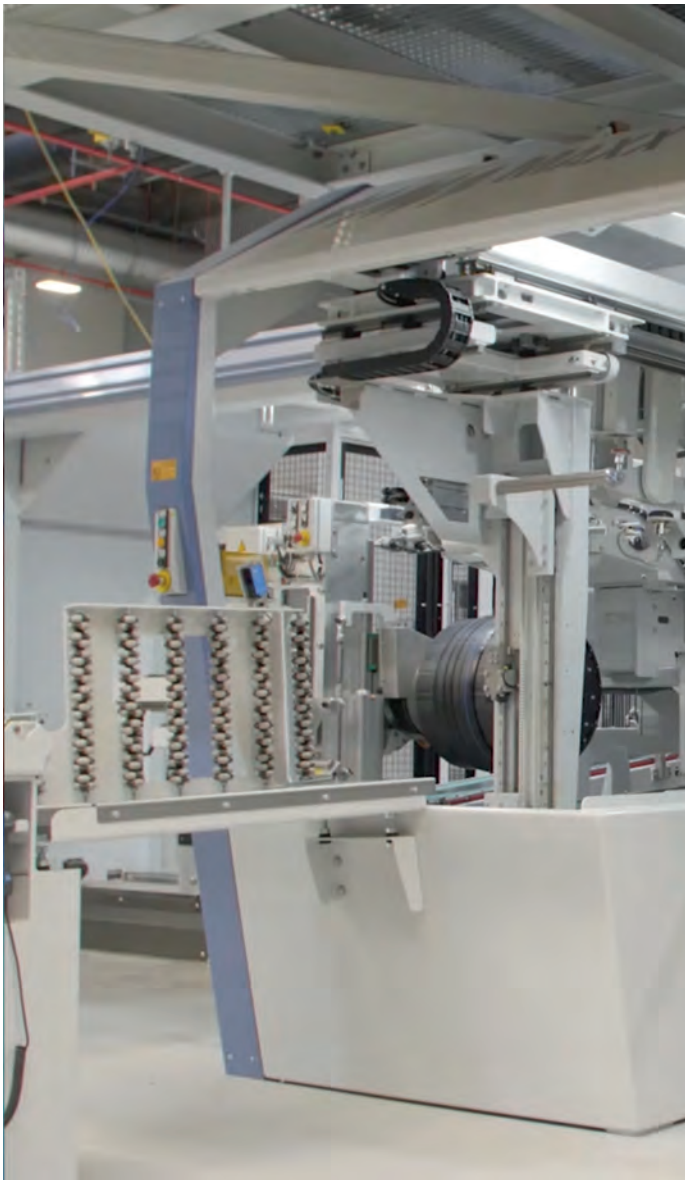
As you approach, there are two things that stand out. Most obvious is the huge sign announcing Apollo Tyres. It's around 8m high and 34m wide.

A closer look, however, reveals that the highest part of the building is not the mixing room, but the raw materials storage area. It's the first clue to the advanced nature of this factory.

According to Markus Kirsten, Apollo's chief manufacturing officer, the basic factory design is modeled on the company's facility in Chennai. The seven years since the Chennai plant opened have seen some important advances in tire manufacturing technology, and Apollo has updated the basic Chennai design to incorporate many of these advances.

The basic Chennai design has a central spine that houses offices and central services, such as mixing, calendering, testing, quality control and materials storage. This spine serves two tire-building wings. One is dedicated to car and light truck tires. The other is designed for truck and bus tire manufacture. Each wing includes extrusion, building, curing and testing. The Hungary unit follows the same pattern.

Many might see this design as a conceptual precursor to the next generation of factories, in which those central services are carried out in volume, to serve a series of smaller, satellite factories, each with relatively limited output.



Above: The Prime Minister of Hungary, Viktor Orbán (center), along with Onkar Kanwar, chairman (right) and Neeraj Kanwar, vice chairman and MD, Apollo Tyres, press the button to officially start production at the facility

Right: VMI Maxx tire building machines are installed at the Hungarian plant

Production ramp-up

For the time, being, however, Apollo is focusing on regional-scale factories. The Chennai factory is currently being expanded to make 12,000 TBR tires per day, up from 6,000. Kirsten says this will make it the largest TBR factory in the world.

Under Kirsten, there is a series of project teams. Much of the original team from Chennai has moved to Hungary to set up, commission and then ramp up production at the new factory. They expect to stay "for another three or four years until production is running smoothly and then there will be another assignment", according to one member, who acted as guide during a factory tour.

It is not hard to imagine that Apollo is planning a new factory somewhere in the world, and that this could become the new assignment mentioned above (see *Future investments*, overleaf).

Meanwhile, a new expansion team has been developed in Chennai to oversee the growth of that factory. It is all-but certain that this team will move to Hungary once this plant is running at a stable, productive pace. They will manage the planned expansion projects.

For the time being, however, Apollo is concentrating on bringing the Hungary plant on stream.

At the official opening, attended by Viktor Orbán, Hungary's prime minister, on April 7, the factory was barely ready. Nevertheless, as Orbán, Apollo chairman Onkar S Kanwar and his son, CEO Neeraj Kanwar, pressed the ceremonial button to begin operations, a VMI Maxx tire building machine sprang to life, and built the first tire at the plant.

OE flagship factory

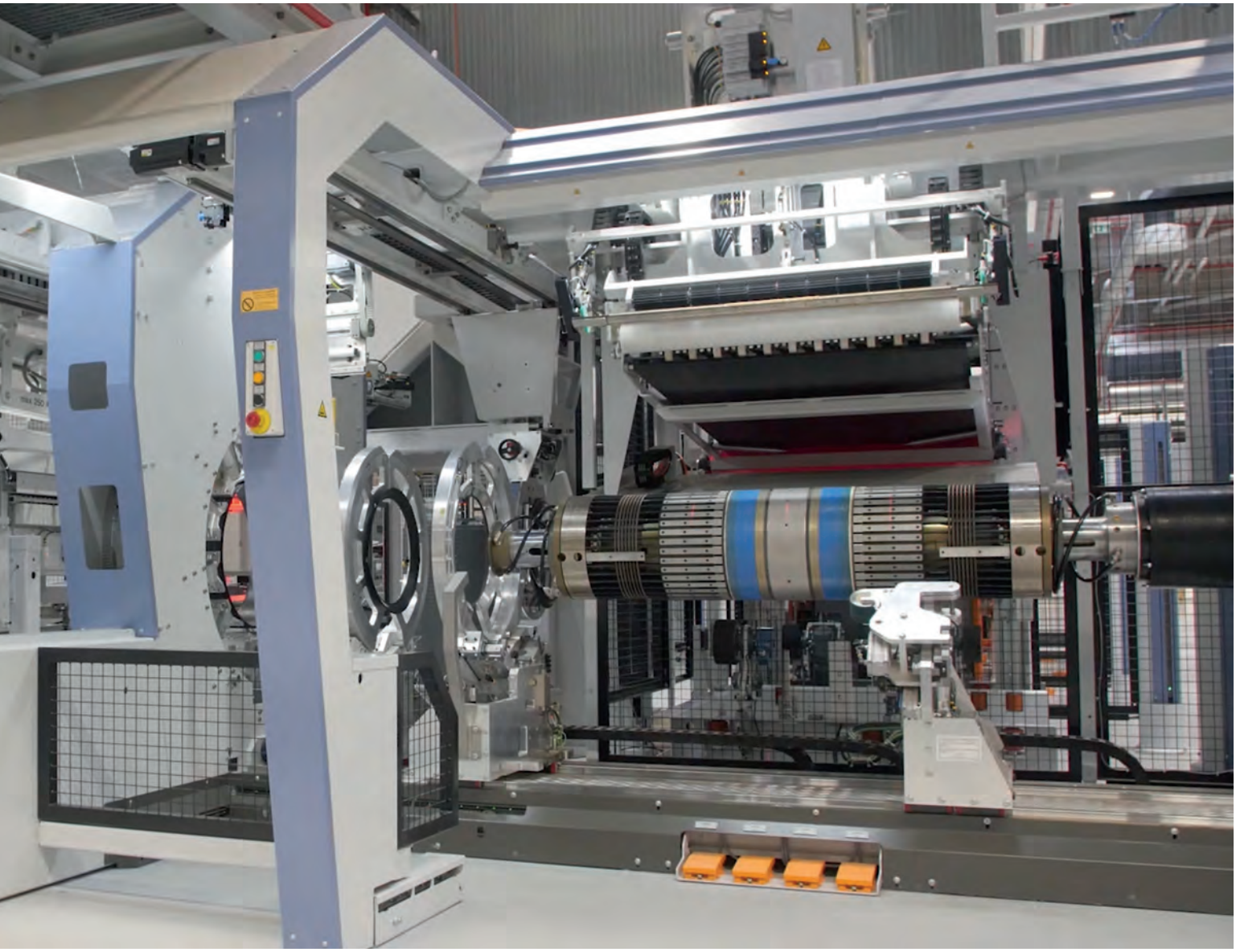
To a tire engineer, the plant is beautiful. It's clean, bright, open and spacious, with a lot of space available for future expansion.

The April opening was for the car tire unit only. The truck tire unit is expected on-stream around the end of the year. Nominal capacity is 5.5 million units/year for high-performance car and light-truck tires. After expansions, this will increase to 11.2 million units, or 32,000 per day.

CEO Kanwar said the Hungary plant will become Apollo's flagship original equipment (OE) factory. According to Matthias Heimann, president of Apollo's European activities, the factory's output over the long term will reflect the global split between OE and replacement. He says, "There is a replacement to OE ratio of at least 3 or 4:1 and that will be reflected in the factory output."

Guided tour

In one of three key innovations in the factory, the raw materials storage area is a multistory warehouse. It is entirely automated, with high-rise picking machines and automated weighing. This



means faster delivery and fewer opportunities for human error. It also means the factory footprint is smaller than it might otherwise be. The company has full track-and-trace systems based on barcodes.

At present, because the mixers are not in operation, the warehouse is almost empty. The mixers will come on-stream over the summer at the latest. Until then, compound is being shipped from the Vredestein factory in Enschede, Netherlands.

Currently, the Hungary plant has five HF mixers, the biggest of which is 440 liters. This number will be increased to eight as the factory expands. Four of the existing mixers are conventional machines; the fifth is a tandem mixer.

A spokesman says that the efficiency at Hungary is around 60kg/man/hour, whereas the Chennai plant, also one of the most modern in the world, produces 50kg/man/hour. The Hungary factory

TRUCK TIRES IN EUROPE

At the recent CV show in Birmingham, UK, Apollo launched a new strategy to sell truck tires in Europe. The company has effectively zero sales today, but aims to absorb the new capacity at the Hungary factory within a few years.

Driving an increase from zero to 675,000, or 5% of the EU market in a few years is going to be challenging. The plan is to use disruptive online sales: instead of selling through agents and wholesalers, the Apollo team aims to sell direct through a website employing transparent pricing.

The first step in that process, according to Marco Paracciani, Apollo's chief retail and marketing officer, was to make a range of tires that offer performance levels between 90% and 110% of the current market leaders. That process has been underway for the last five years. The company has been testing the products among 50 fleets in five different countries in Europe for the last two years and believes that the tires are up to the job.

Now Apollo has launched its website at www.ApolloTyresDirect.com in the UK, Ireland, and the Benelux countries and is selling tires to fleets, wholesalers and others. ■

Above: The Hungarian Prime Minister speaking to an employee inside the facility, in which Apollo has invested €475m (US$534m)

currently employs 500 local workers, most of whom are bused in from the surrounding villages.

This highlights the second key innovation in the factory: it is virtually hands-off. In charge of the factory construction, Apollo's head of projects, Kannan (K P) Prabhakar says, "It is all run by robotics. There is no manual influence at any point in the process."

Calendering and building

The next production step is a single four-bowl calender by Ercole. The machine can handle both steel and fabric. In one of the advances over the Chennai factory, the calendar has an associated extruder. Apollo expects to add two similar machines as the plant expands.

The company is calendering polyester, rayon and nylon fabrics, as well as steel cord. These large webs are then rolled up and carried by automatically guided vehicles (AGV) to the storage area.

Testing also takes place in the central spine, and in the third key innovation, the test machines are integrated with the factory MES system. Results data from the test machines, including RPAs and Mooney viscometers, can be fed backward to modify mixer timings and conditions. This means Apollo can maintain quality and improve compound repeatability, despite changing input characteristics.

This closed-loop control is not yet implemented, but all the sensors, software and equipment are in place. Our tour guide tells us, "This is something totally unique in this factory. We expect to start doing it in the summer."

Moving into the PCR tire building area, the first machine is a quad extruder. The company also runs a quin extruder. During the opening day the quad was running very slowly, at around 7.5m/minute, but at full speed the engineers expect it to run at 38-40m/minute.

At the heart of the PCR factory is a bank of 10 VMI Maxx tire building machines. On the day of the factory tour, seven of these hands-off building machines were already installed. Each machine can produce 620 tires in an eight-hour shift.

If all 10 were all running at full capacity, the factory output would be some 18,500 units/day, or 6.5 million units/year. Apollo says the nominal capacity of the plant is 5.5 million units/year. There is space for more machines for expansions in phases 2 and 3.

The VMI machines are fitted with drums that can produce sizes from 15-24in, but Apollo is initially running them at 16-18in. This is likely to expand up to at least 19in in the next year or so, as the company has won OE contracts in these larger sizes.

Moving into the curing hall, there are three trenches. Each trench comprises two rows of HF presses, one on either side of the trench. Each row is made up of 10 dual-chamber presses (20 chambers) with space for four spare dual-mold cartridges to speed up size changes.

On the day of the tour, only the first trench was complete, and another five dual-chamber presses were being installed in the second trench. The third trench was empty.

Manufacturing portfolio

The Hungary factory is Apollo's sixth factory worldwide and its second in Europe. The company acquired an existing factory in Enschede, Netherlands, when it bought the Vredestein company in 2009. Apollo went through a long process of deciding whether to upgrade the Enschede plant, or build a new greenfield factory, eventually deciding on the Hungary factory.

According to Neeraj Kanwar, "We will move some production from India into this factory. We are also seeing considerable growth, so that the Apollo brand is growing by 15% per year and the Vredestein brand has also grown very successfully over the last three years. This gives us the confidence that both factories will be absolutely viable." **tire**

FUTURE INVESTMENTS

Asked about potential capacity investments, Neeraj Kanwar, CEO of Apollo, confirms that the company is looking at sites for the next factory. The decision appears to be between North America and Southeast Asia. Kanwar says, "I have always maintained that we will look at Thailand for a manufacturing base, but first you must get sufficient volume to have a self-sustaining greenfield investment."

In response to another question, relating to the USA, he adds, "We know that freight is expensive in our business, so we would have to look at setting up a tire factory. This discussion is for five years into the future." The five years will be spent building the right product portfolio, recruiting dealers, and building brand and volume. ■

Data directory

by Paul Ita

According to the latest estimates from Notch Consulting, carbon black will remain the largest volume reinforcing filler in the tire industry through 2025, with 88% of the market

In 2016 the global tire industry purchased nearly 30 million tons of compounding raw materials (excluding steel and textile cords). Rubber retains the largest share of these materials, with usage totaling nearly 16 million tons of natural and synthetic rubber, or 54% of the total.

Behind rubber, reinforcing fillers are the largest volume compounding material, with total demand of 10 million tons, or 34% of the total. Reinforcing fillers include carbon black and precipitated silica.

Aside from rubber and reinforcing fillers, all other materials used in tire manufacturing totaled 3.6 million tons, or 12% of the total. This group includes processing oils, activators such as zinc oxide, antioxidants, accelerators, tackifiers, homogenizers and insoluble sulfur.

Carbon black demand totaled 12.3 million tons in 2015 with a market value of nearly US$12.7bn. Seventy-three percent of carbon black volumes go into tires; another 20% is used in the production of industrial rubber goods such as belts, hoses, gaskets, rollers, roofing and appearance parts; and the remaining 7% goes into specialty (i.e., non-rubber) applications – mainly plastics, inks, paints and coatings. Tire markets for carbon black are roughly divided into 40% passenger car tires; 34% truck and bus tires; and 27% into all other tire types, including large and small OTR, agricultural, aircraft and industrial, as well as retreading.

Carbon black is the largest volume reinforcing filler used in the tire industry, with global volumes of 9.2 million tons in 2016. However, carbon black continues to face functional competition from filler systems based on highly dispersible precipitated silica combined with silane coupling agents, which are increasingly being used in tire tread compounds to reduce rolling resistance and improve fuel economy. The use of silica/silane filler systems is concentrated in passenger car and light truck tires, particularly in the HP/UHP, winter and low rolling resistance segments.

Table 1: Tire industry reinforcing filler demand (thousand ton)

	2016	2025	AGR
Total	10,080	14,075	3.8%
Carbon black	9,185	12,400	3.4%
Precipitated silica	895	1,675	7.2%

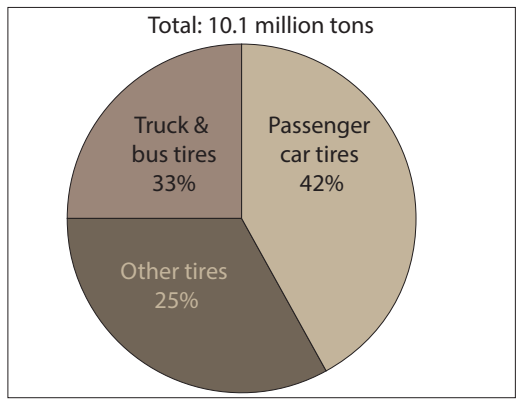


Figure 1: Reinforcing filler demand by tire type, 2016

From a negligible base, silica is also making new inroads into heavy truck tire treads, as silica suppliers address compatibility and processing issues between silica and natural rubber. As a result of these new applications, demand for precipitated silica is growing at roughly double the annual rate of carbon black in tire markets.

While the threat from silica is real, it is important to keep in mind that most of the functional competition from silica is for passenger car tire treads, which represent only about 15% of carbon black usage in tire markets, according to Notch estimates. As such, carbon black will remain the largest volume reinforcing filler in the tire industry through 2025, holding 88% of a 14 million ton market.

Carbon black holds unchallenged dominance in non-tread passenger and light truck tire applications and all segments of the heavy truck and other tire segments (OTR, agricultural, aircraft, etc). Carbon black suppliers have responded to the threat from silica by introducing new grades of carbon black that offer lower rolling resistance with no loss in tread wear, which allows compounders to avoid the substantial costs associated with switching from carbon black to silica mixing. **tire**

Contact

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Release agents

During the production phase, tire quality must not be affected by process aids or indirect materials and instead can be enhanced thanks to new mold release agents

In the tire industry, both commercial and private customers demand the same extremely high levels of quality as stipulated by testing institutes and regulatory bodies. Meanwhile tire manufacturers and supply chain members compete for business worldwide – and it is only the companies that offer innovative products at a competitive price that will prevail.

Advanced production machinery and good-quality raw materials are no longer sufficient to achieve this level of quality and innovation. The entire production process must run efficiently and compromises on quality are not permitted. Process aids and indirect materials must be maintained and must not affect the final product.

Release agents and coatings are increasing in importance as crucial auxiliary materials. Although invisible, these technologies have a great impact on the end product and play a key role in achieving a highly efficient production process.

Since its was founded in 1948, Münch Chemie International, with its headquarters in Weinheim, Germany, has specialized in the development of release agents and process aid solutions for various industries. In the tire industry in particular it has worked hard to develop and improve its solutions.

With a high level of flexibility, quick development turnaround times and a range of customized solutions, Münch Chemie has established itself as a market leader in the field of release agents and has achieved a 35% increase in sales over the past five years. Thanks to its dedicated R&D team, an international sales network and licensed production facilities in Asia and South America, the company's products are well known and have received positive feedback from customers worldwide.

Münch Chemie offers an extensive range of innovative and high-quality solutions for use in several areas of tire manufacturing. They include semi-permanent release agents for press molds, inside and outside lubes, bladder coatings, lubricants for tire fitting and tire paints. In addition to its tried and tested standard products, Münch Chemie also offers customized solutions.

Release agents are an indispensable part of many modern production processes. As an auxiliary material, the value of these products is often underestimated. At one time release agents were merely a necessary measure to prevent mold sticking, but today they increase productivity, accelerate the entire production process, ensure product quality and increase the service life of machinery.

Above: TP-15 tire tread marking paints are available in a variety of colors

Münch Chemie works to continually develop innovative solutions. The company offers high-performance mold release agents containing polymers that create an extremely smooth and homogeneous film surface, considerably reducing friction between the mold and the tire surface.

The company also offers a semi-permanent, water-based mold release agent, MK-529/11, that is ready to use. Thanks to the optimized composition of the active ingredients, MK-529/11 creates an extremely stable, long-lasting film with excellent release properties. The product is ideally suited for application in molds containing spring vents as the bridging and blocking of vents is effectively prevented. For efficient, easy demolding of cured tires, MK-529/11 ensures that the quality of the end product remains intact.

In addition, Münch Chemie offers a permanent water-based mold coating that increases manufacturing productivity. It enables quicker cycles, longer mold service life, and makes possible several thousand demoldings.

In order to reduce the friction between the curing bladder and the green tire, and ensure a smooth curing process, Münch Chemie has developed a comprehensive range of high-performance bladder coatings and inside tire lubes. They can be applied either on the surface of the curing bladder or on the inside of the uncured tire, and can be either sprayed on, brushed or applied using a sponge or cloth.

The water-based products – available either as conventional (Inside Lube IPM-444/10 black special) or semi-permanent (Bladder Coating BC-5140; Inside Lube IP-1612) solutions – are suitable for the production of all types of tires.

Using just one inside lube or bladder coating in tire production removes the need for any further lubrication aids. Specially selected additives used in the formulation greatly reduce friction between the bladder and the green tire, ensuring the quality of the final product.

To reduce tire defects and increase the operating life of the bladder, Münch Chemie offers a permanent solvent-based coating for curing bladders. Application of the technology saves

Above: High-quality release agents can ensure that complex tread patterns release cleanly from the mold

Left: Münch Chemie has developed a range of bladder coatings and inside tire lubes to reduce the friction between the green tire and the curing bladder

time and costs, as the need for any other lubricants or release agents has been eliminated. The product remains on the surface of the curing bladder throughout its entire operating life of more than 300 cycles. A prototype solution is currently being tested by the company and has shown remarkable results.

In addition, Münch Chemie has extended its portfolio with innovative and environmentally friendly tire tread marking paints that can be applied to the tire tread immediately after extrusion. The TP-15 water-based marking paints are free of solvents, which means they are particularly environmentally friendly.

The viscosity of the tire marking paints has been specially fine-tuned to ensure ease of application via typical processes. The paints also offer an extremely quick drying time and color radiance. The intensity of the paint stays unchanged for months and residues on the mold surface are kept to a minimum. TP-15 tread marking paints are available in a variety of colors, including white, yellow, green, orange, pink, violet, blue, red, brown, lime green and gray. **tire**

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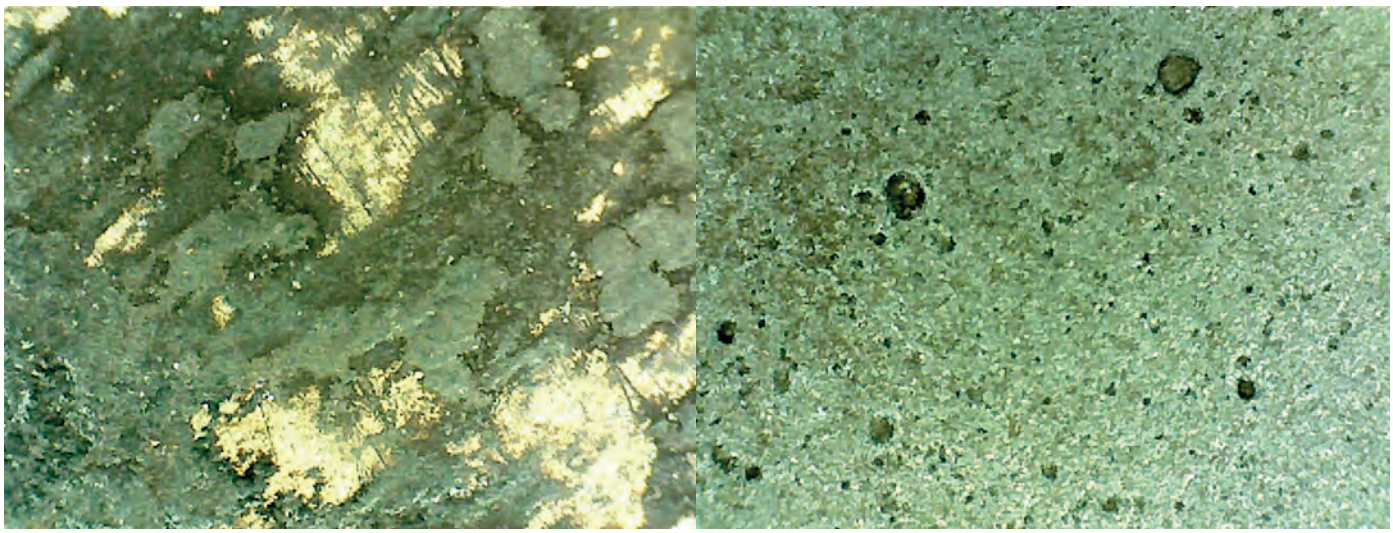
To learn more about Münch Chemie, visit: www.ukimediaevents.com/info/ttm

Mold cleaning

A groundbreaking new tire mold cleaning method that uses bicarbonate offers a more environmentally friendly, cost-effective alternative to current techniques



Cleaning tire molds can be a particularly challenging task. The manufacturing process exposes the tire to high pressures and temperatures, meanwhile patterns are becoming increasingly complex and the quality of the molding surface even more crucial for the final result.

The chosen method of mold maintenance can have a considerable impact on tire production. There are several different cleaning solutions currently available on the market, including sand blasting, dry ice blasting, use of lasers, alkaline spray and ultrasonic mold cleaning. These technologies have both their advantages and disadvantages.

Since its establishment in 1945, Rostan Tiremolds has been a technology-driven company. The Turin, Italy-based company specializes in fully engraved tire molds, and as an innovator in an industry it helped to build, is continuously looking for ways to improve its technology.

As the purchasing budgets of tire manufacturers become smaller, efficiency gains achieved through mold maintenance become much more important. In addition to that, emissions and waste reduction are extremely important considerations, too.

Combining its passion and know-how in tire mold manufacturing, Rostan has established a new partnership with Bicarjet, a surface cleaning specialist, based in Padova, Italy. The two companies aim to deliver radical innovations in mold management and together have developed a revolutionary cleaning technology designed to help tire manufacturers to gain a competitive edge and become more environmentally friendly.

This groundbreaking system is produced by Bicarjet, which also developed and patented the SobiJet machines. This technology uses a mixture of low-pressure compressed air, water and bicarbonate to deliver extremely high-quality, efficient surface cleaning. After an initial demonstration of the technology, Pier Giorgio Santo, business development manager for Rostan Tiremolds, and Ivan Girardi, director of Bicarjet, immediately saw great potential in a partnership.

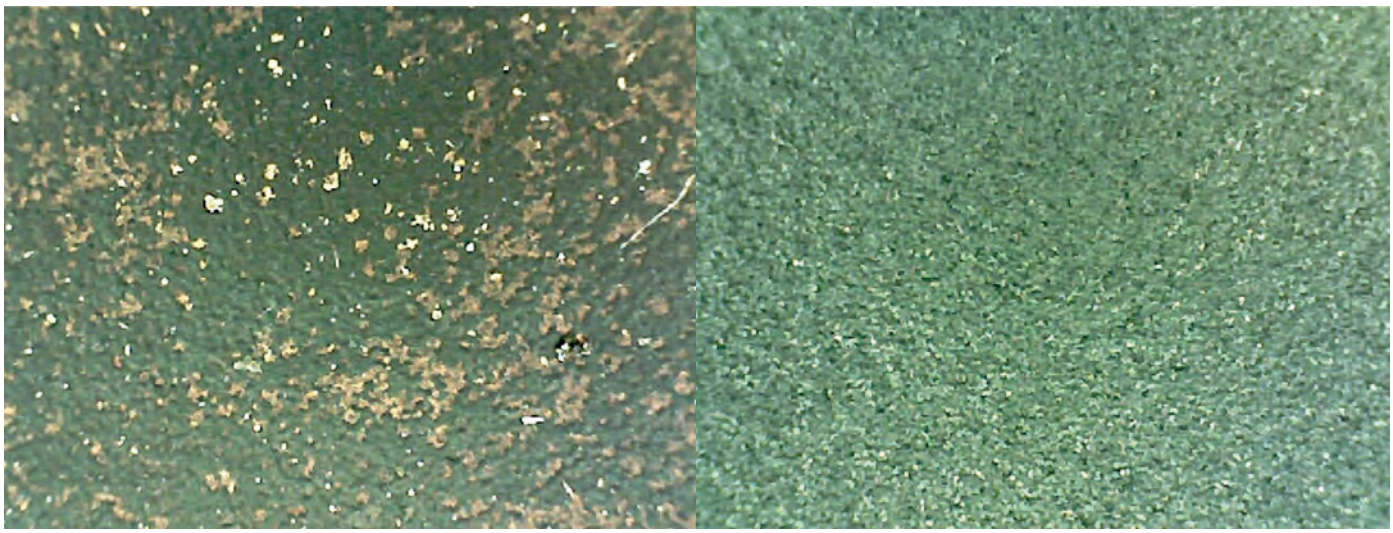
The two companies put their knowledge to the challenge and worked closely together to fine-tune the product. After almost two years of development, the new version of SobiJet, designed for high-quality tire mold maintenance, was created.

The initial focus was to tackle the out-of-press maintenance of tire molds. Often the pieces are exposed to very aggressive cleaning techniques in this phase. Sand blasting, heating (to clean away surface treatments) and other techniques wear out the mold – more so than the curing cycles.

Top: Mold flank before (left) and after (right) bicarbonate cleaning

Above: SobiJet manual cleaning unit

Rostan and Bicarjet's new technology provides a very effective surface treatment that preserves the mechanical parts. This is particularly important as curing residuals and rust may form on the flanks or the back of the segments of a mold. Usually these parts are ignored in order to prevent damage, however



they can be cleaned using bicarbonate without any issues. A study conducted at the University of Trento on a range of metals used in the production of molds showed that the cleaning process does not affect the surface, it only eliminates the curing residuals.

The newly developed cleaning process also protects the spring vents. Tests have shown that the number of vents that could not be unblocked during maintenance, and thus have to be replaced, is reduced by almost 90% compared with traditional cleaning systems.

In addition, many high-performance tires are made with tacky compounds. For production of these tires, the molds are often coated with Teflon-based products that required a specific treatment to be removed and renovated. The SobiJet machine can clean these treatments off in seconds at room temperature.

The basic cleaning principle behind the system is to spray bicarbonate powder with water at low pressure (3-6 bar) on the surface. This can be administered either using a manual unit or via an automated system. Manual machines are a valuable option, enabling high-quality cleaning at minimum cost. They can be installed quickly and easily in existing mold maintenance workshops and do not take up too much production space. This was a key focus during development of the new system in order to ensure ease of introduction in an industrial setting. Rostan and Bicarjet have successfully been able to realize this vision. The manual SobiJet unit clearly demonstrates that the best solutions do not always have to be complicated.

Top: Molding surface before (left) and after (right) cleaning

Above: Rostan's headquarters in Turin

Furthermore, bicarbonate mold cleaning is extremely environmentally friendly. It ensures minimal pollution, while ensuring a thorough clean process. It is also effective in treating the most intricate parts of the tire mold, which means the mold can be reused again for the next batch, quickly, safely and sustainably.

This technological innovation has been applied successfully in several other fields. On one hand, this means that customers are able to take advantage of an existing sales network worldwide. On the other hand, as stated by Bicarjet's Girardi, valuable experience and know-how gained through application of the SobiJet system in other industries can now be applied in the tire mold sector. In a number of examples, this technology has proved not only effective in surface cleaning, but also in prolonging the time a mold can stay in the press after maintenance, beyond expectations.

Customer feedback from other industries clearly highlights the benefits of the technology, now made possible in the tire industry with the new SobiJet machine. The system improves manufacturing processes and reduces the environmental impact of operations. Experts at Rostan have expressed their excitement to see the results of extensive application of this cleaning system in the tire industry. **tire**

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Rolling resistance focus

Novel reinforcement solutions will remain a core component in new, lighter tire designs – helping to reduce rolling resistance and enabling the auto industry to meet future vehicle emissions targets

There are many research studies and projects underway aimed at reducing the rolling resistance of tires, but only a few of them focus centrally on novel reinforcement solutions. In terms of CO_2 emissions in the mid and long term, taking a global perspective will help us to understand the future challenges in the development of tire reinforcement.

Compounds are a central component of rolling resistance reduction. At first, it appears that reinforcement materials do not impact upon rolling resistance to the same extent that compounds do. However, if compound and reinforcement materials are considered as a composite, then reinforcement materials become an extremely crucial factor. This is due to the fact that using thinner reinforcement cords reduces the amount of the compounds required.

Another novel solution to reduce rolling resistance is to eliminate compounds entirely or apply the reinforcement without any compounds. Kordsa's continuous R&D efforts focus on reduction and elimination of compounds in tires.

The EU target of reducing fleet average CO_2 emissions to 95g/km by 2020 presents challenges for both automotive OEMs and tire makers. Even though today's average fleet emission levels do not look promising to achieve this target by 2020, EU authorities have even discussed an aim to reduce emissions down to 70g/km by 2025.

To reduce emissions – or even better, eliminate them – there are several problems that have to be solved. Table 1 shows the two potential targets and a road map to achieve them. As regulations become stricter than ever, ways to achieve them are becoming more difficult to find. Total elimination of CO_2 emissions is the ideal solution, however currently electric vehicles are the only viable option for doing so.

EVs are not new and many improvements to the technology have already been made by the industry. For example, vehicle range has increased greatly compared with five years ago and battery packs are 65% cheaper. Nevertheless, EVs still have a low penetration in the automotive industry – less than 1%.

It takes several decades for any new technology to achieve market acceptance in the automotive industry. Looking back through history, automatic transmissions, the airbag, navigation systems and hybrid vehicles have had deployment times of between 15 and 50 years. Regulations have become a driving force in accelerating the deployment of EVs. As authorities continue to implement new and more stringent standards, car manufacturers have increased the amount of research and development that is focused on the introduction of electric vehicles.

According to analysts, investment in electrical engines is a much more economic option to achieve future emissions levels of 70g/km by 2025, compared with investment in conventional engines. In fact, many major OEMs have already switched the focus of future R&D from internal combustion engines to EVs. A recent study conducted by KPMG confirms that the rate of introduction of EVs has greatly increased over the past five years.

In future, rolling resistance will therefore remain a central focus for tire and automotive companies. Shared mobility will reduce the total cost of mileage of EVs; however, energy losses must still be greatly reduced.

Tires are claimed to be the industry's easy target for improving vehicle fuel efficiency and reducing emissions – rather than the development of other components.

Tire companies have collaborated on the reduction of rolling resistance for many years now and have achieved considerable improvements in end-products with the help of raw materials innovations and intelligent tire design. Rolling resistance had been considered an area of compromise in favor of other essential performance parameters, including wet grip and mileage.

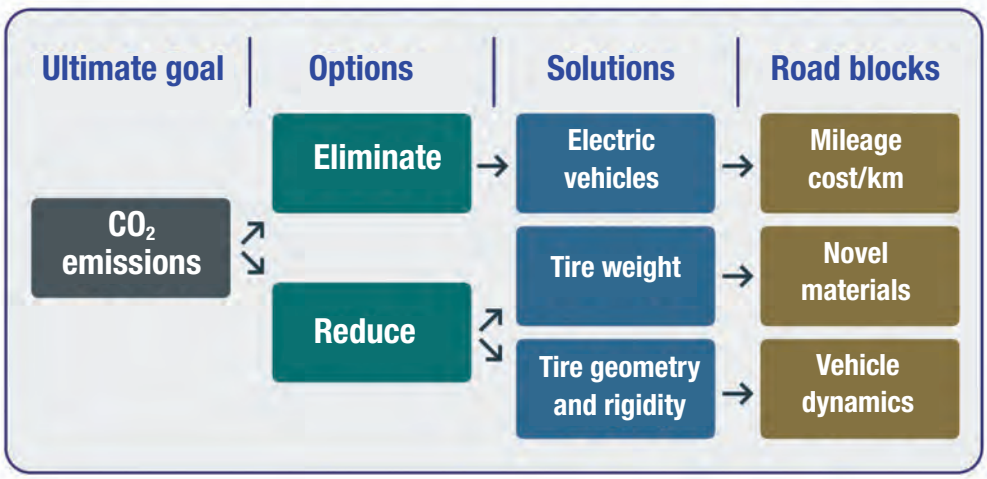
Tests conducted by OEMs of tall and narrow tires, compared with traditional tires, have shown a quantum leap in the reduction of rolling resistance – by around 15% – with good results in other performance parameters.

However, rolling resistance also has an impact on vehicle dynamics. Here, vehicle design plays an important role to ensure it does not have a negative impact – therefore it is predicted that the introduction of tall and narrow tires will not be fast.

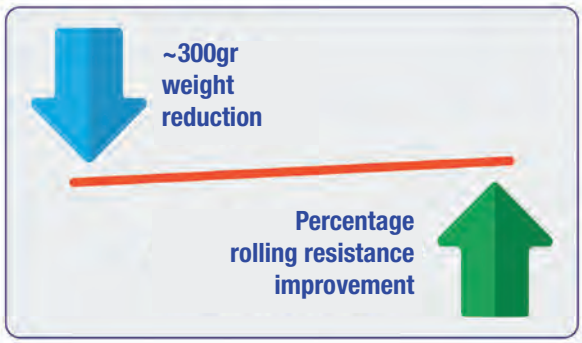
It is expected that most of the automotive OEMs will not meet the EU emissions target by 2020. This indicates that manufacturers will be looking for new and emerging solutions to decrease their fleet-average CO_2 emissions.

As already noted, investment in conventional powertrains may not be a desired option. Therefore, improvement of the rolling resistance of tires for ICE cars will be a crucial solution to meet these targets.

A reduction in tire weight will prevent hysteresis losses directly or indirectly. The hysteresis of a rubber compound is the controlling factor for rolling



Below: Various methods are being adopted by the auto and tire industries to meet future EU emissions targets



Above: The relationship between weight reduction and rolling resistance improvement when using Kordsa's Capmax

resistance, therefore a reduction in the rubber compound required is essential. Here, the focus has been on the tire tread. Rubber compound is also applied to cover the reinforcement materials in the tire. Rubberized components include the carcass, cap-ply, steel belts and bead.

It is possible to reduce the amount of compound by applying higher modulus NY66 cords in the cap-ply and higher tenacity PET cords in the carcass. Advanced NY66 cord designs, produced by twisting heavy dtex single yarns, are enabling ultra-high levels of performance. This advanced cord design results in 20% less cord gauge and a 35% higher modulus that enables a huge reduction in the compounds compared with regular NY66 1400/2 cord constructions.

Ready-to-use cap-ply materials, such as Capmax from Kordsa, can also be used to eliminate compounds used in reinforcement. Thanks to the application of this innovative cap-ply material, a reduction of up to ~300g in tire weight can be achieved. Since there is no compound to lead hysteresis, a positive effect is observed in the form of a ~4% reduction in rolling resistance. Depending on the test, tires with Capmax perform the same as tires with conventional rubberized cap-ply.

Pioneering new reinforcement materials – such as Kordsa's Capmax – are leading the way to help reduce rolling resistance and will continue to play a central role in the development of tires for future vehicles. **tire**

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Improved processes

High-performance tire mold release agents and demolding solutions ensure efficiency and quality in production as well as reduced defects

Continually increasing regulatory requirements and high customer expectations are putting tire makers under pressure, but high-grade release agents can help to reduce costs, improve processing efficiency in manufacturing and optimize the properties of the final product. This applies to both the tire's appearance and prevention of defects.

Chem-Trend has worked with OEMs for decades and understands their production requirements clearly. To meet new demands and comply with the latest legislation, Chem-Trend has at its disposal a range of R&D tools, including laboratory equipment and state-of-the-art software.

Chem-Trend's experts are familiar with every detail of the curing process, thanks to profound R&D and a tradition of working closely with customers on the production floor. Its aim is always to help customers to achieve highly efficient production alongside optimized product quality.

"In the manufacturing of tires, achieving optimum production efficiency and reducing operating costs is extremely important – and ensures the highest product quality," says Doug Butcher, business development director for the tire industry at Chem-Trend. "Today OEMs cannot afford to produce tires with defects. Our release agents and processing auxiliaries help minimize waste and faults."

Modern tire designs can create challenges in the curing process. When a tire arrives at the curing stage, around 90% of the working capital has already been invested. High-performance inside tire paints help to ensure this critical process step runs smoothly and that high-quality tires are produced.

There are several important factors to consider during vulcanization. First, the green tire must be centrally secured during the vulcanization process. Prevention of trapped air between the green tire and the bladder is also critical as well as ventilation between the tire and the mold. Prevention of soiling in the tire mold is also important. Furthermore downtime on the heating press must be kept to a minimum. Finally, the demolding process must be closely monitored, especially for tires with complicated tread patterns and sticky tread mixtures.

Chem-Trend's bladder coatings protect the bladders from chemical and abrasive attack during use. This improves bladder service life and reduces waste. The coatings, which have been developed as a single-use product, are applied to a new bladder before it is installed in the vulcanization press. This coating does not need to be reapplied for the entire service life of the bladder. Alongside the Chem-Trend inside tire paint, these coatings improve the performance of the vulcanizing bladder, reduce costs as a result of the extended service life and help to reduce waste. During the curing process, the focus is on both the optimization of the slip properties of the green tire on the bladder, to reduce defects related to vulcanization, and protection from chemical influences and mechanical wear during use. Chem-Trend can also offer a comprehensive range of release agents for the tire vulcanization process.

Above: Coatings from Chem-Trend improve the performance of the bladder and mold release **(bottom)**

Below: Chem-Trend's global headquarters in Michigan has just undergone an expansion, increasing the R&D laboratory space by 50%, including an all-new expanded tire product development laboratory

The company's solutions ensure problem-free release of the tire from the bladder and demolding of tires. Furthermore, Chem-Trend's inside and outside tire paints improve ventilation, the flow of rubber and the appearance of the finished tire. Users benefit in multiple ways, particularly from the prevention of rapid mold fouling, quick drying times, and clean handling.

Beyond the development of products for use in the production of tires, the company has also developed solutions that contribute to improving process efficiency in tire retreading – in particular when demolding prevulcanized tire surfaces and coating vulcanizing envelopes.

Chem-Trend's complete product range comprises a number of inside and outside tire paints, bladder coatings and mold release agents. It can also offer also specially formulated solutions, helping tire manufacturers overcome the specific demands of each production process for new tire lines. **tire**

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Additional bladder sizes

Experts at Continental have used finite element modeling techniques to design a curing bladder profile that ensures trouble-free molding and stripping in ultra-high-performance tire production

Continental has developed a new curing bladder line to meet the requirements of today's ultra-high-performance tire segment.

This new line incorporates the latest technology in bladder contour, compound and surface treatment to provide a product that is designed specifically to fit the low-profile shape of ultra-high-performance tires.

Bladders are available to fit the complete spectrum of ultra-high-performance tire sizes, and can be ordered to fit all common press types.

The Continental bladder design group has used state-of-the-art FEM techniques to create a curing bladder profile that is optimized to match the relatively square shoulder contour of an ultra-high-performance tire. This minimizes the problem of air trapped between the tire and the curing bladder during the initial shaping of the tire in the curing press.

To further eliminate air trapped between the tire and curing bladder, the latest surface treatments have been used. The advanced pebble design used on the surface channels the air from between the tire and the curing bladder, while producing a pattern on the inside of the finished tire that does not interfere with the inspection of the tire after curing. In addition, this advanced pebble design also maximizes the retained inner liner gauge in the finished tire for the ultimate in performance and durability.

With a wide range of dimensions available, these bladders are designed to fit all press types and also come in a selection of clamping diameters to fit the tooling design criteria.

Calculations used for the fitment of the curing bladder to the tire sizes vary from company to company. Continental offers a specially developed curing bladder fitment tool that can be accessed online. By using the Bladder APP tool on the company's website, users can determine which bladder best fits the application. Online catalogs are also available online in English. Users can also order a DVD or watch a video about bladder design and manufacture.

Above: Conti's new bladder line is designed to fit the low-profile shape of UHP tires

Earlier in 2017 Continental was awarded Tire Manufacturer of the Year at the Tire Technology International Awards, having won twice previously. This has provided motivation for the team to further develop and improve its bladder technology. **tire**

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Modernization benefit

Installed in older tire building machines, a laser positioning system can enhance accuracy and ensures the quality of the tire remains high, eliminating the need for costly investment in newer TBMs

In order to meet increasingly demanding tire manufacturing requirements, many operators of older tire building machines are faced with the task of updating their systems. Instead of replacing an existing unit, tire quality can be improved by integrating a laser positioning system.

The requirements for modern tires are becoming more specific. Not only does the tire have to provide the desired safety and performance characteristics, but automotive OEMs also now require vehicle-specific tires. Meanwhile, tire building machines are designed to be robust with an operating life of over 30 years, which means that although older systems can keep producing tires for many years, they may only meet current requirements to a limited extent. Therefore, it becomes necessary to modernize and upgrade these machines with new equipment.

An integral component of the modernization model may be a positioning system, for accurately positioning the individual rubber layers of the tire. While modern tire building machines position the layers automatically, tire construction is typically carried out manually on many older machines or when a special line is being produced. Here, positioning of the layers becomes a particular challenge.

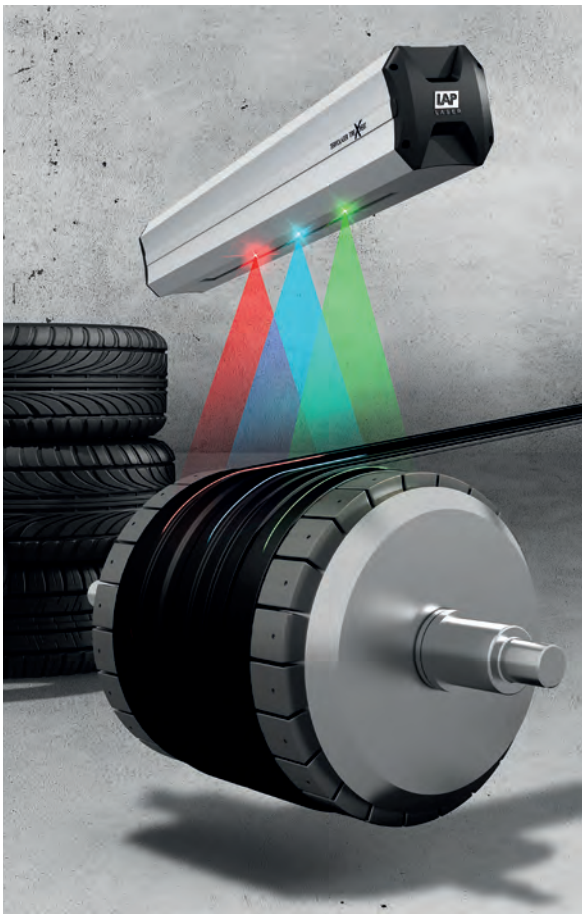
The Servolaser Xpert projects lines onto the drum, enabling precise positioning of individual layers. The lines can be adapted for each new position and projection precision is within a distance of 1m (±0.18mm).

Another advantage of the laser positioning system is its wide range of possible variations in configuration. Machine operators can configure the system according to their machine, regardless of the type of tire being manufactured, whether that is PCR, TBR or OTR tires. Seven different moving ranges from 600-2,600mm are available for this purpose. Thanks to the many possible configurations, complex conversion work on the machine is not required – instead the Servolaser Xpert is adapted to the machine.

Customers can choose whether the lines are to be moved symmetrically to each other or independently of each other. In addition, the colors of the projected lines (red, green and blue) can be freely selected and combined. All lines are projected using a diode laser, which has a long service life of over 30,000 hours.

Thanks to the many communication protocols that are available on the market such as Ethernet/IP, Profibus/ Profinet and Modbus, Servolaser Xpert can easily be integrated into the existing machine controls. Only the mechanical mounting points of the positioning system are specified. This is necessary in order to maintain projection precision. The laser can be positioned precisely via the machine controls.

In addition, temperature fluctuations, vibration and the choice of mounting points can influence the precision of the projection – these influential factors were taken into consideration when developing the Servolaser Xpert. Thanks to the materials selected and the geometry of the system, it is particularly resistant to deformation and impervious to temperature fluctuations.



Above left: Machine operators can configure the system according to their machine

Right: By projecting lines onto the drum, the Servolaser Xpert system enables precise positioning of individual layers in tire production

Furthermore, the system is not affected by vibrations thanks to its extremely robust packaging.

The Servolaser Xpert system is currently installed at many tire manufacturing facilities worldwide in various machines. Customers have reported positive feedback on its performance. The application possibilities could be further extended – even if the tire building machine has a high degree of automation, the positioning system can also provide important assistance to visual quality control. This makes Servolaser Xpert a valuable investment not only for the modernization of older machines, but also for usage in new machines. **tire**

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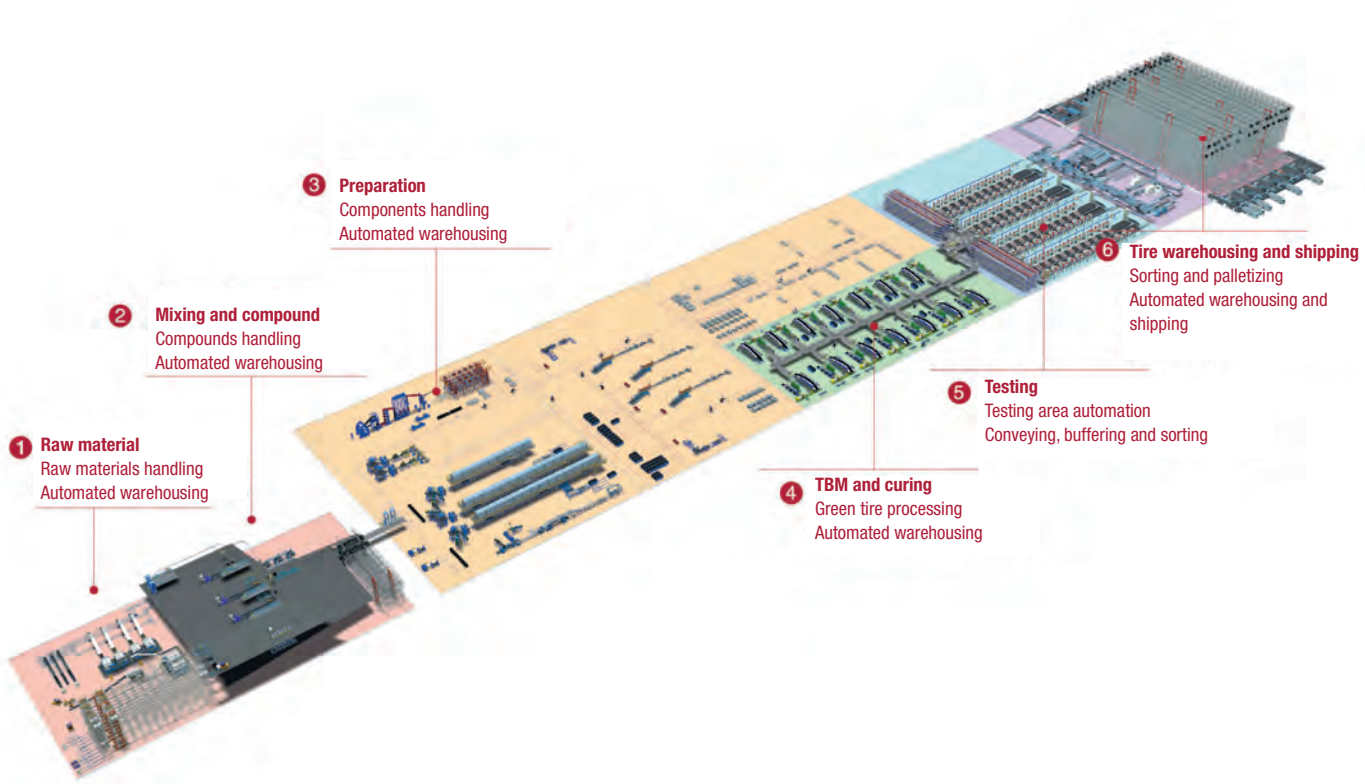
Automated production

Material and data flow can be optimized from raw material storage through to finished tire loading thanks to an intelligent smart factory concept solution



As the development of high-performance and environmentally friendly tires becomes a primary focus in the tire industry, high-end intelligent equipment and logistics solutions have become more important to guarantee reliable automated manufacturing. Manufacturing automation is required not only for cost reductions, but also to improve quality and reliability of the tire production process.

The intelligent equipment and system division at Mesnac has refined its expertise not only as a manufacturer but also as a system integrator, in order to provide high-quality solutions to challenges faced by customers across the tire industry. At present, the company is able to provide integrated logistics system solutions from technical consulting, project planning, equipment D&R, processing and manufacturing through to project implementation.

To date, it has completed various projects for tire manufacturers in the development of automated handling systems, ASRS solutions and smart factory development. Mesnac's smart factory solution is provided with the following features.

First is an integrated automation management of the whole plant. The system adopts advanced handling equipment and techniques to realize automatic store and retrieval and unmanned handling, to greatly improve production efficiency and reduce labor.

There's also data monitoring and tracing throughout the whole process. Based on material flow information management, the system can automatically collect data throughout the production process to ensure raw materials through to finished products can be traced.

Finally, the smart factory has an intelligent decision-making platform. The system automatically collects production data in real time. It uses big data and cloud computing techniques to delve deeper into production data and provide accurate data support for each level of management decision-making of an enterprise.

An automated logistics solution can increase factory throughput and lower production costs

Through these solutions, customers can reduce investment, improve the utilization of space and the area, and dispatch the specified materials timely, correctly and efficiently to the required position in accordance with process requirements. The system can automatically acquire data identification and information to confirm who, where, when, which and how of the target products have been produced and therefore provide a database for intelligent management to automate manufacturing processes.

Mesnac has successfully implemented an automatic manufacturing system for a tire plant located in Hefei, China, and all handling solutions have now been in action for more than half a year. **tire**

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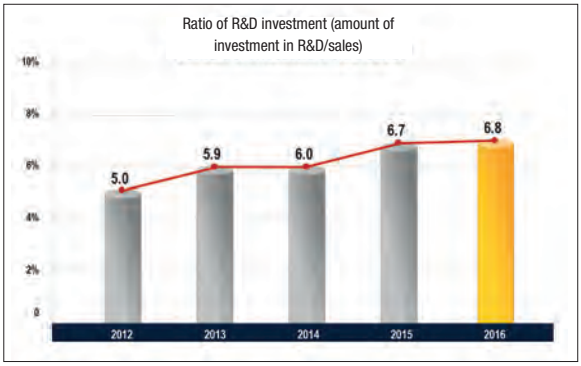
Production tools

Automation remains a key requisite in tire manufacturing and inspection, and has underpinned the development of a range of innovative measurement and control devices



Afache is helping to take cutting-edge manufacturing technology to the next level. In the future, the industry will depend largely on automation. Afache is at the vanguard of automated system solutions, which it believes are among the best in the world. The company strives to become the world's leading supplier in this area and has developed a range of factory automation, control devices and measurement systems.

Afache's extensive R&D is driven by a need for uncompromising quality and high-level engineering in its products. It has three R&D centers in South Korea, where the company invests over 6% of its turnover each year; its R&D expenditure in 2015 for example, was US$3.7m. The company's main R&D center in Daejeon has secured 27 patents – both domestic and overseas. Many of its technology solutions are top sellers in the global market.

"We have been developing new technology based on industrial trends, not only by improving our existing technology, but also by participating in tire industry exhibitions in Germany, China and India every year," says CEO Jongmoon Park.

The company's target is to build systems for a complete smart factory – a concept integral to Industry 4.0, which involves automation and data exchange in manufacturing technologies. It also includes the Internet of Things (IoT). Afache has been a specialist in automation engineering for over 20 years, successfully developing IoT software and hardware elements that it says can make a remarkable difference to the tire-making process.

The company's auto laser marker and 3D measurement system, which was developed in 2014, was one of the first tire manufacturing automation technologies in Korea. This unique tool can be controlled remotely and wirelessly.

Through continuous research and investment in its 3D vision technology, Afache has also developed what are claimed to be the world's first sheet-of-laser measurement method, JLB (cap-ply) cord counter and portable EPI measurement unit for the tire industry.

The JLB (cap-ply) cord counter is designed to measure the number of textile cords inside the tire belt using a 3D camera system in real time. This system is also said to have been the first of its kind worldwide. Major competitors' products measure the belts using x-ray off-line.

Left: Afache's portable EPI measurement system

Above: Ratio of R&D investment (amount of investment in R&D/sales)

Bottom left: JLB (cap-ply) tension controller

Bottom right: JLB cord counter

In addition, the device is said to be more compact than other brands, which means it needs less installation space. Results are precisely displayed on a screen and saved automatically for using the data in quality maintenance of cap-ply. The system is simple to install and easy to maintain, which reduces costs.

Afache's portable EPI measurement system can be used in the calendering process for measuring the number of textile cords per inch in fabric prior to calendering and is designed to be easily held by the user. This unique system was showcased at Tire Technology Expo 2017 in Hannover in February.

The JLB tension controller is a standalone system that applies jointless belt material to the drum, maintaining constant tension in the tire building process. Results are clearly displayed on a screen and the data is automatically saved. The system is compact and easy to set up. It provides a low-tension control tolerance ±200gf and enables users to control the belt's tension by changing target sections (maximum of 10) at a time.

From mixing through to the final quality inspection process, Afache provides customized solutions for use across the tire production line. The company's portfolio also includes an online profiler, off-line profiler, 3D run-out measurement system (standalone), splice checker, ultrasonic cutter, web guiding system and auto laser marker. **tire**

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Chemical weighing

A revolutionary fully automatic small chemical dosage system ensures quality and repeatability in tire mixing and eliminates the potential for human error

Color Service and Pelmar Engineering have designed and built an innovative and reliable system that guarantees 24/7 repeatability, traceability and accuracy in the dosing process for small chemicals in tire and rubber compounding.

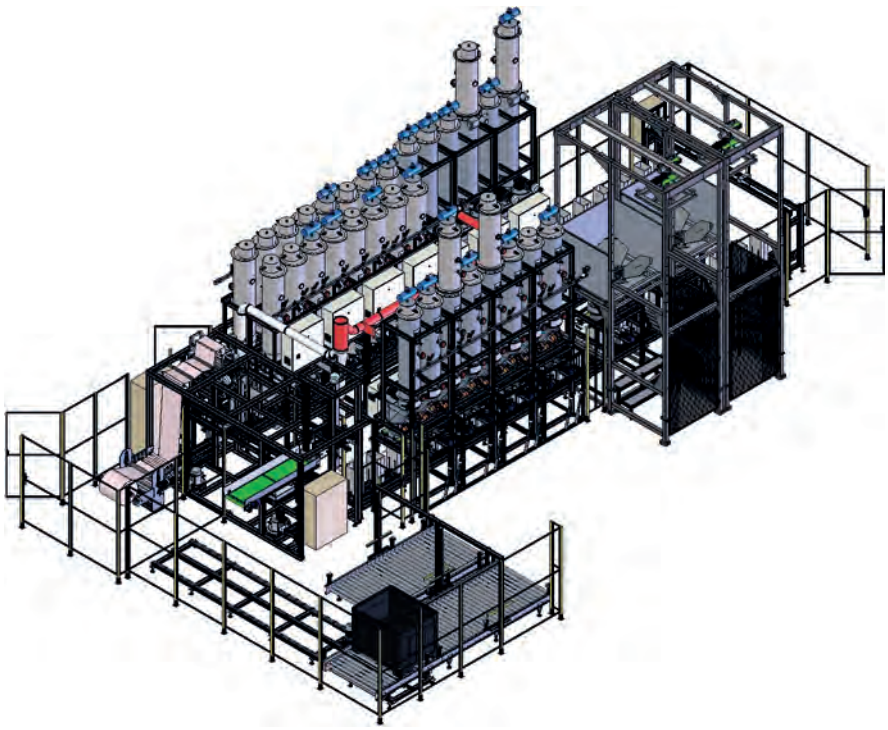
In the production of the many and varied rubber products developed by tire manufacturers, there can be numerous combinations of chemical dispersions that are combined with polymers/elastomers. These formulations are designed to achieve the desired physical and chemical properties of the end products. Accurate and repeatable weighing of additives and chemicals is paramount to achieving consistent results. These stringent requirements have led Color Service, with the assistance of Pelmar Engineering, to engineer a fully automatic system that overcomes the problems of weighing products manually.

The functionality of the Color Service system is straightforward. It automatically forms EVA bags from a tubular film roll, prints all information on the bag according to the recipe, barcodes and seals the bag horizontally avoiding a knot. It weighs quickly, simultaneously and accurately all components (stocked in storage modules) into sealable EVA bags. It then discharges the sealed bags ready to be delivered to the mixer mezzanine or, alternatively, automatically to the mixers themselves.

All the operational and weight data is recorded by an intuitive, advanced management software system. The customer obtains complete records and traceability of the dosing process for quality control, verification purposes and R&D. The system can also interface with existing management systems for seamless reports, archives and functionality.

The benefits of Color Service's technology are considerable. It enables consistent production and very precise recipes, avoiding human error. Tolerances are extremely small, even beyond the existing requirements today. As a result, compounders and tire manufacturers are eligible for quality certification and grading far beyond any existing system. Manual labor requirements are reduced as well as installation requirements, which results in an extremely fast ROI.

Another important feature of the system is its functionality in dispensing all products at the same time enabling a production rate of two bags per minute, which equals 2,880 bagged dispersions per day.



Above: Color Service's chemical dosing line

Below: The system automatically forms labeled EVA bags from a tubular film roll

Color Service and Pelmar Engineering have taken into account customers' requirements and can engineer all new systems to suit the manufacturer's process. The system is built modularly so increased production output in the future would only require a relatively low additional investment. Products can be loaded by vacuum into or from stainless steel silos, or in big tanks manually filled. It can also run from big bags that come directly from the chemical supplier. Systems can be customized for any requirement.

The entire system is controlled via a pressurized system combined with a dust extraction unit placed beneath each feeding point. This avoids any pollution of powders and/or odors, which meets all environmental regulations worldwide. **tire**

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INCREASED PRESENCE IN INDIA

Black Donuts Engineering has expanded its footprint in India with the opening of a new office in Delhi. Black Donuts Engineering Pvt aims to make advanced tire technology more readily available to the Indian market. It will offer an impressive range of services in tire plant design and technology, tire design and development, materials development and tire testing.

The tire market in India is currently driven by technology growth. Keeping pace with the fast-evolving automotive sector, the tire industry is undergoing a tremendous transformation. Ambitious capacity expansion plans are underway. Meanwhile, the industry is geared to compete alongside the best automotive OEMs internationally. The office in Delhi is expected to provide a unique gateway for Indian tire makers that want to stay ahead and be globally competitive with leading technology.

Providing one-stop solutions in all fields of tire manufacturing and development, Black Donuts has the latest equipment and expertise. A rapid increase in the demand for expertise in terms of tire production, development and marketing in India, as well as the company's strategic aim to be close to its customers, is what initiated Black Donuts to establish its facility in India.

Support can be provided for both the building of new greenfield plants and in the optimization of productivity of existing factories. Black Donuts Engineering also helps its customers in gathering information, systems and technologies required to create managerial tools for efficiency evaluation, quality assurance and production.

Black Donuts continues to enter into new arenas, setting new standards in tire technology growth. Its experience and expertise in process development and product quality are now available to meet the needs of companies in India.

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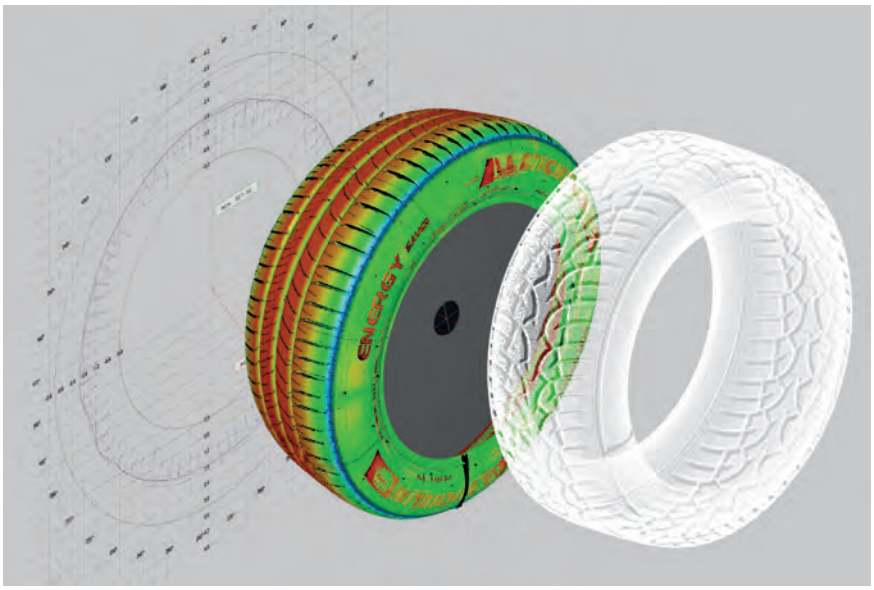
SURFACE SCANNING SYSTEM



GL Messtechnik's state-of-the-art TriScan tire system is undergoing improvements in order to exceed the requirements of customers and remain the top choice of tool. The demand for quicker measurement speeds is higher than ever and has been taken into account in the development of several of GLM's products.

TriScan is a universal 2D and 3D surface scanning system for tires and rims, which uses laser sensors to make non-contact measurements. The system is now available with a 20kHz point laser, which has increased the accuracy and is five times faster than the previous laser. In order to give the customer more choices, the TriScan tire system will also be available with multiple line laser sensors, which are fixed around the tire rotation unit. This method increases the speed of measurements and enables further applications of the system. This creates more possibilities for wear analysis, and enables high-speed contour measurements and collection of pure measurement data.

In addition to the hardware changes, the software has also been expanded with new functions and improvements. It is now possible to make a complete evaluation of a rim, measuring all the most important points. The rim can thus be tested for concentricity and lateral impact. Improved harmonics analysis for circumferential measurements, better comparison of radial and lateral run-out, and mandrel diameter calculation functions are also included in the package. Furthermore, it is now possible to set two locations on an active contour; the connection is calculated and shows the length of the resembling contour. More improvements have also been made in the 360° 3D tire surface mapping software, providing more complete, complex bead-to-bead measurement.

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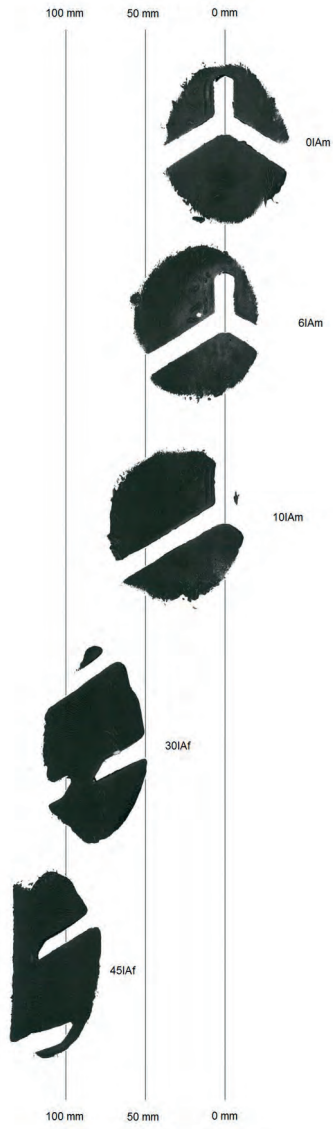
MOTORCYCLE TIRE TESTING



Equipment available for motorcycle tire testing is limited – only a few tire companies have their own custom-built machines. Those tire or motorcycle developers that do not have access to such equipment use on-track development processes to research the effects of compounds, materials and designs. However, this process is time-consuming, expensive, and produces significant variation due to human riders, environmental conditions, surface changes, and minimal instrumentation on the motorcycles. Bringing motorcycle tire testing into a laboratory greatly reduces variation and cost resulting from these factors.

Motorcycle tires achieve a high camber angle (i.e. greater than 40°) during use. While this high camber is difficult to achieve on standard flat-surface equipment, GCAPS has designed a system for its force and moment machine (LTRe) to achieve the necessary angle. This project involves two phases. Phase one successfully achieved camber greater than 40° and applied braking forces to the tire. Multiple tire sizes and test conditions have been collected to both validate the system and create models such as MF and FTire. Phase two of the motorcycle fixture will include the ability to apply a driving torque to the tire. The phase two fixture will be a variation of the phase one fixture, with additional mechanisms to transmit the torque from the existing spindle motor to the tire. It is expected that phase two will be completed later in 2017.

The experts at GCAPS are excited to translate their experience and expertise in tire testing and tire model creation for passenger cars and light trucks to the motorcycle market using a high camber system.

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Gregory Smith

"Tire testing is expensive, so any cost-cutting ideas are broadly welcomed. Can you semi-populate a tire model to save money in such a way that it's still useful?"

In my last column I discussed what would be required to 'fully test a tire' and what useful information could come from this endeavor. However, every thought has an equal and opposite thought, which raises the questions: what is the minimum amount of testing required to generate useful results, and how can those results be used?

Tire testing will always be a very expensive pastime, so any cost-cutting ideas are broadly welcomed. This formed the basis of my ongoing PhD to develop a cost-effective and complete flat-track test procedure called GS2MF. The objective is to obtain all the required data using the least possible rig time, thereby minimizing costs. However, even when using GS2MF at least a few hours of flat-track time are required to obtain one complete data set used to build a fully populated Magic Formula 6.1 handling model with pressure sensitivity. That's still a costly chunk of test time, so what if that's not feasible? Can you semi-populate a tire model with a reduced data set to save money? Would that still be useful?

The law of diminishing returns can be applied here, whereby the more testing you do the less useful each additional piece of data is. So, halving the amount of testing will not usually halve the value of the data. With that in mind, in place of a full test procedure such as GS2MF, very minimal testing could be carried out and still give very useful results.

Conducting simple steering sweeps at around five loads will provide adequate data pertaining to what are arguably the most important tire performance attributes, namely cornering stiffness, aligning stiffness and peak grip, as well as load sensitivities. Add in extra sweeps at the middle load and at three camber angles, then again at three inflation pressures, and a reasonable approximation of the tire's complete steering characteristics can be established from just 11 test sweeps.

Furthermore, statistical approaches exist that can estimate a tire's longitudinal and combined performance from just the steering data. If there is budget for extra testing, the same 11 sweeps could be run longitudinally to measure the pure braking and driving performance. Then one can use a friction ellipse assumption to fill in the gaps and estimate the combined performance (steering while braking or accelerating).

With only this minimal data set, a perfectly reasonable tire model could be parameterized and used successfully in full-vehicle simulations.

A similar approach could be used to obtain the tire's ride performance. Extensive footprint tests can be conducted very cheaply using a hydraulic press with a load cell and either carbon paper or normal paper and a hot wire. With this it is possible to build up a decent data set of footprint sizes and shapes comprising many different loads, camber angles and inflation pressures, without spending heavily.

This data is very important and fundamental to the parameterization of the FTire, CDTire or RMOD-K ride models, among others, where the mantra of 'Get the footprint right and the rest will follow' is often adhered to.

After this, fitting a regulator valve to the hydraulic press along with a distance sensor will enable measurement of the tire's vertical force versus displacement. Using this system, an extensive data set of static vertical stiffnesses can be obtained cheaply, and this forms the basis for the next step of the ride model parameterization. Once this is complete, some testing on a drum rig will be required to gather dynamic cleat test data necessary to finish off the ride model. As with the handling model, this will not be a perfect ride model but will be perfectly reasonable and could be used effectively in full-vehicle simulations to generate valuable vehicle-level results.

Tire testing will always be expensive, but there are ways the costs can be minimized and useful results still obtained. Even with a substantial test budget, depending on the application it is often more beneficial to conduct a reduced test over a wide range of tires than an exhaustive test on just a few. This is due to the fact there are usually substantial variations between tire constructions, even within similar types and sizes of tires. An exploratory exercise such as the one described here could be informative, even for the established tire tester. I'd welcome your feedback! **tire**

Gregory Smith is the director of Tyre CAE and Modelling Consultants, providing tire testing and modeling services to the OEM and motorsport industries. More information at www.tyremodeling.com

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