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automotive manufacturing solutions

A new Vantage point

Aston Martin refocuses on capacity and cost improvements

Global focus
Iran is leading a production boom in the Middle East

OEM focus
Suzuki maintains independence while going beyond Japan

Technology
Servo presses take a big step forward

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Gaining momentum

In my introduction to the July-August issue of *AMS* I commented on the increasingly rapid adoption of new production technologies; in the intervening period, there has been a plethora of announcements regarding the shift away from internal combustion powered vehicles.

Vehicle-makers have been producing electric vehicles (EVs) for years, but now all the major OEMs are making bold statements regarding the position of EVs in their respective vehicle line-ups; even governments have jumped on the bandwagon, with announcements from France and the UK regarding a planned ban on the sale of petrol and diesel powered vehicles by 2040.

Similarly, the idea of fully autonomous vehicles being in large-scale use on the roads seems to be rapidly progressing from concept to reality, with OEMs making serious investment in IT companies. New brands are appearing, primarily from the Chinese OEMs, to challenge the established names, while old ones are in danger of disappearing all together; for example, consider the speculation regarding the sale of some of FCA's brands.

Aston Martin is increasing automation levels and ramping up output

Certainly, none of the above is happening overnight but the pace of change is gaining momentum and we all have to adjust our predictions on when the next big change will come. For Aston Martin, that will be the luxury performance carmaker's new factory in Cardiff, Wales, as it prepares to start production of the DBX crossover (see p12). As we report, the company is increasing automation levels and ramping up output.

This issue also has a focus on the automotive industry in the Middle East, particularly Iran (p26). This country has a long history of vehicle production but years of economic sanctions have seen its automotive industry stagnate.

Continuous development is keeping steel at the forefront in lightweight vehicles structures

However, the easing of restrictions has seen a flurry of activity and investment by foreign OEMs entering into joint ventures with Iranian vehicle- and component-makers.

Recent years have also seen rapid changes in the materials being used to mass-produce cars and trucks. Most notably, Ford's decision to switch to aluminium to build its bestselling F-150 pick-up truck put something of a 'dent' in the steel industry's primacy in this area. But steel is fighting back, as we discover in our materials feature (p40), with continuous development keeping steel at the forefront in lightweight vehicles structures.

There are more potentially big changes ahead for the global automotive industry as the Trump administration aims for a significant renegotiation of NAFTA and the UK tries to work out the complexities of Brexit; we could be in for a bumpy ride over the next few years.

Nick Holt, Editor

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FROM THE INDUSTRY...

A guide to vehicle-makers, suppliers, organisations and institutions appearing in this issue.
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Globe at a glance

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- Ford celebrates truck production centenary

UK

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- Honda 2Wheelers unveils fourth line at Karnataka

North America

Toyota and Mazda's JV factory

US – The two companies signed an agreement in August to enter a business and capital alliance that will include the production of vehicles in the US.

Toyota and Mazda also pledged to jointly develop connected-car and electric-vehicle technologies; collaborate on advanced safety technologies; and to expand complementary products. The OEMs will take shares in each other's business.

The proposed plant in the US would have an annual capacity of 300,000 vehicles and focus on the production of the Toyota Corolla plus new Mazda crossovers for the North American market.

The factory will require an investment of $1.6 billion, shared equally, and a 4,000-strong workforce.

Following on from product and technology collaboration, the US plant is intended to improve the companies' competitiveness in manufacturing. Mazda would be able to develop a production structure to support its growth in North America, while Toyota said it would "further pursue management that is closer to the region".

Toyota has changed its plan to make the Corolla at its upcoming plant in Guanajuato, Mexico, where it will now make the Tacoma pickup truck. The OEM claimed there will be "no substantial impact" on investment and employment in Mexico.

Meanwhile, the expansion of complementary products will be explored on a global level, beyond the existing supply of a compact sedan by Mazda to Toyota in North America and the imminent supply of a 'two-box' van by Toyota to Mazda in Japan.

The new alliance builds on an agreement signed in May 2015 to develop an ongoing collaboration.

Speaking of the next step in their partnership, Mazda's president and CEO, Masamichi Kogai, expressed his hope that the new alliance will "energise the auto industry… by bringing together two competitive spirits", while Toyota's president, Akio Toyoda, said it increased his company's "sense of not wanting to be bested by Mazda".

- **www.toyota.com**
- **www.mazda.com**

Europe

Volvo pledges electric motors for all future models

Sweden – The vehicle-maker declared "the historic end of cars that only have an internal combustion engine (ICE)" with the decision to fit an electric motor to every model launched from 2019 onwards, which will include full electric vehicles, plug-in hybrids and "mild" hybrids. The OEM said it was "placing electrification at the core of its future business".

"Volvo Cars has stated that it plans to have sold a total of 1m electrified cars by 2025," said Håken Samuelsson, the OEM's president and CEO. "When we said it, we meant it. This is how we are going to do it."

He noted the increasing demand for electrified cars, saying that Volvo wanted to "respond to our customers' current and future needs".

The company will launch five EVs between 2019 and 2021, three for Volvo and two for Polestar, its high-performance brand. Details of these will be released at a later date, said Volvo. Additionally, there will be a range of petrol and diesel plug-in hybrid and mild hybrid 48-volt options for all models, which the OEM believes will be "one of the broadest electrified car offerings of any carmaker". ICE models will gradually be phased out.

The announcement is part of Volvo's ongoing commitment to establishing "climate-neutral" manufacturing operations by 2025.

- **www.volvo.com**

South America

Nissan Resende's second shift

Brazil – Nissan has added another shift of 600 workers at its manufacturing complex in Rio de Janeiro in order to meet demand for its Kicks crossover, which has been made at Resende since April. The total workforce now stands at 2,400 individuals.

"Local production of the Kicks demonstrates the company's healthy growth," said Marco Silva, president of Nissan Brazil. "We are strengthening our commitment to the country with investments and the creation of hundreds of jobs."

Preparations for the launch of the Kicks involved a 750m *reais* ($192m) investment.

Silva added that Nissan's Resende site operates with "world-class manufacturing standards" and "a focus on product quality, sustainability and efficiency". This includes comprehensive training for the new recruits, who were hired through Formasan, a programme jointly developed by Nissan and SENAI, a National Service for Industrial Training. Candidates who pass the skills assessments at the end of the programme undertake a four-stage course with Nissan.

Alongside the Kicks, Resende builds the March and Versa compact cars, plus 1-litre and 1.6-litre engines. Production began there three years ago.

- **www.nissan-global.com**

Asia

BBAC to build EV battery plant

China – An investment running into "three-digit million" euros will enable battery production by the joint venture between Daimler and BAIC Motor, Beijing Benz Automotive (BBAC), representing the German OEM's first battery manufacture outside its home country.

The two partners plan to jointly invest five billion yuan ($758m) in the production of battery electric vehicles (BEVs) under the Mercedes-Benz brand, including battery manufacture. BEV production is scheduled to start by 2020.

"We are investing in the world's largest market for battery electric vehicles," said Hubertus Troska, member of the board of management, Daimler, with responsibility for Greater China. "By 2025, the Chinese market will have a substantial share in sales of Mercedes-Benz electric vehicles [EVs]. Therefore, local production will be key to the success of our EV portfolio, and crucial to flexibly serving local demand for electric vehicles."

Xu Heyi, chairman of the BAIC Group, said the two companies were "laying the groundwork for our joint-venture facility, BBAC, to become a future BEV production hub in China".

According to Daimler, the BBAC plant will combine the newest industry standards, the latest production facilities and Industry 4.0 technologies. The cells for the batteries will be sourced from China.

The factory will be part of a global battery production network for Mercedes-Benz Cars which is supported by an investment of €1 billion ($1.2 billion) from Daimler.

So far, this includes a site at Kamenz, Germany, which opened in 2010 and another under construction at a cost of €500m.

More than ten electric Mercedes-Benz vehicles are set to be launched by 2022, with €10 billion invested in its electric expansion over the coming years. Daimler estimates that EVs will make up 15-25% of total sales for Mercedes-Benz by 2025.

✱ **www.daimler.com**

Finding a new Vantage point

In a effort to end its boom-bust cycle, Aston Martin aims to double production capacity by 2019 while cutting manufacturing costs. Nick Gibbs reports

For a luxury maker so used to luring the rich, profits have proven elusive for Aston Martin over the course of its 104-year existence. But the first signs that its CEO, former Nissan executive Andy Palmer, will overturn that pattern came in the first quarter of this year, when the privately owned company posted profits of £5.9m ($7.5m) for those three months, against losses of £29.7m for the same period the previous year.

The catalyst for this turnaround was the launch of the DB11 supercar last year, a key model in what Palmer calls "the second-century plan" and the first on a new aluminium platform to replace the outdated architecture created by Aston's previous owner, Ford. Later this year, Aston Martin will unveil the entry Vantage model and in 2018 it will lift the covers on the range-topping Vanquish, both of which use the same bonded platform. Then, in 2019, comes the real game-changer, an SUV called DBX that will be built at a new plant in St Athan, south Wales.

Filling capacity

The DB11 came too late to really revive sales last year, which stood at 3,687, down from a high of around 7,000 just before Ford sold the company in 2007. But the Q1 total this year was 1,203, suggesting that Aston could get closer to 5,000 by December, particularly when sales of the newly launched V8-engined model are added to those of the V12 version.

This is still nowhere near to the capacity of Aston's UK plant in Gaydon, Warwickshire which is almost 10,000 units when working at three shifts, according to production director Keith Stanton. Right now, only the bodyshop operates three shifts, with two in paint and one in trim and final assembly. However, in 2018 assembly will move up to two shifts to incorporate the next model, the replacement for the Vantage, which will increase production capacity to 9,000, Stanton says.

Production director Keith Stanton is keen to install robots wherever it will be cost-effective to do so

He expects the Gaydon plant to build 7,900 cars next year, of which around 5,000 will be the big-selling Vantage. The two cars have a production line each and if this number is achieved it would be a record-breaking figure for Aston, and require more staff; Stanton estimates that another 250 will be needed next year to add to the 650 already working in production. "That would be an all-time high," he says. It's a change from 2015, when Aston announced that it would cut its workforce by 295 people, although none were from production.

Of the current 650 working in manufacturing, 250 are in trim and final assembly, 260 in the body and paint facilities and 140 in 'off-track' areas including special vehicles.

Investing for growth

Gaydon has received significant investment since Andy Palmer arrived in 2014. A new bodyshop was installed as part of an expansion of the factory space by 10,000 sq.m, and in 2015, a multimillion-pound warehouse and logistics hub of around 23,000 sq.m was built nearby in Wellesbourne. A new pre-production line was also installed.

Stanton says he has been working to increase automation in the factory since arriving in 2006 from Ford. "When I first came to Gaydon, the site was a niche car manufacturing facility, with not much conveyorage, no robots at all, low levels of automation and very labour intensive," he recalls.

One of his first moves was to install robots into the paintshop, then conveyor systems for the production lines. More recently, the upgraded bodyshop was fitted with automatic changing gates for the framing section, robots to install doors, boots and bonnets, and more automated adhesive systems to apply glue to bond the bodies together. Stanton has also installed more sophisticated camera systems for making sure the bodies have been bonded straight.

He's open to more robots, if they're cost-effective. "We've got robots in body and paint and final, and if I could find an application in the trim shop, and I can afford it, I'd put it in there as well. I've looked at applications in other car plants, and I'm open-minded," he explains.

Stantan has been under pressure to reduce spending ever since 2015 when Palmer declared that he wanted the company to be "world-class in terms of costs" after finding that Aston Martin never had a dedicated cost-reduction process prior →

> "I'm not going to worry about [the UK potentially leaving the EU customs union] until I know what the problem is. You can spend far too much time contemplating what we should be doing, only to find out we're wasting our time" – **KEITH STANTON,** ASTON MARTIN

Aston Martin and Brexit

The carmaker's production director, Keith Stanton, talks about the challenges of Brexit and how it will alter the company's policy on sourcing parts.

Keith Stanton

Where do you source your parts from, based on value?
Currently 64% is purchased in mainland Europe, 29% comes from the UK and 6% from the rest of the world. The UK figure has been stable for some time. There are some components we use, Brembo for brakes and Graziano for gearboxes [both Italian], and certain suppliers we use because they're the type of supplier we want for the car.

Will that percentage change for the SUV built at St Athan?
We'll use a similar supply base to the sports cars, so I don't see that changing drastically. I want to try and increase the amount of low-cost sourcing of parts like castings in India and China – particularly India. That'll have some impact but not drastically.

Will Brexit push you to become more localised in the UK?
Not particularly. The drive for more low-cost sourcing wasn't driven by Brexit. We were going to do that anyway.

A BBC news report recently used one of your suppliers, engine block maker Grainger & Worrall, to show how many times parts cross the border into France before they are fitted to cars. Does it worry you that the UK might leave the EU customs union?
I'm not going to worry about it until I know what the problem is. You can spend far too much time contemplating what we should be doing, only to find out we're wasting our time, and we've got plenty do already. I'm of the opinion it's not worth working on until we know we've got a problem.

At what point do you need to know?
Normally, if we want to start re-sourcing and looking at alternative suppliers it takes six to 12 months, because a certain amount of validation has to go on.

I guess you can't shift engine supply from Germany, with the V12 coming from the Ford plant in Cologne and the V8 from Mercedes-AMG?
We can't do anything with those two engines, but of course we're at liberty to design new engines for the future and decide what we do and where we build those engines.

The rise and rise of personalisation

Even for low-volume Aston Martins, customers are demanding even more stand-out personalisation, and making that happen in the normal flow of production is a headache for production director Keith Stanton.

"The level of personalisation has increased dramatically in the last two years. For me, it makes it much more complicated," he says. He gives the example of the paintshop, where instead of using stickers applied afterwards, the different options such as stripes and contrasting roof colours, are painted on. "Virtually everything we do is painted, and that's a problem because we have robots that paint, then we have to personalise the car by masking it and spraying the graphics by hand."

That personalisation also applies in the trim area, where bespoke options include leather seats embossed with names or logos. To bring different contrasts to the leather used, Aston has installed new quilting machines developed alongside a Japanese supplier to allow it to feed larger hides through. It also has a brogue-ing machine to punch in perforations. Stanton estimates that the push for personalisation has increased revenue for the firm by around £2-3 m a year.

Stanton estimates that Aston will need to add 250 staff next year to the existing workforce of 650

to his arrival. The drive to increase parts sourcing in low-cost countries such as India or China (see box) is part of that and Stanton is looking for ways to make the manufacturing employees more efficient.

However, he is also focused on quality. "What we don't do is ever drive the cost down at the risk of quality," he says, adding that the ratio of his workforce employed in quality roles is around 13%. "That was opposed to another car plant I worked in, where it was as low as 2-3%," he states.

The factory has also had new rolling roads installed at a cost of £2-3m, allowing the factory to road-test cars off the line without the need to find an actual road. The Gaydon site overlooks JLR's test track as part of its R&D centre located next door, and it frustrates Palmer that he can't access it. "I dearly wish we had the Gaydon track next to us. It sits there and it's a bit frustrating we're not able to use it," he commented recently.

New quilting machines at Gaydon, developed alongside a Japanese supplier, allow for larger hides to be fed through

Mirroring Gaydon at St Athan

The new SUV facility in St Athan, 15 miles west of the Welsh capital of Cardiff, is currently being constructed within old hangars at a former Ministry of Defence airfield. According to Stanton, this is to be almost a mirror of the Gaydon site, with a similar production capacity that will give Aston the ability to produce almost 20,000 cars per year in total. The first DBXs will start production at the end of 2019, Palmer said recently.

Stanton says the recent improvements at Gaydon will be copied over to the new site. "We're going to implement the things we've learnt in Gaydon straight away in St Athan, as opposed to going on a journey again," he says. Like Gaydon, the plant will have a bodyshop and paintshop as well as trim and final assembly. Cars will be moved around using a conveyor system, and the plant will use a dry filtration system for the paintshop, as opposed to wet.

The DBX is going to be a big hitter out of St Athan if Aston repeats the success that Bentley has seen with its Bentayga SUV, now the OEM's top-seller at over 5,000 a year. However, Stanton believes that St Athan could accommodate other models should it need to. Furthermore, Palmer recently said that it would be the base for Aston's push towards electrification.

Aston Martin also sells niche models in addition to its trio of sports cars, which Stanton has to oversee. For example, the Rapide saloon, which currently goes down the same line as the outgoing Vantage, but will shift to Aston's pre-production line when manufacture of the new Vantage gets underway, perhaps a measure of how crowded Gaydon is becoming. Also proving popular is the Zagato-designed version of the Vanquish supercar, for which production is now around 30% of the car's total, or around 20 a month.

The latest niche model is the Valkyrie hypercar developed with Red Bull's Formula 1 team, which Stanton expects to be building in a new facility close to Aston's Wellesbourne logistics centre. Aston will build 150 of the car, which will sell for £2.2m when it launches in 2019. Despite the cost and exotic appearance, Stanton does not foresee any difficulties. "It's no more complicated to build than anything else we've built in the past," he says. ✱

Profile: Keith Stanton

Stanton has worked as Aston Martin's production director since 2006, when he joined from Ford (Aston Martin's owner at the time). He started out at Ford in Dagenham and worked for the company for 24 years, in the UK and elsewhere in Europe, including six years in Portugal. He rose to become head of Transit production for Ford of Britain, before leaving for van-maker LDV. "I was poached to turn LDV into the new Transit. I was promised all sorts of investment, but that only lasted eight months," he said.

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Gareth Price visits KMS in Zilina, a factory that's flying the flag for smaller car-producing nations

Putting the Kia in Slovakia

A picturesque setting is not a metric that OEMs necessarily value when selecting production sites, but it is one in which Kia Motors Slovakia (KMS) scores highly. The facility lies on the outskirts of Žilina in the northern region of the country, with the Fatra mountains providing a sublime backdrop. Žilina is Slovakia's fourth largest city, around 200km from the national capital, Bratislava, and has served as Kia's principal car and engine production base in Europe for more than a decade.

As KMS spokesman Jozef Bǎcé explains, while the area was not devoid of industry, this particular site was developed from scratch. "Previously, it was greenfield – they grew potatoes here," Bǎcé remarks.

These days cars are the crop, with the plant operating three shifts from Monday to Friday. The annual capacity is 350,000 units. "In 2013, for the first time, we exceeded our official capacity. In 2014 we made some changes to the line, installed additional equipment and technology, hired extra operators and we officially increased our capacity to 350,000," Bǎcé explains, "Last year, we produced 339,500 and we're expecting similar output this year."

Historically, besides the cultivation of staple vegetables, the wider region was best known for its chemical plants and engineering operations. A prime example from the country's communist era (while still part of Czechoslovakia), was the ZTS factory in Žilina's neighbouring city of Martin. Originally manufacturing tractors and forestry equipment, the assembly lines at ZTS produced T-72 tanks for the Czechoslovak military and indeed all of the Warsaw Pact nations – 300 vehicles per year from the 1970s right through the collapse of the Soviet Union.

The era left a heritage of engineering and a strong education system that gave Kia strong grounds to invest in the region. "There's a university and many vocational schools. Even after more than ten years of operation we attract plenty of visitors to see the plant, particularly from Korea," Bǎcé notes. "Many students, too – every Monday and Tuesday we are open for visits from technical schools and universities. Annually, more than 6,000 will come."

Other groups visiting the plant include managers of non-automotive businesses in Slovakia, looking to benchmark their operations to those at KMS.

Close friends

"Not even 8km from here, at Nošovice [in Czech Republic] there's a Hyundai plant. In the area between the two factories, there are many suppliers providing parts for us and also HMMC [Hyundai Motor Manufacturing Czech Company]," Bǎcé says.

This dual-siting is a successful business model which was applied by the group elsewhere. "Also in the US," says Bǎcé, "where there are two factories close to each other [in US terms, 100km]. One is in Alabama, the other in Georgia but each is close to the state border."

He continues: "Last year we produced 339,000 cars. This year we are running at more than 1,400 per day. As for engines, it's even higher. Daily production is roughly around 2,400, the reason being we are also producing engines for HMMC. They produce gearboxes for us."

Bǎcé explains: "This model of the factory is implemented through the Hyundai Group worldwide. All newly established factories are built to a very similar system. When I visited HMMC in the Czech Republic for the first time, I felt like I was at home."

Sales in more than 90 countries are served by the KMS plant

Pressing matters

The press shop is fitted with two main press lines and a store of several 20-tonne galvanised steel coils lies adjacent to the bodyshop entrance. "We have different suppliers," says Băcé. "Not only Hyundai Steel but Voestalpine and ArcelorMittal. Of course, the proportion of Hyundai Steel is the biggest one. Some suppliers are providing coils for specific parts but basically we tender every half-year."

The bodyshop consists of a blanking line and two presslines, supplied by Hyundai Rotem, each with a capacity of 4,500 tonnes. The four-stage process delivers one of the 86 panel types every 20 seconds.

"With each set of dies we'll make around 600 panels. Then we will change them – each change takes around 20-25 minutes. Once we set up production of the new type, the first panels in the run are checked with our 3D inspection system before we launch full production," Băcé says.

Quality arrangements at the end of the line comprise two inspectors checking, by hand and eye, every 20th panel, referring any issues to the 3D optical inspection system.

The press shop maintenance area has two smaller presslines, one with a capacity of 1,000 tonnes, the other 2,000 tonnes. They are not used for series production but to keep the dies in good working order.

In the storage area, regular panels are placed on colour-coded pallets and moved by forklift truck. Stock numbers are indicated to the forklift drivers on the overhead panels. A green-amber-red light system allows them to quickly prioritise part lines that require replenishing.

The only exception are the side panels, their larger dimensions making them unsuitable for forklifts. Instead, an automated storage system with a capacity of around 8,000 pieces is employed. From the end of the line, an electric monorail conveyor palletises the side panels in a two-storey hangar area before continuing through to the bodyshop.

Around 360 conveying and welding robots are deployed in the bodyshop, accommodating a range of separate body types on a single line. "We are producing five different bodies but there's scope to extend to another three in the future," says Băcé. "That's helpful when we are switching from an old model. We can still produce the old one for certain markets overlapping with production of a new one."

> "About 43% of all parts that we assemble here come supplied as modules. It speeds up our process... we finalise a car within six hours" – **JOZEF BACÉ**, KIA MOTORS SLOVAKIA

The three-storey paintshop at KMS features tanks for 360-degree rotation-dipping for pre-treatment and electrochemical coating. Overall, each body passes through individual phases of the production process measuring 7.5km, including buffer zones. "Storage capacity for the painted bodies is 180 bodies," reveals Băcé. "Essentially, that's the stock for three hours – so if something happens in either the paint or bodyshop we have that time to work with."

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Automated assembly

Robot technology also plays its part within the 100,000 sq.m assembly hall, where 1,400 vehicles roll off the production lines every day. Automated dashboard mounting is a particularly innovative feature. As the body moves into this station, the robot anchors itself to a peg fixed to the conveyor, then gathers the full dashboard unit – provided by Hyundai Mobis – from the lineside. Turning the module 90 degrees, the robot feeds it through the right-hand door aperture. Lifting the dashboard forward and fixing it in place, the robot arm then releases and navigates itself out of the door aperture, with only 2-3cm clearance.

"A barcode tells the robot which type of body it's working to. It will also read the barcode on the dashboard unit just to verify it is intended to be fitted inside this particular job," Bǎcé explains.

It's a prefect instance of the automation advantage, coping easily with the size, weight and awkward shape of the dashboard module as well as the limited working space.

A further example is evident as the glass preparation station. Robots apply a line of primer to the glass – front and rear screens – tracing just the adhesive bead path. The pane is then set aside for three minutes before it is moved to the assembly station where the adhesive bead is fed on and the glass fitted onto the vehicle. The pause is set intentionally at three minutes as the optimum timing for the chemistry between the primer and the adhesive bead to bond.

Naturally, tight and effective timing is crucial to the entire operation. At KMS, Bǎcé explains, a key approach to this is a high ratio of modularisation: "About 43% of all parts that we assemble here come supplied as modules. It speeds up our assembly process. We are able to finalise a car within six hours of it arriving at the assembly line."

Kia Motors Slovakia: Facts and figures

- **Groundbreaking:** April 2004
- **Start of production:** December 2006
- **Employees**: Around 3,800
- **Production:** 339,500 units in 2016 (capacity: 350,000)
- **Models:** Cee'd, Pro_cee'd, Cee'd Sportswagon, Sportage, Sportage GT Line and Venga
- **Engine production:** 2,475 per day

Engine production

Within the KMS complex, two engine plants are in operation. The first opened in 2006 to produce both petrol and diesel engines. As production at KMS and HMMC increased, a second petrol engine shop started operation in 2011. Upgrade work is planned for the original engine shop during the latter part of 2017.

Each day, on average, around 2,475 engines are produced; half are delivered to HMMC in the Czech Republic. "The engine is produced by us and the gearbox comes from HMMC in Czech Republic. They are delivered to Mobis, who finalise and fit the fuel system [supplied externally]. Mobis also supply the front and rear suspension," says Bǎcé.

National pride

Sales in more than 90 countries are served by the plant. The focus is mostly on Europe and Russia but vehicles have also been supplied as far as Australia and New Zealand; Mexico too, until production began there. Other markets in the Middle East and North Africa are also being explored.

"The Sportage is the most important for us. We're on the fourth generation already and it represents 64% of our current production. It's our cash cow," says Bǎcé.

"The Venga has been our shining star for so many years. Basically, production began in 2009 in Nošovice [HMMC] then operations were switched to KMS, so we're at eight years now and we're pretty stable at 30,000 units per year."

Economic importance

"Automotive investment in Slovakia is important for our economy. It accounts for around 44% of the country's entire industrial profile."

Three, soon to be four, OEMs are producing cars here, aided by 300 suppliers. The national population is around 5.4m and more than 250,000 people are employed, directly for OEMs in the country, be it Kia, Volkswagen or PSA, or through tier suppliers.

Jaguar Land Rover has begun work on a plant at Nitra, but Bǎcé warns that it may prove tough for JLR to recruit operatives: "Unemployment levels dropped below 5% in Slovakia. It's even lower in the Nitra area. It will be quite difficult for them and their suppliers to find suitable staff. The situation is having an impact on wages. The pressure is increasing now; the wages rises here at KMS were above the national average. I believe it will continue."

Unemployment levels have dropped in Slovakia, meaning that it may become harder for vehicle-makers to recruit suitable workers

"We are really depending on the automotive industry, especially western and central regions. The east is a different story. The highway infrastructure is not complete yet. It's the reason why the OEMs and suppliers are established in the western part of the country."

Žilina is an exception, lying in the north-west. The national government is working to provide higher incentives to companies willing to establish operations in the east, especially to specific regions where unemployment is far higher than the national average. In some districts in the east and south, unemployment can reach 20%, while in the west around Bratislava it is closer to 2.5%.

Slovakia became an independent nation in 1993 after the dissolution of the Czechoslovak federal state and the nations remain fierce rivals in the automotive sphere. "We are a very small country; the output of China, US, Korea, Germany, Japan, in real numbers is much higher, but we are the number-one producers in terms of cars per capita." With a smile, Bǎcé adds, "We like this statistic; it means we beat the Czechs." ✱

Autonomy drive

Ian Henry examines how Suzuki has stayed independent of big joint ventures despite becoming increasingly dependent on markets outside Japan

In an industry where mergers and collaborations between major players are increasingly common, Suzuki remains something of an outlier. It has largely eschewed wide-ranging, large-scale alliances with other vehicle companies, especially since its joint venture with GM ended in 2009. Its much-heralded cross-shareholding alliance with Volkswagen, designed to help VW especially improve its offering in the small-car market, was short lived and ended owing to what VW's CEO Matthias Mueller called "cultural divergence".

A planned link-up with Toyota was announced in October 2016 and by February 2017 the companies had reportedly progressed to "concrete examinations", focusing on safety, IT, environmental technologies and potential component sharing. Since then it has not moved far beyond the initial talking stage and there are parallels with the failed Volkswagen alliance, in that the giant OEM is looking to learn as much from its smaller partner. Whether this latest venture will prove more successful for Suzuki is open to debate, especially as Toyota's CEO has admitted that his company has not always been very good at making alliances work.

In a highly symbolic move, exports of the Baleno hatchback to Japan began in 2017, making it the first Indian-made car to be sold there

Suzuki plants in India are producing more vehicles than those in Japan

Suzuki has become increasingly dependent on markets outside Japan for much of its growth in recent times. Although Japanese production grew last year and has continued to rise this year, its sales in Japan have fallen. Financial results for 2016/17 showed a 1% fall in revenue, mainly due to declines in *kei* cars and contract production for other vehicle companies. Overall, however, profits have risen due to sales growth in India and Europe, with the result that the company was able to increase its dividend payout by more than 15%. Its Indian operation still reports

separate financial results, with revenue in the last financial year up 18.5% and net profits up nearly 37%.

A pioneering passage

Suzuki was one of the first Japanese vehicle companies to establish a significant presence in India. It had held a minority 26% stake in Maruti for several years, raising it to 40% in 1987, 50% in 1992, before taking a controlling 56.21% stake in 2013. Its share has remained at this level since then; and Suzuki has a dominant market share in India as well, just over 50% in 2016.

Globally, however, Suzuki was the ninth-largest vehicle company, according to OICA statistics for 2015. That year it produced close to 3m vehicles, ahead of both Renault and PSA, and a similar number, just over 3m, were made in 2016. These figures reflect production in Japan, India, Thailand and Hungary, where it has full manufacturing facilities, and several CKD sites around the world.

Chinese production of Suzuki models is counted within the numbers for the OEM's joint ventures with Changan and Changhe; the Changan partnership produces some of the SX4 S-Cross sold in China, with others imported from India. In addition, Changan Suzuki imports the Ignis compact car from Japan. The future of the Changhe JV is in some doubt as Changhe itself is now majority owned by BAIC.

Rising output

Suzuki has seen its production volumes rise in recent times. In the last financial year from April 2016 to March 2017, it produced just under 3.1m vehicles, a 4.2% rise on the previous year, with around 874,000 vehicles made in Japan, and 2.2m outside its home market. While overseas production increased for the fifth consecutive year, the 1.5% rise in Japan was the first time Suzuki's domestic production had grown for two years. Approximately 139,000 (or 16%) of Japanese production was exported.

The positive production picture for 2016 has continued during 2017; output was up 6.9% year-on-year in May at nearly 71,000 units for the month, and up 28.3% year-on-year at over 422,000 for the first five months of 2017. Outside Japan, production was up nearly 12% for May, at over 202,500 units, and up 8%, at 976,000 units, for the first five months of the year. In both cases, this was the fifth consecutive month of rising production.

Suzuki in Japan

- The OEM's home plant, at Takatsuka in Hamamatsu City, focuses on motorcycle engine production, as well as HQ functions associated with the car arm of the business
- Kosai in Shizuoka mainly covers mini or *kei* vehicles, including the Wagon R, Alto, Lapin, Spacia and Hustler. The plant has a capacity of around 650,000 vehicles a year and also produces engines. It is the centre of the company's CKD operations, shipping parts across the globe
- Iwata, also in Shizuoka, has a capacity of around 280,000 vehicles and focuses on four-wheel-drive vehicles (Jimny and Vitara) and mini-trucks such as Carry and Every
- Sagara, at Makinohara in Shizuoka, is the smallest car plant, producing around 80,000 cars, currently the Swift and similarly sized models; the factory also casts and machines engine parts and assembles engines
- Osuka is the company's largest aluminium foundry plant, casting and machining engine and suspension parts
- Toyakawa is a motorcycle plant, and also assembles marine engines

As well as producing mainly *kei* vehicles, Suzuki's Kosai plant is the centre for its global CKD operations

Production network for Japan and India

In terms of its global manufacturing footprint, Suzuki produces vehicles in 11 countries, with its principal

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production bases being in Japan and India. In addition, there are full production plants in Thailand (from where the Celerio entry model is exported to Europe) and Hungary, which supplies the S-cross for Europe and Japan, and the Vitara for Europe as well as global markets outside Japan. Production of the Celerio for Europe switched from India (where only Euro 4-compliant vehicles are made) to Thailand in mid-2014; the Thai plant is equipped to make Euro 5-compliant vehicles.

Suzuki has six plants in Japan (see previous page): its

In Hungary, significant new investment at Suzuki's Esztergom plant will see upgrades in laser welding and injection-moulding technologies

home plant at Takatsuka in Hamamatsu City; Toyakawa; Osuka; and three sites in Shizuoka. Outside Japan, Suzuki's main production activities are in India – through its 56.21% stake in Maruti – and Thailand and Hungary, along with a series of CKD plants in Egypt, South America (Brazil, Argentina, Colombia and Ecuador), and production joint ventures with Chongqing Changan and Jiangxi Changhe in China. The Changan JV produces the S-Cross, Alto and Cultus, while the Changhe JV produces the Liana and Splash, as well versions of these Suzuki models for sale under the Chinese brands' names.

Increasing investment in India

The Suzuki plants in India are its most significant overall, producing more vehicles than in Japan. In the year ending March 31, 2017, Suzuki produced 1.59m vehicles in India. Most of the production was for the domestic market, with just 124,000 exported in the last year to more than 100 countries worldwide, including several European markets, as well as most of Asia and Africa. In addition, in a highly symbolic move, exports of the Baleno hatchback to Japan began in 2017, the first Indian-made car to be sold in the country.

Maruti Suzuki's top export models are: the Alto, Swift, Celerio, Baleno and Ciaz; and its leading export markets are the Sri Lanka, Chile, the Philippines, Peru and Bolivia. The Indian operations also export a light commercial vehicle, the Super Carry, to South Africa and Tanzania, with Suzuki intending to export to other African markets in due course.

In addition to original Maruti plants in India, the company has also opened its first wholly owned plant in the country. This factory, in Gujarat, started production in early 2017 and will supply both the local market and export destinations, in Europe, Africa and Japan (notably with the Baleno). The two plants on the Maruti side of the business – at Gurgaon (with a 700,000-unit annual capacity) and Manesar (800,000 units) – both operated at full capacity in 2016. The new Gujarat plant adds another 250,000 units of annual capacity; furthermore, a second plant at Gujarat will be open by the start of 2019, raising Suzuki's total capacity in India to as much as 2.25m units per year.

Expansion at Gujarat has been accompanied by increased engine and transmission production following an investment in recent times of $900m. In addition, the Gujarat plant, designed with enough space for a third plant on the site if demand justifies this, has also been accompanied by a renewed burst of investment in India by Japanese component companies.

Toyoda Gosei, for example, has opened a new plant to supply the Suzuki Gujarat factory with airbags and weather-stripping. Meanwhile, Mitsui Chemicals and its Korean partner, SK Chemicals, are building a factory to manufacture polyurethane seat covers for the Suzuki Gujarat plant from 2019; however, this facility will certainly supply other factories because it will be able to make seat covers for 1m vehicles a year.

While Suzuki has expanded Indian production capacity in cars and conventional powertrains, it is also moving into electric-vehicle battery production. The OEM has established a joint venture with Toshiba and Denso to make lithium-ion batteries at a plant which will be in production by the end of 2017, supplying cells for Suzuki's growing range of plug-in hybrid electric vehicles sold in India.

Suzuki is also investing in its R&D facility in Haryana state, planning to spend 19 billion rupees ($280m) there by 2019. In parallel, the Maruti Suzuki side of the business is setting up an institute in Gujarat that will train 300 new engineers a year.

Expansion in Esztergom

In 2016, Suzuki's plant at Esztergom, Hungary, made just over 211,000 vehicles and passed its three-millionth vehicle milestone in April 2017. Last year, Suzuki confirmed it will be improving the factory's production and logistics systems with an investment of 5.3 billion forints ($20.6m), funded by 2.71 billion forints from Suzuki in Japan and 2.59 billion forints from the EU.

The investment will prepare the plant for laser welding and develop a new polymer research programme in cooperation with PEMU, a local supplier of injection mouldings and foam parts to Esztergom.

Although, like many Japanese car companies in Europe, Suzuki has encouraged existing key suppliers to locate close its Esztergom factory, it also makes use of domestic sources. For example, for the new Vitara SUV in 2015, Gyor-based Raba was given a six-year contract to sew seat covers and head rests, press seat pans, weld the seat frames, and produce both seat hinges and wire frames for seat backs. This continues a long-established supply arrangement, and in fact means that Raba supplies these parts to all Suzuki models currently made in Hungary. ✱

Off the grid

By convention, single-seater cars are machines for the racing circuit but, as Mike Farish reports, one family business is striving to become the exception

The BAC Mono is made by small UK company Briggs Automotive Company, based in Liverpool. The vehicle is a low-slung machine that first saw the light of day in 2011 as the brainchild of two brothers, Ian and Neil Briggs, who still occupy day-to-day positions in the company as directors, respectively, for design and product development.

The machine itself is described by the company as a "road-legal supercar" now in its third variant, selling for around £200,000. It uses a carbon-fibre composite body around a steel safety shell, though at first glance its most evident feature is probably the contrast between its enclosed front end and an open rear with its engine and exhaust system on view.

A core feature of each vehicle is that it is built to fit a specific driver, whose measurements are used to define the precise layout of the cockpit – the distance from seat to foot pedals, for instance. Lightweighting is also a core design principle to enable high speeds to be attained without the use of a massive and, in itself, heavy engine. The current version of the car uses a 2.5-litre, 305bhp Mountune powerplant and has a dry weight, depending on options, of just 580kg. Top speed is 170mph and the 0-60mph time is 2.8 seconds.

The company moved into its current premises adjacent to John Lennon Airport, whose runways are occasionally used for vehicle testing, some three-and-a-half years ago. At that time, production volume was three cars a year; now it is said to be three cars a month.

More suppliers than employees

Confirmation of those figures is provided by director of manufacturing Rainer Kuehlwein, who joined the company at its inception. Like BAC's founders, Kuehlwein has worked in various other sectors of the automotive industry such as with Porsche. He says that, out of the 27 people employed by BAC now, about ten are involved in manufacturing tasks.

Unsurprisingly, given that small number of people, Kuehlwein confirms that operations at Liverpool are effectively confined to manual assembly procedures involving major subassemblies delivered from outside, though a few are put together in-house.

Indeed, the company has more suppliers than employees, around 100 providing roughly 1,200 parts for each vehicle. The biggest subassembly in the car, says Kuehlwein, is the rear end, including the gearbox and rear suspension, though that is one of the few major elements which are put together in-house. The Hewland gearbox in the BAC Mono, Kuehlwein points out, is actually a "structural element" that replaces the chassis in its location.

Another major subassembly for which BAC takes responsibility is the pedal box that forms such a crucial element of the customised ergonomics. In contrast, the welded tubular chassis is delivered complete with the aluminium floor already attached.

Interestingly, Kuehlwein also says that the supplier base charged with the relevant responsibilities, which even includes the welding of the chassis, is overwhelmingly based within the UK – well over 90%, with just handful in Germany and Italy. In a manner which echoes the way that major OEMs have closely located their supply bases, Kuehlwein adds that 20-25% of BAC's suppliers are very nearby in the north-west of England.

Single sourcing of parts with responsibility devolved in all cases to just one external party is also standard policy. Kuehlwein says that if the company ever started to produce

different variants of the car at the same time then that might change to permit similar, but not quite identical, parts to be sourced from different suppliers. But he is adamant that, otherwise, BAC's current policy is the right one. "We will never source identical parts from different suppliers," he states. "What we aim to do is get quality levels, delivery schedules and prices right with single suppliers because it would not make sense to do anything else with our production volumes."

The basic philosophy underlying the construction of that network – and the devolution of such high levels of work – is not likely to change. Indeed, Kuehlwein indicates that BAC intends to move increasingly towards reliance on external "system suppliers". But he also stresses that complacency is never allowed to creep into the situation. "Continuous work and communication" is, he states, a hallmark of BAC's relations with its supplier base.

A bespoke creation

A clever aspect of the Mono, as Kuehlwein explains, is that the customisation of the car to suit the physiology of individual purchasers does not require any fundamental re-engineering of the vehicle's structure – the chassis, most obviously, remains exactly the same. Instead, the elements which are altered are internal to the cockpit – the distance from seat to pedals and the steering wheel position.

The company's close working relationship with its suppliers is also evident in the option it provides of a seat shaped to suit individual drivers. As Kuehlwein explains, the supplier in this case is UK company Pro-Seat, which specialises in making custom-moulded seats for extreme environments, such as F3 racing. BAC has a "seat fitting chassis" that uses Pro-Seat's own patented process, which requires the individual in question to position themselves in what is effectively a cushion. This adapts itself exactly to the person's shape, before a vacuum system is used to record these details for the formation of a seat precisely replicating this shape.

Apart from the limited amount of subassembly work that takes place at Liverpool, Kuehlwein states that work on the cars there starts with what he terms "chassis dress" and "powertrain dress". Essentially, he says, "we start with a bare chassis, put a tank system in it, add the electrics and front end, then the engine and then the rear end including the gearbox – at that point we can actually start it up."

All of the procedures to accomplish these stages, Kuehlwein confirms, are purely manual – a mix of physical manipulation of the vehicle elements and manual, mechanical fixing of them together. There is some minor use of adhesives in the car, but that takes place almost entirely at the supplier level. "We have what we call a main body – that is the shell that sits on top of the car, and there is a sub-frame that is glued to that," he says, as an example.

Since 2015, BAC's production volume has increased from three cars a year to three cars a month. At least 75 cars are actually in use

As such, the crucial parameter that BAC's own internal assembly procedures has to achieve is "ensuring the correct torques" on the screw fixings. The most critical of those, Kuehlwein adds, are specified in the build manual, though others are left to the skill and experience of the assembly workers to get right. It is no exaggeration to say that the most advanced items of assembly technology involved are "mechanical torque wrenches with electronic readouts".

The lead time for the vehicles is four weeks. "That is how long it takes from the time we first touch the chassis to when we have a vehicle ready to drive," Kuehlwein confirms. Demand, though, is such that the waiting time from order to delivery for customers is from six to nine months.

The increasing popularity of the vehicles will have implications for the manufacturing processes. Kuehlwein says that the fact there are now at least 75 of the cars actually in use is enough to create a sufficient volume of feedback about real, in-use performance to support a total quality management system back at Liverpool. "We can learn lessons from the running fleet that can be used to help enhance production," he states. ✱

Unlocking demand

Violent unrest and economic uncertainty continue to rack the Middle East, but automotive production is booming thanks to the liberation of demand in Iran, the biggest consumer of vehicles in the region. Nick Gibbs reports

Up until they were lifted in early 2016, Iran suffered heavily under the yoke of nuclear-related economic sanctions imposed both by Europe and the US, particularly those dating from 2012. However, since then, the country has seen production and sales of vehicles rise, prompting the return of foreign vehicle-makers, led by the French, eager to either resume previous joint ventures with Iran's dominant state-led companies or to forge new agreements.

Iran boasts the second-largest population in the Middle East at around 82m and the biggest vehicle market, with car sales rising 25% last year to 1.28m according to global car sales aggregator Bestsellingcarsblog.com. With imports of mainstream cars discouraged via high taxation, this has boosted local vehicle production, which stood at 1.16m last year, up 19%, according to figures from global vehicle trade association OICA, around 90,000 of which were medium or heavy commercials.

> Iran Khodro, along with SAIPA, is responsible for the production of around 80% of cars sold in the country. Both makers are part-owned by the largest company in Iran, the government-run Industrial Development & Renovation Organization of Iran (IDRO)

A check of the bestseller charts gives the impression that Peugeot is the dominant carmaker in the region, but all of its 400,000-plus cars sold last year were built under licence by Iran Khodro, which along with SAIPA is responsible for the production of around 80% of cars sold in the country. Both makers are part-owned by the largest company in Iran, the government-run Industrial Development & Renovation Organization of Iran (IDRO).

IDRO is slowly divesting itself of the two companies and now owns 15% of Iran Khodro (*khodro* being the Iranian word for car), and 36% of SAIPA, but the duo's grasp on local production is such that the automotive industry here can safely be described as an oligopoly.

SAIPA, which kicked-started automotive production in Iran with Citroën Dyane-based models in the 1960s, makes last year's bestselling car, the Siapa Pride, a supermini sold with myriad body styles including a pick-up, all based on the 1990s Kia Pride.

The giant company has around 100 subsidiaries and affiliates, according to its website, and builds Renaults under licence as well as trucks for Iveco, Volvo and Renault Truck. It has forged partnerships with Chinese makers in recent years and produces cars for Brilliance and Changan as well as trucks for Dongfeng and Foton. SAIPA's subsidiaries build a wide range of parts including engines, gearboxes, dashboards, seats, shock absorbers, springs and radiators.

Iran Khodro's big models are the Peugeot 405 and very similar Peugeot Pars, Iran's second and third bestselling cars last year. It also builds the Peugeot 206 supermini, the Renault Tondar small saloon (as does SAIPA, curiously) and a range of own-brand cars based mainly on old Peugeot platforms, the bestselling model of which is the Samand.

Also known as IKCO, Iran Khodro is perhaps most

famous for its long-running production of the Paykan, a rebadged version of the British Hillman Hunter, which ended production in Iran in 2005. The company has eight vehicle production plants with a capacity of around 1.3m, meaning that it suffers from overcapacity.

New agreements with the French

Any overcapacity might be cured by new agreements signed with PSA Peugeot Citroën last June, which will see Iran Khodro producing new Peugeots under a 50:50 joint venture with PSA. Meanwhile SAIPA will produce new Citroëns, again in a 50:50 joint venture (instead of under licence). This brings PSA back to the country after it was forced to leave because of the EU sanctions.

The Iran Khodro deal will see the joint-venture company invest "up to" €400m ($470m) to 2021 according to PSA, both in manufacturing and R&D. It brings brand-new models into production, including the Peugeot 208 supermini, 2008 supermini SUV and 301 small saloon. Iran Khodro will also develop a new vehicle using the Peugeot platform underpinning these cars. A Peugeot spokesperson told *AMS* that the JV had already built 16,000 of the 2008 as of the end of July, with sales beginning later this year.

Citroën's joint venture with SAIPA will see the new company invest "more than" €300m in manufacturing and R&D by 2021 and it will produce three new, unnamed models, "adapted for the Iranian market" according to Citroën, at a plant in Kashan, 250km south of the capital, Tehran. SAIPA opened a new plant there in 2010.

Meanwhile, Renault last year announced a joint venture with government-owned company IDRO (the one that has a share in the two dominant Iranian vehicle producers), with the French maker as the majority shareholder. The resultant operation will build a new plant with an annual capacity of 150,000 units as well as an engineering and purchasing centre for an undisclosed investment. It plans to start building the Symbol supermini saloon and Duster small SUV in 2018. This would take the French OEM's capacity to 350,000 in the country, including the deals with Iran Khodro and SAIPA.

So far, no other foreign carmaker has said that it will set up new production facilities in Iran after the end of sanctions, but VW could be about to take the plunge after it announced in July its return to the market with import models to be sold from August in partnership with Mammut Khodro, a subsidiary of the Dubai-based conglomerate. VW had withdrawn from Iran back in 2000.

Iran's bestselling car models in 2016

	Model	Units	From 2015
1	Saipa Pride	248,789	+23%
2	Peugeot 405	148,593	+29%
3	Peugeot 206	145,565	+38%
4	Peugeot Pars	121,892	0%
5	Iran Khodro Samand	102,045	+20%
6	Saipa Tiba	98,060	+32%
7	Renault Tondar 90	79,851	+114%
8	Renault Sandero	25,846	+3,231%
9	Iran Khodro Dena	24,241	+51%
10	Brilliance H330	16,666	+288%

Iran's bestselling brands in 2016

	Brand	Units	Share	From 2015
1	Peugeot	416,051	32%	21%
2	Saipa	365,544	28%	24%
3	Iran Khodro	159,899	12%	5%
4	Renault	112,426	8.7%	177%
5	Chery	48,774	3.8%	62%
6	Brilliance	29,724	2.3%	428%
7	Zamyad	27,440	2.1%	14%
8	Kia	23,289	1.8%	41%
9	JAC	20,239	1.6%	-34%
10	Hyundai	16,402	1.3%	-36%

Source: Bestsellingcarsblog.com

Confidence growing

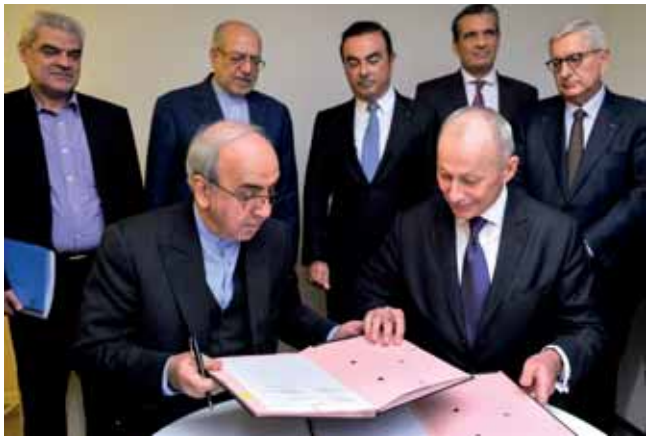
The big push by the manufacturers demonstrates their confidence that the market will grow. Automotive analysts at IHS Markit predict that Iranian car sales will increase from 1.25m last year to 1.55m in 2018 and 1.7m in 2020 before reaching 1.85m in the longer term. PSA has predicted that the market will top 2m but IHS's analyst for the region, Michel Jacinto, disagrees. "When we look at purchasing power there and compare the GPD per capita with Turkey or South Africa, it's lower in Iran," he says.

Some manufacturers remain cautious about investing in Iran because they worry, in particular, that the thaw in relations with the US will not last, especially with President Trump threatening to re-impose sanctions. Indeed, *The Economist* argued persuasively at the end of July that Trump might get tough on Iran in reaction to being blocked by Congress on easing Russian sanctions.

"We are well aware of the market potential in Iran but we can't afford to take any risks," a source close to VW told *Reuters* in May. "Any company operating in Iran or planning to enter the market needs to ask itself what could happen if there is a fundamental change of course by the US."

Also wary is Daimler, which signed a deal with Iran Khodro Diesel and Mammut Group to produce Mercedes-Benz trucks and components back in January last year, starting with CKD assembly of the Actros and Axor range of trucks. "The suspension of the sanctions imposed on Iran represents an opportunity," the company wrote in its annual report published earlier this year, before going on to say that the resumption of local production and sales of trucks was "dependent on the further development of local conditions". The company told *Reuters* in May: "There is hardly any economic growth in Iran, so demand for commercial vehicles is generally low."

Iran's locally produced vehicles are undergoing a badly needed update in quality after a revolt by consumers. "At the end of 2015, customers were boycotting new cars because they thought the current offerings were poor regarding safety features, comfort and design," says IHS's Jacinto. →



Renault has announced a joint venture with government-owned IDRO

VW may return to the Iranian market with import models sold in partnership with Mammut Khodro

"Many people perceive them as outdated."

Jacinto believes that Peugeot/Iran Khodro will drop the long-running 405/Par, a bestseller for two decades, within the next two or three years after it introduces three new models. Local media reported earlier this year that on the commercials side, Iran Khodro would stop making the Arisun pick-up, based on (what else?) the Peugeot 405, and also the Mercedes L-series, a tipper truck that started life in 1959 and has been in production for nearly 30 years in Iran.

> Egypt's success story is the MCV Group, which claims an annual production capacity of 10,000 buses and 1,500 trucks per year, 60% of which are claimed to be exported, including double-decker buses to London

The sanctions that kept Western vehicle-makers from upgrading models gave opportunities to the Chinese, which were not restricted from doing business in the country. Last year Chery became the fourth-largest car brand with sales up 62% to 48,774, followed by Brilliance, which saw 428% growth. JAC was ninth.

Chery describes itself as the largest private carmaker in Iran after partnering with the Modiran Vehicle Manufacturing Company (MVM) back in 2004, when it started building cars from CKD kits. Chery bought a controlling share in the partnership in 2009 and now has a plant in Bam, 1,000km south-east of Tehran, with an annual capacity of 60,000 units. There are plans to expand this capacity to 100,000. MVM claims to employ 2,500 people at the factory.

The growth of the Chinese OEMs is a problem for the two local makers. "The big challenge is to manage future competition between the Chinese and domestic brands," explains Jacinto, who adds that, while Iran needs the investment from China, at the same time it has to support Iran Khodro and SAIPA. However, SAIPA, for one, is working with the Chinese, building Brilliance and Changan cars, as well as Foton and Dongfeng trucks.

Slump elsewhere

Nowhere else in the Middle East comes close to matching Iran in terms of vehicle production, but many are trying to develop their own industry.

Egypt (included in the Middle East for the purpose of this analysis; Turkey is not) is the only country in the region with a greater population than Iran, at around 95m, but recent unrest and poor economic outlook has suppressed the country's long-standing vehicle production, which last year stood at just 36,230, up 0.6%, according to OICA. Of those, 25,300 were commercials and 10,930 were cars.

Vehicle production started here in the 1960s and expanded when industry was liberalised in the 1980s, which is when General Motors set up an assembly plant in the capital, Cairo.Today, GM builds Chevrolet-badged versions of Chinese Wuling people-carrier style cars designed by its China joint-venture with SAIC. Its plant in the 6th October district of Cairo makes the Move and the Optra. GM has sold its East Africa business to Isuzu as a part of a global withdrawal but so far has not shown signs of off-loading its Egyptian operations, perhaps because of the Wuling connection.

Other makers include the Bavarian Auto Group contract manufacturer, which started out making CKD BMWs but now builds cars for India's Mahindra and China's Brilliance, according to its website. Its rival, Arab American Vehicles (AAV), was set up in 1978 as a joint venture between Chrysler and the Arab Organisation for Industrialization (AOI), a military-aligned company that pays no customs duties for imported parts or taxes on its revenue. Its website says that it still makes Jeeps, mainly for military use, but in July this year it started building the Toyota Fortuner, a big SUV based on the Hilux pick-up, at an estimated output of 3,000 a year. Also building cars in the country is Nissan, which makes the Sunny saloon.

Egypt's automotive success story is the MCV Group, which describes itself as the leader in commercial vehicles in the Middle East and Africa. It claims an annual capacity of 10,000 buses, which are what it is best known for, but can also make 1,500 trucks a year. MCV says that it exports 60% of its production, including double-decker buses to London. The vehicles are mostly adaptations of Daimler commercials.

GM's plant in the 6th October district of Cairo makes the Move and the Optra

Zahid Tractor builds for Volvo Trucks and its subsidiary Renault Trucks on the outskirts of Jeddah

Saudi and UAE

The biggest Middle East car markets outside Iran are Saudi Arabia, followed by the United Arab Emirates (UAE), which includes Dubai and Abu Dhabi.

Saudi Arabia is another economy which is being hit hard by the current slump in oil prices and its car sales last year fell 21% to 691,114, according to Bestsellingcarsblog.com. All are imported but the country is trying to strengthen its automotive industry, which currently just makes commercial vehicles. Jaguar Land Rover briefly toyed with the idea of setting up a car factory there before settling on Slovakia, but Toyota could be the first after the company signed a memorandum of understanding with a Saudi government agency in March to investigate producing vehicles there.

It would have to overcome a shortage in skills and supplier network, but Toyota does have the advantage of being the country's bestselling brand, thanks in part to the success of the Hilux pick-up, the country's second bestseller last year. The small Hyundai Accent saloon was the most popular.

In terms of commercial vehicles, local company Zahid Tractor builds for Volvo Trucks and its subsidiary Renault Trucks on the outskirts of Jeddah. It claims to have a capacity of 4,000 units a year on a single shift, but neither OEM released figures in their most recent annual reports. That could be because the company is aware that doing business in countries such as Saudi Arabia, which have poor human rights records, hurts its image. Volvo actually addressed this issue in its company report in a roundabout way, writing that "business connected with complex markets like Israel, Palestine, Burma/Myanmar, Saudi Arabia and Iran" was one of the "most common business ethics questions from stakeholders".

The UAE's car market was also well down at just over 300,000 units in 2016, but again, the local automotive industry is focused on commercials. For example, India's Ashok Leyland has a large bus plant located in the Ras Al Khaimah emirate, which doubled its capacity to 24 buses a day last year. Military vehicles are also produced in the UAE; NIMR in Abu Dhabi builds a range of wheeled vehicles (as opposed to tanks) in a 37,500 sq.m facility. *

From paper labels to

From the Internet of Things to Industry 4.0, manufacturing is changing. Paper labels no longer fit process complexities; what's required is an optimal flexibility and quality assurance

For 40 years, paper has been a trusted flag in manufacturing, providing sequential work instructions for operators. This simple visual cue has been the core of a process which balances production and creates more efficient just-in-time inventory.

It may then be a surprise to many who work in the industry to find out that the static paper-based, or kanban, systems that have been at the core of material flow management for decades are also the number-one cause of factory inefficiency today.

With technology and customisation trends expanding how do factories keep up?

The automotive industry, for example, is under intense pressure to deliver new or refreshed models with ever more options at an accelerated rate. The most critical factor to success in expanding market share is rapidly introducing new models that meet or exceed customer requirements and staying ahead of competitors with features. Designers are using technology to shorten their cycles dramatically, putting the pressure on manufacturing to keep up.

Despite the need to change, it's easy to see why software or auto identification systems have been unsuccessful in replacing traditional paper: paper is simple, reliable, visual and familiar to the workforce. It can be used by both low-skilled labour and high-end operators.

However, it is highly inflexible. Once the paper label is placed onto a container and launched into the process, its instructions or trajectory cannot be changed without a significant amount of human resources or costly manual work-arounds. It cannot be wirelessly tracked or communicate with robots or machines on the line.

A next-generation system ideally needs all these attributes while still retaining the simplicity and reliability of paper.

"We've been in factories where containers were pulled off the line and were sitting for literally days or sometimes longer because no one knew what to do with them," says George E. Daddis, Jr, CEO of Omni-ID.

A view to the factory floor

Some common examples of challenges that are being solved today using the ProVIEW system:

Issue: Rescheduling/reassigning routes for work in process
When bottlenecks occur, it is prohibitively expensive for racks to be tracked down and new labels applied. Or, operators compensate by ignoring the instructions on the label to bypass issues. The result of this is chaos on the factory floor.

Resolution: Using existing systems to know what machines and operators are available and instantly use this information to send a message to the View tags to create optimised routing for each rack or smart container.

Issue: Out-of-sequence container or rack delivery
Parts are often hard to distinguish from one another – if installed in the wrong sequence it can destroy the value of an entire batch. This could result in a costly write-off of the entire WIP.

Resolution: Each View tag ensures that its rack or container is associated to a specific work process. If it arrives out of order, it automatically signals the operator with a message indicating that they should not use the materials as they have arrived out of order.

smart containers

Enter the IIoT and smart containers

The Industrial Internet of Things has been a key driver to bring new interactive technologies to existing processes like material flow management. This demand for technology to make material 'smart' has resulted in an innovative combination of e-Paper, RF communication and simple business logic called ProVIEW.

In most factories, the scheduling team meets in the mornings to determine the demand for the day and create the jobs and output for the day. The schedule is committed to hundreds of paper labels with instructions upon them and manually affixed to the racks of materials for the day – and the process begins. If something goes awry, new labels need to be reprinted and manually sent out onto the floor, resulting in process bottlenecks with no way to quickly re-route materials.

Instead, a wirelessly updated, e-paper or 'View' tag is placed on containers routing through the manufacturing process. Unlike paper, the screen can change instructions along the route to tell operators what to do with them next and where they should go if there are bottlenecks or other issues. These 'smart' containers also become immediately traceable in real time. With e-paper replacing paper, View tags fit seamlessly into most existing process, with a multitude of additional benefits that paper simply cannot provide. This system is the first of its kind to provide paperless, wireless and interactive material flow management along with end-to-end process visibility.

The ProVIEW system also provides a complete two-way feedback communication loop – the tags tell the operators what to do with them, operators execute instructions and interact with the system for confirmation of action, such as a call for parts or changes to the 'as built' records with the simple push of a button. Machines can also interact via wireless communication with the material. All the actions are tracked and stored, enabling process tracking and analytics.

Every rack, item, container on the factory floor is tracked by its location, state and condition – which can be dynamically changed at any time to accommodate a work flow change.

Repurposing some material for another part of the line or staging it to balance flow? No problem. Machine is down and material needs to be re-routed to optimise output?

Testimonial

"ProVIEW's Pick Application reduced our average pick times from 47.5 to 29.2 seconds and our accuracy on quantity and sequence was dramatically better with the visual instructions right at the point of picking.

"Most impressive for us, is the ease of use of the system. New workers could jump in and be effective immediately because of the easy visual cues and instructions.

Setting up a new picking cell when we reconfigured lines used to take more than a week. Using the wireless tags and simple software, last month we did a changeover in two hours using just the line operators, no IT.

– Plant manager, tier one supplier

ProVIEW can take care of that.

The electronic View tag simply replaces the paper in key processes such as; picking, replenishment, container management and work instructions, minimal to no training is necessary for operators!

ProVIEW user Detroit Diesel, for example, found that, unlike paper and other traditional electronic tagging solutions, ProVIEW is an IoT solution that provides the ability to not only track materials, but control the flows. The process visibility and control that the system provides creates a number of efficiencies – not to mention the savings from the paper alone.

✳ **www.omni-id.com**

Issue: Updating build instructions for WIP

Updating build instructions, especially during the production process, is difficult. For instance, if tooling is serviced or updated at any given station an extra QA step must be added to qualify the new tool.

Resolution: Build instructions are easily changed in real time with the ProVIEW system to accommodate for quality or process changes. The View tags are equipped with buttons to provide a means for the operator to indicate that the QA has been done and is automatically notated to the system.

Issue: Reconfiguring pick areas

Setting up to enable optimal picking when a new job is put to the floor can take a week or two depending on the installation of shelves, racks, configuring or even coding the picking software to match the setup. With changes happening more and more often, this wasted time is becoming significant in the overall efficiency.

Resolution: Wireless View tags make it easy to swap out parts or reset a pick area. View tags can be quickly mounted where they are needed with simple Velcro tape or snap in brackets. What took a week can literally take an hour, making multiple changeovers possible for competitive advantage.

The upward curve of servo

The recent installation of what is claimed to be the biggest ever servopress machine anywhere in global automotive metalforming sector demonstrates the key advances made in pressing technology. Mike Farish reports

Servo press technology has been making increasing inroads into automotive metalforming applications for some time now. The reasons are not particular to the demands of the automotive sector but reflect the advantages the technology can bring to manufacturing processes. The most crucial of these is simply the element of control flexibility that servo presses can provide; the motion of the slide is driven directly by the motor and can be varied during a single operation – speeded up, slowed down or made to dwell – according to requirements. The consequence is an enhanced ability to form parts accurately and without compromise to material quality irrespective of the intended part geometry.

The technique has two older rival pressing technologies. These are non-servo mechanical presses – in which the energy of the motor is transmitted to the slide via a complex system involving a clutch, gears and flywheel – and hydraulic presses – in which the motor drives a hydraulic pump which in turn actuates a piston-cylinder unit to drive the slide. Both still have their uses but neither can match the intrinsic flexibility of servo presses because in both cases the slide motion is fixed in both amplitude and speed.

Moreover, the advance of servo press technology in the automotive manufacturing sector has recently taken a giant step forward – quite literally, with the recent commissioning of what is claimed, plausibly, to be the biggest such machine in use in the sector anywhere. The machine in question is now in operation at the plant in Bielefeld, Germany, of Spanish-owned component maker Gestamp Automoción. Appropriately, the machine itself has Spanish origins since the project to design and install it was carried out by a team drawn from both Bielefeld and the Logroño, Spain, office of Japanese-Spanish equipment supplier Nidec ARISA.

Big in Bielefeld

The sheer dimensions of the installation, which was shipped to Germany last December, indicate just how unusual it is. The whole thing is 37 metres in length, 20 metres in width and rises 10 metres above ground level with a further six metres extending vertically in the opposite direction. Its total weight is 1,350 tonnes and it has a power rating of 9MW of torque and 7MW of energy storage effected through a system of compensation engines. All this enables the machine to deliver 45,000KN of force at the die surface.

The overall system is configured as a single press with two carriages and three uprights, which makes it capable of levelling the eccentric loads of the die. The machine is fed by means of a format destacker with multiple loading stations in order to support ergonomic efficiency for machine operators. Meanwhile, a conveyor belt system

transports materials through an oil-programmable band lubricator in order to ensure the best oil application level for each operation. The die change system, including change of references in the unstacker, is fully automated.

Off-line programming is effected through Nidec ARISA's own Optiservo software, which has been specially written to take account of the fact that the company's servo presses have an open curve capability that enables the operator to create as many different curves as needed. Specifically, the software enables a production engineer to simulate and optimise the curves without stopping production, both reducing set-up times and preventing collisions.

The details are confirmed by Roberto Gonzalo, responsible for project management at Nidec ARISA, who also says that the Bielefeld installation represents the biggest servo press application that the company has so far implemented – "and for a tandem double servo press," he adds. Nevertheless, the record may soon be at least equalled if not exceeded since Gonzalo explains that "we are also doing other machines with similar dimensions".

> "The specifications and the continuous and quick development of the automotive industry make it necessary to have very accurate and flexible machines that are able to work with different materials and dies at the maximum speed and the minimum energy consumption"
> – **ROBERTO GONZALO,** NIDEC ARISA

A new frontier

According to Gonzalo, the project to design and build the new servo press installation at Bielefeld involved confronting some fundamental questions about how its performance objectives could be achieved. "During the design process, we had to deal with the fact that the requirements for the printing processes to cope with new materials with high tensile strength, especially the differences of force between the first and subsequent forming stations, cause problems in the deformations of the transfer presses," he reports.

A number of possible solutions presented themselves, including the use of an individual press prior to the transfer press, though, as Gonzalo states, this approach would be far from straightforward. "The deformation processes, which would normally be deep-drawing, require high forces," he says, explaining that this might compromise the symmetry of the die loads in the press. However, the major disadvantage of such a system would be an overall reduced performance due to the need to move the parts from one press to another.

Another possible solution would have been to manufacture a standalone asymmetric press, which would allow the deformations caused by the forces generated during use to be compensated for by the asymmetric structure of the press. But, again, this option was not without its accompanying problems. "This solution would be feasible as long as the dimensions required for the die were such that a single carriage press could not be manufactured," states Gonzalo. "In addition, such a press would cause asymmetric deformations when working with dies with the distribution of cantered loads."

Therefore, Gonzalo continues, the technical solution chosen was to acquire a single press with two carriages and three uprights, capable of levelling the eccentric loads of the die and with sufficient die dimensions for a wide range of present and future work. It was implicit in this option that "the press should have servo drive" in order to achieve the necessary quality levels, which, along with its transfer process, would also allow for a high production rate. "The high tensile strength material needs a very accurate forming speed in order to achieve the required part quality," he says. "This is only possible with the precise speed control of servo presses." Moreover, during construction the challenge was to build and mount components weighing more than 200 tonnes to accuracies of less than 0.1mm.

The 37-metre long, 1,350-tonne servo press at Gestamp Bielefeld

Keeping the customer satisfied

Gonzalo adds that this level of performance requirement, though not unique to the automotive industry, is now typical to it. "The specifications and the continuous and quick development of the automotive industry make it necessary to have very accurate and flexible machines that are able to work with different materials and dies at the maximum speed and the minimum energy consumption," he states. "Only servo presses can satisfy all these requirements."

Meanwhile, the user of the press indicates that the new machine is fulfilling expectations. According to Lutz Huxholl, Gestamp Bielefeld plant manager, the press is now successfully making "mainly chassis" parts for several major customers from high-strength steel. The parts include "spring links and lower control arms".

As for the scale of the installation, Huxholl says that apart from its ability to tackle immediate manufacturing tasks, Gestamp also regards it as providing a degree of future-proofing and even of enhanced credibility in the market. "With this investment, the Gestamp Bielefeld plant is heading towards the future as well as ensuring it is competitive in the present," he states. "This servo transfer →

press opens up various new manufacturing options. It is always important for automotive suppliers to be equipped with modern production facilities. Furthermore, such a servo transfer press provides a unique selling point."

Improving energy management

But servo press technology is also making a significant impact in the industry on the other side of the Atlantic. A major supplier of the technology there is Komatsu North America. Product manager George Schreck acknowledges that precise control of the slide motion is a key attribute of the technology, while pointing out that it also represents a distinct advance in "energy management" compared with flywheel-based counterparts. The key limitation with the latter, he says, is that they can only deliver energy to the slide when they are spinning at a fast rate, which means that the slide motion has to be quick as well. But the technology is in any case intrinsically more energy efficient.

On that count, Schreck says that testing carried out by Komatsu in cooperation with a third-party agency has shown that "during physical work a servo press is 30-40% more energy efficient than one using a flywheel." The saving in comparison with a hydraulic press would, he adds, be even greater.

This does not mean that there are no circumstances in which either hydraulic or flywheel-based presses would be more appropriate techniques to use. The former, notes Schreck, has superior "deep drawing" capabilities while the latter makes more sense in the case of a high but single-speed slide motion that does not require advanced control capability. Nevertheless, Schreck confirms, there is an increasing market preference for servo press technology. In the case of Komatsu North America, he adds, that is evident from the fact that "seven out of ten" sales of mechanical presses are now of servo type machines.

A first step for FCA at Warren

One major vehicle-maker in North America which first explored the use of servo press machines as primary manufacturing systems as recently as last year is FCA US. In January 2016, the company started production on a new, $63m, 180-inch wide servo tandem press line at its Warren Stamping Plant in Michigan, supplied by Komatsu. Within six months, FCA had commissioned two further identical installations at its Sterling Stamping Plant, also in Michigan.

The details are confirmed by Al Whitted, global head of press shops and dies for FCA, who says that although the company previously operated "some smaller servos" in other countries, the Warren installation was its first implementation of the technology "in the NAFTA region". The immediate spur for the investment at Warren was, Whitted adds, simply a requirement for extra capacity. "We were having to offload work, and that imposes a huge price penalty," he explains.

The decision to take this step into the new world of servo technology was, Whitted says, the result of a number of factors. One was the feedback the former Chrysler part of the company was able to glean from the previous Fiat experience of the technology - "our colleagues in EMEA", as he describes them, though he notes that "they were also fairly new to it". However, the main attraction was just the promise the technology held of increased output, enhanced flexibility, energy efficiency and decreased die changeover times. He indicates that all those expectations were fulfilled.

> "We have some old lines where the die change can take 40 minutes, whereas on these new lines that can take just two to three minutes"
> – **AL WHITTED,** FCA US

On that latter count, for example, Whitted reports that: "We have some old lines where the die change can take 40 minutes, whereas on these new lines that can take just two to three minutes." However, the reason for that is less the servo technology itself than the modernity of the equipment. "Our previous newest such systems were 20 years old," he admits.

So far, the new servo systems at both plants have been used for the production of existing parts but, says Whitted, that is soon about to change. "We have got the JL coming up, which is our new Jeep Wrangler, and our new Ram pick-up truck, and we have designed the dies for them specifically for the servo presses," he confirms. The launch dates for those vehicles will be, respectively, November of this year and Q1 of next year with part production preceding those dates by appropriate margins.

When that happens, Whitted adds, the new machines will run "at 100% capacity", though they are already close to that level because the company has pulled as many jobs as possible from older crossbar machines and transferred them to the servos, modifying the dies where necessary. The consequence for the parts involved, he reports, was a "30% increase in speed". Though he refrains from giving actual production figures, Whitted says that "parts we used to run at nine strokes per minute we now run at 12 strokes per minute and we expect to run them even faster when we start using the dies that have been specially designed for them."

Given the size of the machines, Whitted says that the

The new, high-speed servo tandem press at Warren Stamping Plant

company's intention is to run "all of its really big parts in them". He gives the examples of "body side apertures, double door inners and outers and hood inners and outers". Their role in the successful launch of the new vehicles will be "critical", says Whitted.

On the point of the dies designed for the servo machines, Whitted says that one thing that becomes possible is to make them "with a lower profile" than has been the case previously. In turn, that enables parts to be transferred "from one station to the next" faster than might otherwise be possible. The significance is that each of the new servo installations comprises five immediately co-located presses in sequence – that is the meaning of the word 'tandem' in this context – with the lead press rated at 2,400 tons and the other four at 1,200 tons.

Given that the new machines represented a first foray into a new type of technology, a lot of preparatory work was necessary. Again, though, the US operation was able to draw on experience in parallel operations in the former Fiat business. "We had a lot of read-across from EMEA," says Whitted, adding that a "big cross-section" of personnel from the US were deployed worldwide to familiarise themselves with the requirements for successful servo operation: "We sent them to Serbia, Italy and Japan."

In consequence, the commissioning process for the Warren Stamping installation was, Whitted suggests, not overly problematical. It was even less so for the two at Sterling, which benefitted from the experience at Warren.

Whitted says that the company is still "learning every day" about how to get the most from the technology, but he can pinpoint some of the key lessons so far. The first is the necessity for the inclusion of people at all levels and from all relevant technology areas, from as far upstream as die design and as far downstream as maintenance, in the planning as well as practical implementation processes. The second is to effectively integrate of all supporting technologies - "robots, washer units, destackers – if those things are not properly integrated then however sophisticated the press technology, the installation won't run."

A quality check is performed on a freshly stamped door at FCA's Warren Stamping Plant, Michigan

Nevertheless, the potential of the technology to improve production processes has also become evident. Whitted says that what has impressed him and FCA US most is the capability it provides "to put the tonnage exactly where we need it on the part". *

In itself, the term 'blanking' denotes something fairly straightforward and unexceptional – creating flat shapes out of sheet metal that may then be subjected to some further process such as bending. But companies wanting to carry out the process are nevertheless faced with an immediate decision about which of the available techniques are most likely to be best suited to their requirements. The three that present themselves are: pressing with an individual cutting die for each profile; cutting with mechanical shears; and cutting by means of a laser beam.

Master piecers

Mike Farish reports on the techniques used in the typically bespoke but ever larger-scale production of blanks

As Manuel Hunger, head of sales for technology supplier Schuler Automation, explains, the production of a 2D shape is the shared objective of each of those approaches, and choosing between them is a matter of balancing a number of factors, including intended production rates, material types and part geometries. He says that shears, for instance, are appropriate in "high-performance, high-volume" applications, adding that in relevant equipment they are also capable of cutting at an angle of "up to 35 degrees", which is comparable with what can be achieved by oscillating dies.

Meanwhile, the capital cost and fixed geometry of each die used in pressing operations means that the main factor influencing their choice will be a demand for high-volume parts of unvarying geometries. As such, Hunger notes, press techniques for blank production – most likely using servo presses – are still the most frequently used technology in mainstream OEM environments.

Cost and volume

Hunger observes that, typically, a press blanking operation in an automotive manufacturing context for parts such as doors, hoods and side panels might well be used to produce "as many as 40,000 parts in a 24-hour period". But, he adds, he is aware of at least one operation within Schuler's user base that can achieve 60,000 parts, albeit of a different type, over the same period.

One drawback is that, depending on the size and geometry of the part, the outlay for a die might be €50,000-€300,000 ($59,000-$94,000). Once a die is made, it is also difficult and costly to make anything more than very minor changes to it. While still fairly versatile, dies are subject to some limitations in the shapes they can economically produce; round edges, for instance, are much more costly that 90° angles.

The key difference in applicability between shearing and pressing is the blank shape, not the volume. Hunger explains that shearing is really only suitable for use where a blank has a straightforward shape. Anything more complex or irregular will almost certainly require the machining of an appropriate die. The real advantage that shearing holds over pressing is that, for instances where a combination of a relatively simple shape and sufficient volume holds sway, the initial capital investment should be appreciably lower.

That leaves the third option: laser cutting, which is unsurprisingly the most modern of the three. In the case of Schuler, for example, Hunger says that the company first introduced the technology to the market as recently as 2011.

At the most basic level the choice between laser blanking and either of its rival techniques is a matter of balancing the much higher production rates the latter can produce against the much greater flexibility of the former. As Hunger explains, a laser cutting installation handling a "typical automotive portfolio" might produce around 20,000 parts over the same 24-hour period in which a pressing counterpart might produce roughly double that figure.

But, as he also points out, there are counterbalancing factors that make the business case for laser blanking rather more complex than it might at first seem. For a start, a laser blanking line is much more flexible in that it does not have to be reconfigured in order to produce parts of different shapes, merely reprogrammed – something that facilitates not just the use of exactly the same hardware to produce entirely different parts, but also the ability to adjust the geometry of a particular part during production if necessary. "You can change the profile of a blank in a matter of minutes," he states. In contrast, making even slight alterations to a machined die, while not impossible, will be costly and time-consuming.

Material considerations

Another important factor is the continuing development of new materials. As Hunger explains, the advent of high-strength and ultra high-strength materials as part of the ongoing drive towards the lightweighting of vehicles is causing problems for both shears and blanking presses, and in particular for non-servo pressing techniques using dies. Quite simply, he says, these developments are "bringing existing equipment to a limit" and even "causing failures".

What happens is that the impact forces such materials require, in order to form parts, cause what Hunger terms "reverse tonnage" – in other words, the transmission of unwelcome forces back into the press equipment, damaging it. He indicates that with existing types of such equipment the limits of mechanical cutting become more obvious when the tensile strength of the processed material reaches around 1,000 megapascals or more. Servo presses can certainly mitigate such effects though the capability for the speed at which they operate to be varied during individual strokes, thereby minimising percussive rebound effects.

"You can program the slide so that the actual impact is at slow speed and then speed it up again for the rest of the cycle," notes Hunger. "But in contrast, if you slow down part of the motion in a conventional mechanical press then you have to slow down the complete cycle as well." Meanwhile, he adds, though shearing could be used to tackle newer, higher strength materials the inhibiting factor would be excessive blade wear.

In the circumstances, Hunger indicates his belief that, in general terms, the future of blanking operations in the automotive manufacturing industry will increasingly involve users making a choice between servo press and laser-based technologies. Moreover, in the case of the latter technique, the hardness of the material involved is completely irrelevant. "A laser does not care about the tensile strength of the material," he states.

Dies for Daimler

One company that has faced up to making a choice between the continued use of heavy dies and the adoption of laser techniques, taking the latter course, is Daimler, which has commissioned two laser blanking lines using Schuler technology at its plant in Kuppenheim, south-west Germany. Moreover, given the comparatively slow speed identified by Hunger at which laser technology operates, the OEM has opted to install two laser blanking lines to satisfy its volume requirements.

But in light of the intrinsic flexibility of the technology, both the lines, which are meant for the serial production of compact vehicles, can be changed instantly to another cutting style at the touch of a button. The programming of the contours is carried off-line and can be simulated for production optimisation. But much more fundamentally, by dispensing with the dependence on heavy dies, Daimler believes that the pressing plant is now optimally prepared for all the projected different types of car models scheduled for the next few years.

Daimler has commissioned two laser blanking lines using Schuler technology at its plant in Kuppenheim, Germany

Working together

In each system, three laser heads work in tandem to cut contours at a speed of more than 100 metres/min from steel or aluminium sheet which is fed continuously and directly from the coil. This yields surface-sensitive, pre-cut components for mudguards, side parts, roofs and engine hoods. Part transport is carried out by a conveyor that moves through the system at a speed of up to 60 metres/min. The cut blanks are separated from scrap and stacked continuously. Subsequently, two press lines in the hall, also supplied by Schuler, form these pre-cut blanks into chassis parts, which are assembled in the adjacent Mercedes-Benz Rastatt factory.

The contrast with the non-laser alternative is stark. Normally, blanks are stamped using blanking dies that weigh upwards of 25 tons and cost up to €200,000 each before further outlays for storage, repair and maintenance are taken into account. Moreover, the introduction of a new vehicle or vehicle variant may well necessitate the refit of existing dies or the introduction of completely new ones. A final factor in Daimler's decision to adopt this new technology was that the laser systems do not need expensive foundations or a basement, thus getting around the space limitations at the plant which might have impeded the installation of a die-based blanking system. ✱

Composites

Pressing and forming technology for composite materials are a key part of modern automotive production. Andrew Williams looks at the latest developments

When manufacturing composite parts, companies throughout the automotive supply chain commonly rely on hydraulic press systems, which are generally far better at increasing the curing time of materials compared with traditional sheet metal forming with the use of a mechanical press.

Composite manufacturers can also choose from a variety of materials and technological processes as well as a range of matrix systems such as thermoset and thermoplastic. A recent innovation in this field has been the development of thermoset composite material processes like high-pressure resin transfer moulding (HP-RTM), which presses or forms composites in a number of key stages. To begin with, several layers of preformed dry fibres are put into the press, where a mix and dosage unit injects the matrix system.

German press technology supplier Schuler Automation produces two types of composite press system: well-proven long-stroke presses and multifunctional short-stroke presses. As Paul Thom, Schuler's sales and product manager for hydraulic press systems, explains, the company has recently optimised its machines for automotive parts applications and developed multifunctional presses for 'enhanced flexibility using different technologies throughout production processes.'

One interesting example is a novel 'congruent-bending-lines' press feature, which is claimed to reduce rejection rates and improve part quality. Elsewhere, BMW also uses HP-RTM processes on ten Schuler presses for series production of carbon fibre-reinforced polymer (CFRP) 'life modules' for its i3 and i8 electric vehicles. "Series applications for approximately 25,000 vehicles with the complete life module are manufactured with composites by using the HP-RTM process per year," says Thom.

A 36,000kN Schuler press has also recently been delivered to the Institute for Advanced Composites Manufacturing Innovation (IACMI) in Detroit, Michigan. The 4,000-ton machine, with a clamping surface of 142 x 94 inches, forms a key part of the ongoing expansion of an R&D vehicle scale-up facility. It is available for use by IACMI members working on a number of projects, largely in an effort to help the Institute meet US Department of Energy CFRP goals of 25% lower production costs, a 50% cut in embodied energy and 80% recyclability into 'useful products'.

Reducing scrap

Also in Michigan, automotive parts supplier Plasan Carbon Composites, which manufactures carbon-fibre components such as bonnets, roofs and side panels for vehicles including the Chevrolet Corvette, Dodge Viper and Ford Mustang, has recently teamed up with Rockwell Automation to implement a software solution to reduce scrap waste from the high-speed presses operating at its Grand Rapids plant. As Danny McKinnon, controls engineer at Plasan, explains, the proprietary Historian software is employed to serialise and track each part moving through the pressure presses, and to "record and report process parameters within the presses".

"The fact that there were so many variables to our process meant that it seemed almost impossible to figure out," he says. "However, the software helped us to track each variable to uncover a pattern that revealed why we were getting scrap parts. In the process, this has greatly reduced press room scrap and is setting a new standard for quality in the plant."

Adapting aerospace materials

Elsewhere in North America, global automotive supplier Magna uses several pressing and forming technologies at its Composites Center of Excellence in Greater Toronto, Canada – the lead location for much of its development work in this area. This centre is a partnership between Magna Exteriors and the National Research Council of Canada which aims to support the automotive industry in developing next-generation vehicles that are safer, affordable, environmentally friendly and fuel-efficient.

On the material side, Andrew Swikoski, global product

Forming developments should make composites more cost-effective

line director for Lightweight Composites at Magna Exteriors, explains that the centre carries out research into a range of different reinforcements "like glass and carbon fibre in continuous uni-direction, as well as fabrics and chopped formats." On the resin side, it deals with both thermoplastics and thermosets such as liquids, pellets, sheets and prepregs, most of which can be processed via injection moulding, compression moulding or resin transfer moulding.

Swikoski claims that Magna is now "at the forefront" of several trends in the pressing and forming of composites, including the transformation of carbon-fibre materials used

take shape

for aerospace parts and race cars into materials suitable for mainstream automotive manufacturing. He says that as well as making them affordable "we also reduce cycle times to form a part from hours to minutes or even seconds, as is required in automotive".

"We recently launched a few lightweight composite parts into production, including the Ford Mustang grille opening reinforcement with a carbon-fibre filled PA66 injection moulding process," Swikoski states. "Next, we launched a couple of carbon-fibre-reinforced epoxy prepreg hoods that are compression-moulded. Most recently we developed, in partnership with Ford Motor Company, a front subframe made with a carbon-fibre-reinforced sheet moulding compound that is compression-moulded."

Finding smarter solutions

Another recent development is the CLASS (Composite Lightweight Automotive Suspension System) initiative, a UK-funded research project to design a carbon-fibre replacement for the current steel knuckle/tieblade suspension component, which supports the rear wheel in a Ford Focus. According to Ken Kendall, head of structural composites at the Automotive Composites Research Centre (ACRC) at WMG, University of Warwick – which is a partner in the project, alongside Ford, Gestamp and GRM – the "extremely challenging loads" that this component experiences call for a "very novel manufacturing solution".

Although the details have yet to be made public, Kendall reveals that the "backbone" of the manufacturing method involves the combined use of continuous and discontinuous fibres in a single moulding process. He says the bending, torsion and buckling loads are managed primarily by the continuous fibre tieblade, whereas discontinuous fibres provide attachment to the vehicle and suspension.

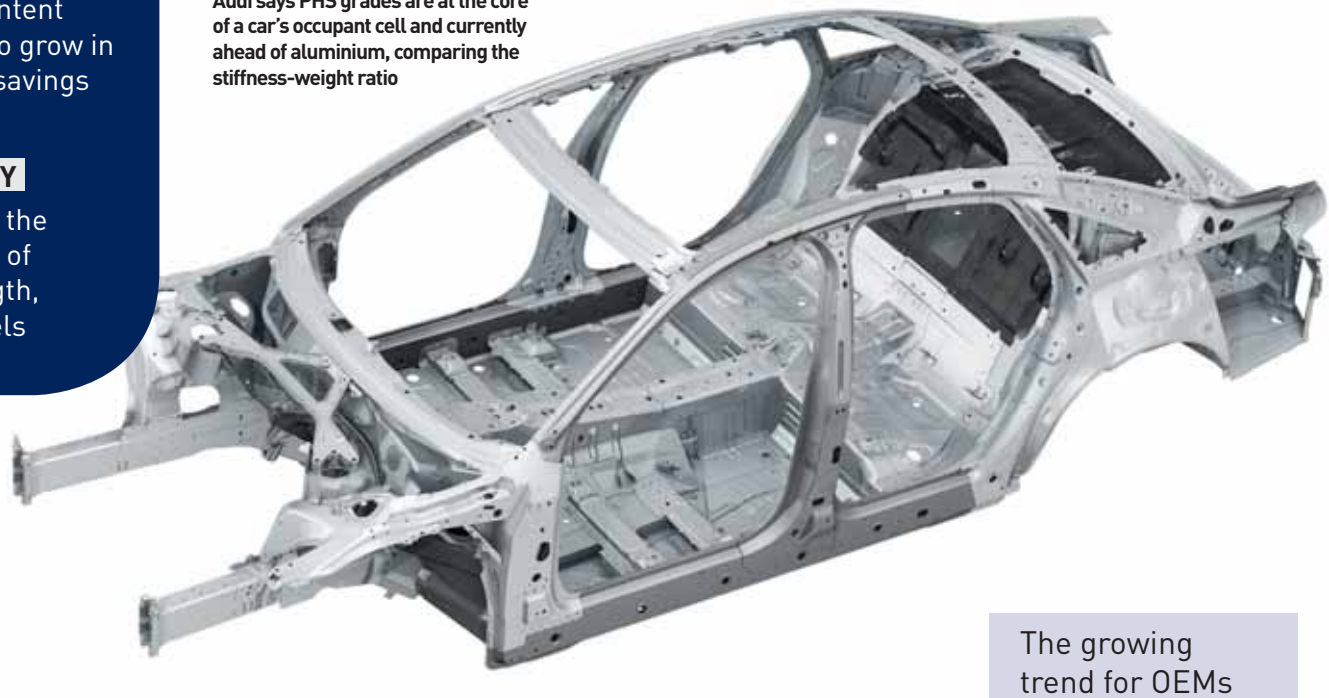
Kendall explains: "Nineteen layers of prepreg were cut and assembled into a 2D blank, which was then preformed and trimmed in matched metal tooling. The prepreg and sheet moulding compound (SMC) were assembled into the mould and compression moulded to make the complete part in a single process. The project is nearing completion and the testing program is currently underway."

Looking ahead, Kendall believes that Automatic Fibre Placement (AFP) and Automatic Tape Laying (ATL) processes could one day be used to replace the cutting and assembly of fabric plies from rolls, helping to "significantly" reduce waste. Although he admits there are challenges in achieving this, not least the slowness of the processes traditionally used in aerospace, Kendall points out that there are opportunities to increase the speed and reduce the equipment costs by relaxing the manufacturing tolerances when switching to automotive applications.

"Material cost is probably the biggest barrier to widespread application of composites in the automotive industry," he says. "So, in addition to reducing the costs of raw materials like fibres and resins, there are opportunities in reducing the cost of converting these materials into fabrics and prepregs. "Waste reduction is also key as current waste levels when stamp-forming blanks is unsustainable. Re-use of this waste in primary component manufacturing processes is an option being investigated."

Meanwhile, Thom predicts that material innovations will be a key part of the use of composite pressing and forming technology, and machinery for the automotive industry over the next few years, for example via the development of what he describes as an "intelligent material mix".

"The use of just carbon composites won't be economical in the near future. The right material at the right position has to be the goal. Additionally, hybrid processes will combine the advantages of composites and steel," he says. "For example, a completely automated process, with significant waste reduction compared to some of the existing processes, will be established and required." *



Audi says PHS grades are at the core of a car's occupant cell and currently ahead of aluminium, comparing the stiffness-weight ratio

Body conscious

The growing trend for OEMs to opt for AHSS components has surpassed the expectations of steelmakers. James Bakewell reports

Audi's decision to use a mass-produced carbon-fibre-reinforced plastic (CFRP) part in the body structure of its A8 may have secured many headlines, but the company's extensive use of steel rather than aluminium in this model may be more significant.

A high-strength combination of steel components make up the occupant cell, which comprises the lower section of the front bulkhead, the side sills, the B-pillars and the front section of the roof line. Indeed, over 40% of the A8 body structure will be made from steel, up by around 32% in comparison with the 2009 model.

About 17% of the A8 body structure will be made of press-hardenable steel (PHS), some of which will be supplied by ArcelorMittal. These steels have yield strengths up to 1,500MPa after press hardening. Some of the sheet metal blanks used in the body are tailored to varying thicknesses, and others undergo only partial heat treatment. This reduces weight and increases strength, especially in areas of the vehicle that are particularly critical for safety.

The head of Audi's Lightweight Construction Center, Bernd Mlekusch, recently told German newspaper *Frankfurter Allgemeine Zeitung*: "There will be no cars made of aluminium alone in the future. PHS will play a special role in this development. PHS grades are at the core of a car's occupant cell, which protects the driver and passengers in case of a collision. If you compare the stiffness-weight ratio, PHS is currently ahead of aluminium."

Kennet Olsson, automotive business development specialist at SSAB, says: "It is a growing trend on the market right now for high-end premium cars, which go from full aluminium to multi-material constructions. This seems to be the optimised solution regarding weight saving and crash performance."

Steel switchback

Joining technologies employed in the manufacture of the body structure include roller hemming at the front and rear door cut-outs. This mechanical, cold technology is used to join the aluminium side wall frame to the PHS sheets at the B-pillar, roof line and sills. Using this process, Audi engineers have realised improvements of up to 36mm at the door cut-outs compared with the predecessor model. That, in turn, makes getting in and out of the car even more comfortable and widens the driver's field of vision around the A-pillar – an area that is key to safe driving.

"Audi switching back to steel for the A8 luxury segment model shows clearly that cost is not the only reason that AHSS [advanced high-strength steels] have the edge," comments ArcelorMittal's chief marketing officer for global automotive, Brad Davey. "When it comes to safety, the performance of steel cannot be matched. Steel is a flexible material that has continuously evolved to keep up with ever-changing vehicle design challenges. And the challenges of better fuel economy are no different."

According to the president of flat-rolled steel distributor LexCentral, Bill Douglass, it remains to be seen how significant Audi's decision to use steel will be. It's obviously good for the steel industry, but Douglass points out that vehicle manufacturers have been making performance cars out of steel for a long time and that this development follows on from a significant blow for the steel industry.

"I think the decision Ford made to switch the Ford F-150

pick-up to aluminium really hurt the steel industry," he explains. "Steel's single biggest advantage is strength and durability, and it had no competition previously in the truck arena. That was a perfect inroad for aluminium, which is much lighter, but nowhere near as strong.

"In the end, I think the aluminium producers were the only winners in that scenario, as they hadn't found a market in trucks until this point. The steel industry obviously lost that round, but I think Ford lost as well. GM was able to leverage its message of strength and durability in ads, and they were right: if you want an extra mile per gallon or so, then aluminium will get you some fuel savings. However, if you want to haul a load of bricks, lumber or whatever else you need to do on a job site, steel is the way to go.

"I think the Ford F-150 is still number one in sales, but any significant loss in market share could be attributed to this decision. Time will tell if this was Ford's 'New Coke' moment, as loyalty in the American car market is strong, especially among truck owners."

Threefold increase

Audi's choice of steel over aluminium is part of a growing trend that is surpassing even the expectations of steelmakers, according to data released by the Steel Market Development Institute (SMDI). Between 2006 and 2015, the use of AHSS in vehicles has grown from an average of 37kg to 124kg – a threefold increase in just ten years. Furthermore, between 2012 and 2015 the use of AHSS has increased by around 10% each year, well above steel industry forecasts.

This increase is not just being seen in luxury vehicles, but in everyday cars too. "The new Chrysler Pacifica body structure is made up of 72% high-strength steels and is 113kg lighter than the model it replaced," says Brad Davey.

"It also features ArcelorMittal's S-in motion five-piece laser-welded door ring, making it one of the lightest minivans on the road, and the only one to earn the NHTSA five-star safety rating. That resulted in the Pacifica winning the North American Utility of the Year 2017 award. The body of the Honda Ridgeline is another example. It is made up of 96% steel, 19.3% ultra-high-strength steel [UHSS], 35.7% high-strength steel and 41.3% other steel."

The new Chrysler Pacifica body is made up of 72% high-strength steels

The need to reduce the weight of their vehicles has driven carmakers to explore the use of a variety of alternatives to steel as they attempt to comply with increasingly stringent regulations on CO_2 emissions and fuel efficiency. For example, all cars sold in the EU can emit no more than 130g of CO_2 per kilometre travelled. This target will be lowered to 95g/km in 2021. As we have seen, Ford has explored the →

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extensive use of aluminium. BMW, on the other hand, has invested heavily in the manufacture and use of CFRPs, most notably in its 'i' models and the 7 Series.

However, according to a report by Tata Steel, carmakers have mostly been able to meet these targets by increasing the efficiency of their powertrains. The use of lightweight materials has had a positive, but minor, contribution to reducing CO_2 emissions. Indeed, the average mass of vehicles sold in the EU actually increased (by around 1%) in 2010-2015. Generation by generation, vehicles continue to get bigger both in terms of their footprint and their volume. Consumers are increasingly purchasing SUVs rather than family sedans, while cars now feature greater levels of safety equipment, in-car entertainment and connected devices.

The use of lightweight materials has helped to minimise mass increases associated with these trends, and much of this is thanks to smarter use of advanced steels, as there has not been a significant shift towards non-ferrous materials during this period. These materials are significantly more expensive than steel, and steel producers have been working hard to improve their product in the face of this competition.

"[Steel] is now thinner, stronger and more exotic in the chemistries used in production," says LexCentral's Bill Douglass. "Steel companies have continued to invest heavily in equipment, helping them to achieve advancements in an age-old industry. Steel has always had the advantages of strength, durability, formability, cost and is a great option for recycling. Even the threat of corrosion was solved decades ago, so the only remaining challenge continues to be weight. That is the challenge."

In response, steelmakers have developed increasingly stronger grades of UHSS for press hardening, and increasingly stronger and more formable grades of AHSS for cold-forming processes.

"Using the latest steel solutions from ArcelorMittal, we have calculated that carmakers can reduce the weight of a car body by 20-25% compared to 2010," says Brad Davey. "Through our S-in motion studies we are now expanding the scope of AHSS applications beyond the body-in-white to vehicle parts such as doors and seats. In the case of doors, weight savings of up to 34% can be achieved."

SSAB's Kennet Olsson continues: "Our strategy is to focus on components that take up the force of energy in a crash, where high-strength steel is the better material than aluminium. CFRPs are very expensive, and while we may see a small increase in the use of these materials, it will still be very limited. Steel is a well-known material in forming and joining and its behaviour is very predictable in a crash. CFRPs are, of course, excellent in weight, strength and stiffness, but they are not very predictable in a crash. Joining is a big challenge also."

Seeking sustainability

Looking to the future, Tata Steel says that increasing demand for ultra-low emission vehicles (ULEV) will drive growth in steel supply to the European automotive industry by 4.2m tonnes. Its study shows that demand for advanced steels for the structure of these vehicles will increase by approximately 2.6m tonnes by 2050, as manufacturers look to save weight in cost-effective ways.

Another key growth area for steel will be in the powertrain used in ULEVs, including electric motors and battery cells. Expected to account for a 1.6m-tonne increase in the demand for steel, these components will use greater levels of electrical and plated steels, respectively. High performance electrical steels can improve an electric motor's efficiency, enhancing range and power, while the lithium-ion batteries commonly used in ULEVs require advanced plated steel.

Tata predicts that aluminium and CFRP will have a relatively low impact on these vehicles for two reasons: firstly, they will remain prohibitively expensive; secondly, they are less sustainable when looking at the full lifecycle, which will be a major, future driver in the automotive industry. Steel is infinitely recyclable with no loss of quality.

"In terms of environmental sustainability, we see our customers moving from tailpipe assessment towards life-cycle assessment [LCA], the true assessment of a vehicle's environmental credentials, from cradle to grave," says Chris Wooffindin, automotive marketing manager at Tata Steel. "This assessment confirms some non-steel materials are

Steel companies are now manufacturing products that are thinner and stronger, with more exotic chemistries

significantly less attractive compared to steel. We believe, and are seeing, that advanced steels are the answer; offering sustainable solutions which suit the automotive industry for both the immediate and long-term future."

Douglass concurs, and is sceptical with regard to the environmental credentials of ULEVs. "Very few people realise that the Tesla weighs about 800lbs more than the BMW 5 Series and the Audi A6," he notes. "As a result, it consumes more energy than its peers. The difference is only in how we measure energy consumption. No thought is given to where the energy used to charge the batteries comes from, or what happens when the useful life of the car or its components is met. Steel is easily recycled whereas plastic sits in landfills and batteries are known to be highly toxic."

Looking to the future, Davey says: "The introduction of autonomous vehicles is not likely to affect the current growth projections for AHSS. There are two main reasons for this. Firstly, for the foreseeable future, autonomous vehicles are going to have to interact on the roads with non-autonomous vehicles. That means existing safety measures will need to be built into these vehicles and AHSS is the ideal material to do this cost-effectively. Secondly, autonomous vehicles will still need to be lightweight (to reduce emissions), cost-effective, and recyclable. Steel is the best material that can fulfil these requirements." ✱

The strength-ductility

High-strength, ductile steels could soon be processed on an industrial scale thanks to a new research project from WMG at the University of Warwick in the UK. James Bakewell investigates

The team at the University of Warwick's WMG claim to have found a way of controlling undesired brittle stages induced in the metal during production. Lead researcher on the project Alireza Rahnama says: "The most important point of this research is that we showed how we can harness the strength of brittle phases – they are not easily shearable – and increase the overall ductility of lightweight steels. It provides fine directions for the design of new lightweight steel."

In recent years, OEMs have turned increasingly to lightweight alternatives to steel, such as aluminium and composites, to reduce the weight of their vehicles. Of course, the steel industry is not taking this threat to its supremacy lying down. It is investing heavily in the R&D of stronger and lighter advanced and ultra-high-strength steels (AHSS and UHSS) in order to compete.

Generally speaking, AHSS is steel that demonstrates an ultimate tensile strength (UTS) of over 500MPa, while UHSS is a steel that possesses a UTS in excess of 980MPa. These materials are used primarily in the body-in-white (BIW) of a vehicle to produce components that must adsorb large amounts of energy in the event of a crash, such as the side, front-side and rear members.

However, there is a tricky balance that steelmakers must find. The stronger they make their metals, the less ductile they tend to become, which limits the methods that can be used to form them into parts.

Multiple phase steels

There is a wide variety of AHSS and UHSS grades, with each type displaying slightly different properties. Typically, they have a martensitic microstructure. Martensite is the hardest and strongest form of steel, but it also is the least formable. To rectify this issue, a mixture of formable and strong phases is required.

The most commonly used AHSS today is first-generation dual-phase (DP) steel – ferritic and martensitic phases for a balance of formability and strength. Currently, DP steels are available with tensile strengths of 590–1,400MPa, and are highly suitable for press forming. Complex-phase (CP) steels can usually be formed more easily than DP steels and contain an additional bainite phase.

Transformation-induced plasticity (TRIP) steels contain retained austenite in addition to ferrite and martensite. When deformed, the austenite transforms to martensite, which helps distribute the strain and increase elongation. These steels are more easily formed than CP and DP steels.

Meanwhile, second-generation twinning-induced plasticity (TWIP) steels are 100% austenite at room temperature. However, high-alloy elements – greater than 15% manganese – cause the formation of twin boundaries when the steel is deformed. These twin boundaries strengthen the steel, enabling them to demonstrate more than 50% elongation at a strength of about 1000MPa.

Rahnama says: "Mainly, TRIP and TWIP steels are currently used in automotive industry. The manufacturing of steel is much cheaper than aluminium and composites. On the other hand, aluminium alloys and composites have lower density, which in turn reduces the car weight, which in turn leads to increased fuel consumption efficiency and reduced carbon dioxide emissions. However, low-density steels benefit from the low-cost manufacturing of steel as well as reduced weight. So, the cars made with this type of steel will be cheaper while lighter."

Martensitic steels are – as their name implies – mostly martensitic with some small amounts of ferrite and bainite. These steels possess exceptionally high strength – 900-1,700MPa – but are difficult to form using any process other than roll forming.

Hot stamped for high-strength

Other UHSS grades can only be formed using hot stamping. Developed in Sweden, this was first used in the automotive industry by Saab in 1984. Using the process, a blank – usually made from boron steel – is heated in a furnace to its austenitisation temperature of around 900°C, formed in an internally cooled die set, and quenched under pressure at a minimum cooling rate of 27°C per second. This minimum cooling rate ensures the formation of a martensitic microstructure in the part, imparting high strength – which can be in excess of 1,500MPa.

This means that it is possible to construct components with thinner gauges of steel than would otherwise be possible. Furthermore, parts with complex geometries can be produced without the problem of spring-back, where a metal tends to revert to its original shape owing to its natural elastic recovery properties.

The entire process, from heating the blank in the furnace to stamping in the die takes between five and ten minutes, but furnace technology has enabled a production rate of one part every 20 seconds or so.

The use of hot stamping has increased significantly over recent years, but the energy required to heat the die makes the process more expensive than cold-forming processes.

Developing new processes

Rahnama has developed a new processing route that allows low-density, steel-based alloys to be produced with a high

trade-off

degree of strength, while remaining durable and flexible – a combination that has been hard to achieve until now.

"Most metallurgical mechanisms for increasing strength lead to ductility loss, an effect referred to as the strength-ductility trade-off," he explains. "This [work] studies the kinetics and thermodynamics of microstructural evolution of lightweight steels through simulations and experiments, and proposes a mechanism to achieve higher strength and larger ductility – a method that can be adopted by industry."

In his work, Rahnama looked at high-aluminium steels, also known as Triplex steels. Compared with TRIP and TWIP steels, these materials possess higher strength (which can be well in excess of 1,000MPa) and increased toughness. Also, their density is lower – 6.5g.cm-3 compared with around 7.85g.cm-3.

However, the high aluminium content of these materials leads to problems. "The addition of aluminium leads to the formation of hard-but-brittle phases such as kappa-carbide (k-carbide) and B2 intermetallic compounds," says Rahnama. These make the steels hard but limit their ductility, so they are difficult to form into parts.

Two lightweight steels have been tested by Rahnama and his team – Fe-15Mn-10Al-0.8C-5Ni and Fe-15Mn-10Al-0.8C – for their potential to achieve both high strength and ductility. Through simulation and experimentation, the researchers have found that at certain high annealing temperatures, the brittle phases in these two steels can become much more controllable, allowing the steels to retain their ductility.

"We developed this process through theoretical work and from mathematical modelling," explains Rahnama. "The initial idea was only to understand the phase transformations occurring in low-density steels. The mathematical models provided us with precise directions and showed us how we can actually obtain better mechanical properties through modifying the microstructure of our lightweight steels."

Between 900°C and 1,200°C, the k-carbide phase can be removed from production and the B2 intermetallic brittle phase can become manageable, forming in a disk-like, nanosize morphology, as opposed to a coarser product that forms at lower temperatures.

According to Rahnama, the process could be easy to implement by steelmakers. "We only need to anneal [the steels] at a specific temperature for a specific duration and cooling rate," he says. Rahnama's process is some way from commercial readiness. In the meantime, steelmakers have been developing their own forms of high-strength, formable steel. Announced in 2014, ArcelorMittal's Fortiform range of ductile AHSS, for example, has been developed specifically for cold stamping, and could reduce the weight of components produced using dual-phase steels by up to 20%.

Fortiform 1050 was the first product in this range to be available on the market, and the first serially produced vehicles to use it will roll off assembly lines this year. As a result of its high tensile strength, Fortiform 1050 steel is particularly suitable for the production of parts that must absorb energy in the event of impacts. Samples of two other grades, Fortiform 980 and Fortiform 1180, are currently available to manufacturers for testing.

Nanostructured steel

Meanwhile, NanoSteel – a family of nanostructured ferrous alloys developed by a US company of the same name – demonstrates elongations of over 20% at ambient temperatures, which presents opportunities for cold forming that are impossible using current AHSS and UHSS grades.

In conventional steel, the grains and matrix that comprise the structure of the material are measured in microns. NanoSteel's alloys are nanostructured, meaning that they feature grain and matrix sizes smaller than 100nm. These nanoscale microstructures impart singular mechanical and physical properties. The NanoSteel alloys exploit two new mechanisms that allow the creation of nanostructures in high-temperature production environments and deliver unique properties upon deformation.

The first mechanism is called NanoPhase Refinement. While most nanomaterials experience grain growth when exposed to high temperatures, the company's NanoPhase Refinement mechanism refines these grains, maintaining these favourable properties.

The second mechanism is Dynamic NanoPhase Strengthening, which occurs after yielding and provides both high strain hardening and usable ductility when the material is formed into automotive parts. *

Conveying the right message

The principle event for production and assembly automation solutions, Motek 2017 has much to deliver for the automotive industry, writes Dermot Healy

Said to be the world's leading event in the fields of production and assembly automation, feed technology, material flow, and industrial handling, more than 900 exhibitors from over 25 countries will attend Motek this October.

Among the exhibitors, Flexlink AB, in Hall 3 will showcase a new service offer including pre-studies, OEE tools and 3D production flow simulations. The company is using Motek to launch its new pallet system for smart production and heavy loads. Prepared for the Industrial Internet of Things, it provides predictive maintenance and comes with pre-defined controls and routing features. Also on offer will be its puck system, X85P, that enables shorter throughput time in production lines. The smart electric handling functions for pucks offers quick routing into machine cells while enabling low maintenance and power consumption.

Motek 2017 aims to give visitors a glimpse of technologies that may affect the automotive sector in future

Elsewhere in Hall 3, conveyor technology specialist Maschinenbau Kitz (MK) will present its diverse range of pallet transfer and plant interlinking system solutions. It will focus on the new TKU 2040 indexing chain conveyor system, which is especially well suited for defined, position-oriented supply and removal as well as for interlinking machining centres. As well as the new TKU, and SPU 2040 accumulating pallet circulator, MK will be showcasing its modular Versamove standard pallet transfer system.

In Hall 8, Beckhoff will present its PC-based and EtherCAT-based control technology for the implementation of efficient automation solutions for assembly cells and handling systems; devices such as its new C6015 IPC with up to four CPU cores in an ultra-compact housing, modular I/O components and scalable drive technology. Assembly cells and control cabinets can be made smaller, and machine builders can scale their investment to the exact performance requirements of their specific application.

In Hall 4, MRB Automation will be one of many companies offering automatic measuring and testing machines. For many years MRB has been developing specialised test equipment, particularly for automotive parts suppliers, so its booth will have particular relevance for visitors from the automotive world.

Profactor is another company bringing expertise for automation projects. Its research-based skills are in machine vision, 3D digitisation and flexible robotics and much of its work is in new areas such as additive micro/nano manufacturing. Colleagues from the automotive field will

be keeping a close eye on these developments, as changes in vehicle production and the possibilities of new technologies break down the barriers between different industrial sectors.

Profactor will present the XRob assistance robot, an intuitive set-up process requiring no programming skills. The emphasis upon ease of use with novel software architecture is one that is likely to be echoed across many of the presentations at Motek. The ability to create and manage robotic processes via intuitive actions with limited training reflects the needs of businesses both large and small.

Krups Fördersysteme will exhibit its latest developments in material transfer and conveyor products. As well as a range of handling and assembly line hardware, widely used for engine assembly tasks, Krups will also feature its Logomat range. This offers a versatile system for conveying pallets and parts of various weights and width. The flexible design characteristics, combined with standardised components, allow for almost all conceivable track arrangements along with the ability to easily modify them afterwards. Logomat also offers turnkey solutions for all its Conveyor Series, which incorporate full controls integration, including the software and the piping and wiring.

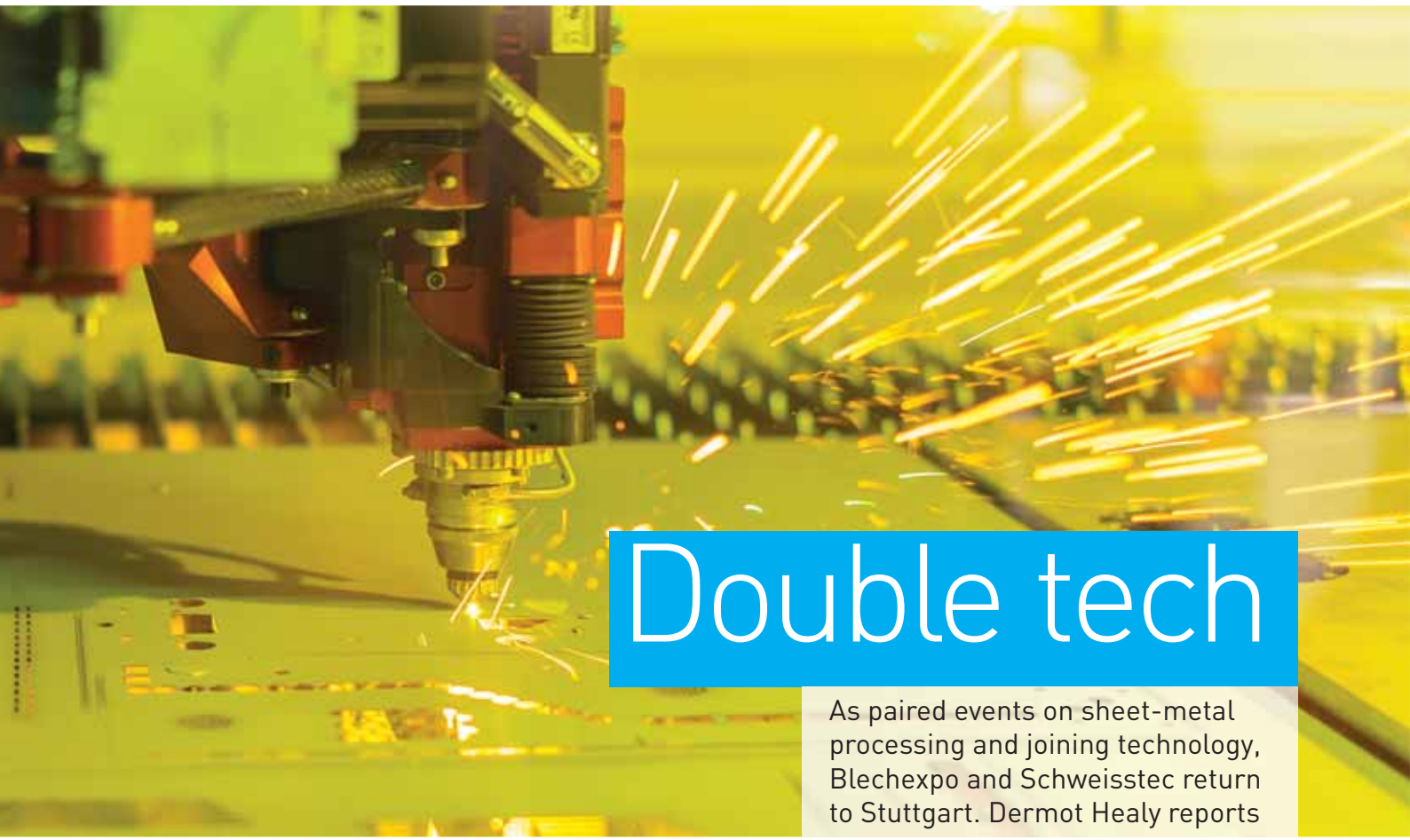
A range of technical presentations on current automation themes will be available to visitors throughout the event. Alongside its traditional automation concerns, in 2017 Motek is continuing its commitment to the field of micro-technology by means of the Microsys Technology Park. The organisers believe that the world of semi-automatic and fully automated production and assembly unfolds within

Profactor will present the XRob assistance robot, an intuitive set-up process which requires no programming skills

an entirely different dimension in microsystems technology than it does in the production of consumer goods and industrial products. The rapidly advancing miniaturisation of components and assemblies may require new strategies and production equipment for economically efficient manufacturing and assembly.

In the longer term, these developments will affect the automotive sector and visitors may welcome the opportunity to view solutions which may, at the moment, be remote from their day-to-day concerns but will in the future have an increasing impact. *

Motek 2017 runs from October 9-12 at Stuttgart Landesmesse. Visit www.motek-messe.de



Double tech

As paired events on sheet-metal processing and joining technology, Blechexpo and Schweisstec return to Stuttgart. Dermot Healy reports

For 2017, Blechexpo and Schweisstec have gained support from all the major names in the sheet metal processing and joining technology field, along with a healthy crop of newcomers. With more than 1,300 exhibitors from 40 countries, the 2017 Blechexpo event will now, for the first time, fill all the halls in the Stuttgart exhibition venue.

Judging from their advance promotional materials, exhibitors across the board at Stuttgart are committed in their desire not just to offer standardised products, but to engage with their customers to provide solutions that really meet their needs. The hope is that suppliers are making the necessary investment in people to build their capacity to do so. Visitors to the shows in Stuttgart will be able to judge the extent to which this ability to act as genuine partners in technical development has become more than marketing cliché and is now an essential prerequisite for successful business.

On display

Exhibitors span the full range of expertise in metalworking and manufacturing. In forming technology, ebu Umformtechnik (Hall 8) will show a punching line with advanced strip feeding equipment, especially designed for the handling of thick sheet metal. The core ebu Umformtechnik product is still its well-established punching automat STA series that is distributed in different designs and with different drive systems. It comes with the smart energy management system – ebu Energetics.

Meanwhile, in Hall 1, Weber LaserService is one of a number of enterprises offering laser cutting equipment and related products.

Also in Hall 1, Belgium-based press brake specialist LVD will showcase its Electra FL, which is capable of cutting a wide range of ferrous and non-ferrous materials as fast as the thermal laser process allows. Also on display will be the ToolCell 135/30 automated tool changing press brake, which cuts tooling set up time to maximise bending productivity.

LVD's patented Easy-Form Laser adaptive bending system provides in-process angle monitoring, which ensures consistent bending results from the first part to the last. The LVD CADMAN software suite facilitates Industry

Belgium-based press brake specialist LVD will showcase its Electra FL

4.0. and helps streamline the complete fabrication process – from production control, communication, planning and management to punching, bending and laser cutting – through integrated, database-driven software that gives real-time insights from the shopfloor and instant control of production processes.

In Hall 6, Walter Heller will display its expertise in resistance welding technology and automation – from the design and concept stage to completed, production-ready facility. As a manufacturer of special machines, Heller looks to develop, design and build to meet customers' specific requirements. Apart from special machine engineering, it is a full-range supplier in the area of resistance welding technology. Heller has been selling the products of TECNA Italy since 1982.

Stahlo, one of Germany's largest independent steel service centres, has production sites in Dillenburg and Gera. Its presentation at Stuttgart will highlight a recent expansion and the development of new facilities. Stahlo is currently working with SAP software solutions for the steel market.

Schmid & Wezel will bring a range of innovative metalworking tools, specific drilling, deburring and grinding requirements, under the BIAX brand.

In Hall 6, Ulamtec will exhibit modular extraction technology, including ATM extraction tables, welding fume filer systems, spark detection and extinguishing equipment, and cyclone pre-separator. The manufacturers claim that their products offer fire protection on a new level, providing reliable protection against flying sparks.

Industry upheaval

From autonomous driving to electromobility, automotive industry manufacturers have to move with several development trends at the same time. ThyssenKrupp points to the fact that dual-phase steels have been developed with these very challenges in mind. At Stuttgart, it will feature new dual-phase steels in the 1,200 strength class.

ThyssenKrupp has expanded its assortment of cold-rolled dual-phase steels far beyond the classic versions of high-strength lightweight structural steels in order to accompany manufacturers in the forthcoming upheaval with suitable and economical material concepts.

The portfolio in the 500 to 1,200 strength classes has now been supplemented by varieties with increased yield strength or increased elongation at break. Of particular interest is likely to be the newly developed DP 1200. Due to its particularly high strength, it is suitable for structural components with special requirements, such as for roof and door reinforcements.

Further fields of application for the new dual-phase steels are longitudinal and transverse beams as well as sills and side impact beams. For surface-refined outer skin applications, dual-phase steels are also increasingly becoming a focus for OEMs. Grades with low sheet thicknesses are in demand, offering the prospect of weight reduction, which remains crucial for manufacturers seeking to achieve the CO_2 target of 95g/km from their European vehicle fleets as of 2021.

SLE Electronic comes to Stuttgart to showcase an environmentally friendly and lasting cleaning solution. Its Microclean compact e-series equipment, to be displayed in Hall 7, features high-performance cleaning systems for endless strips of variable widths. The machines have been specifically developed for the stamping and forming technologies.

By means of diverse adaptations, the systems can be customised at any time to suit particular applications across industry. For special surface requirements a rinsing station, for example, can readily extend the system to neutralise cleaning residues and achieve any rinsing or special surface effects. All SLE products are tuned to individual customer needs and special applications, and thanks to decades of international experience in surface technology, SLE guarantee systems of highest quality.

Panasonic will use the Stuttgart event to draw attention to the potential of its Fusion High Speed Welding. Combining extremely low spatter, along with low heat input and high wire deposition in welding production is a severe challenge. Through extensive research, Panasonic claims that with the increase of short circuit times it is possible to reduce the droplet size, decrease the arc length and minimise the molten pool vibration during the welding process. The resultant flat bead surface with extremely low spatter can be produced within a high-speed welding line.

Situated in Hall 6, machine manufacturer Walter Heller will display its expertise in resistance welding technology and automation

Eberhard Tool Technology will be in Hall 5 showcasing its range of standard and special components for press tools, mould components and fixtures. The company produces a large number of standard parts in an extended range of dimensions and materials. Customised special tooling can be developed to meet the highest requirements with the use of the most advanced technologies and with decades of experience.

Dreher Automation develops, plans, and manufactures highly productive plants for making sheet metal and forged parts. Sheet metal forming, coil handling – uncoiling, straightening, feeding forward and cutting – all of the process steps mesh together and can be tailored. As an automation specialist, Dreher takes customers' blanks through the entire manufacturing process until the finished product emerges. ✱

Blechexpo and Schweisstec 2017 run from November 7-10 at Stuttgart Landesmesse. For details visit: www.blechexpo-messe.de www.schweisstec-messe.de

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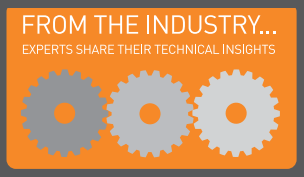

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Digital maintenance assistant

Dürr says its newly developed EcoScreen Maintenance Assistant software will determine the maintenance status of a painting or sealing robot based on actual use, using variables such as the number of valve switching cycles or from the servo motor load profiles.

The system is part of the digital@Dürr concept for Industry 4.0 solutions and uses a simple 'traffic light' system to indicate the current level of maintenance needs – a green wrench shows all is good, yellow indicating maintenance should be planned for the near future and red requiring immediate attention.

The company claims this system provides the maintenance plans on a PC or on the EcoPad tablet, establishes a direct link to the technical operating instructions and updates the maintenance history online. Future development will allow the system to independently analyse data and use intelligent model calculation to perform long-term observations and make comparisons across robots and stations, says Dürr.

✳ **www.durr.com**

Regulated two-stage turbocharger

The regulated two-stage (R2S) turbocharger features a water-cooled compressor housing and consists of two series-connected turbochargers of different sizes to deliver high boost pressures and smooth power over the entire engine speed range, says BorgWarner.

One turbocharger features the company's variable turbine geometry (VTG) technology for the high-pressure stage combined with a larger B03 water-cooled turbocharger, which is optimised for low-pressure exhaust gas recirculation.

Controlled by an electric actuator, the VTG turbocharger responds quickly at low engine speeds, resulting in a rapid rise in boost pressure. As engine speed increases, a bypass gradually redirects the exhaust gas flow towards the larger, low-pressure turbocharger until it takes over the workload completely.

The R2S is fitted to Jaguar Land Rover's new 2.0-litre I4 diesel engine.

✳ **borgwarner.com**

High-speed machine vision camera

The fanless 3-megapixel camera EoSens 3FIBER can transmit data up to a distance of 300 meters through an integrated fiber interface and runs up to 566 frames per second, claims Mikrotron.

Based on a full resolution of 1,696 x 1,710 pixels the frame can be reduced continuously and allows frame rates up to 225,000 at smaller ROIs.

The company says this camera's MTP/MPO connector will remain secure even during fast and sudden movements, and with its c-mount adapter the camera can be integrated into existing production lines, machinery or moving equipment.

Possible applications include various production inspections in the automotive industry.

✳ **www.mikrotron.de**

Polymeric coating for engine bearings

IROX 2 is a new range of polymeric coated crankshaft bearings from Federal-Mogul Powertrain. The company says it has developed this technology to reduce friction and improve the wear resistance and fatigue limit of the bearings used in downsized engines.

The bearings have an overlay that is a PAI (Polyamide-imide) polymer resin binder containing a number of additives dispersed throughout the matrix. These new polymer coated bearings can be used in both light and heavy-duty engines, and are effective in hybrid and start/stop applications that place additional demands on bearings through frequent re-starting, says Federal-Mogul.

✳ **www.federalmogul.com**

Heavy-duty cable carriers

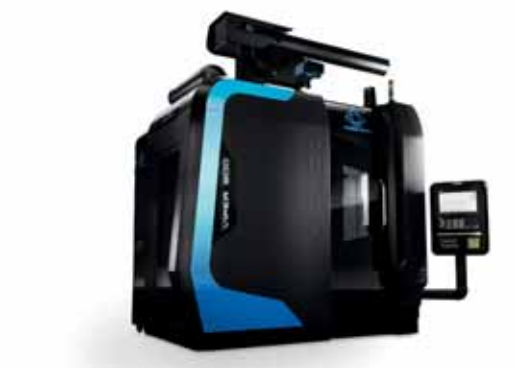
The new TKHD series of heavy-duty cable carriers are suitable for applications with long travel lengths, says Tsubaki Kabelschlepp.

With an inner height of 87mm, the width of the TKHD series can be adapted to the available space and the vertical inner distribution can also be changed flexibly thanks to fixable dividers, claims the company.

The cable carriers can be opened inwards and outwards for installation of cables and hoses, and are also designed to be used gliding, rolling and unsupported.

✳ **www.kabelschlepp.de**

more innovations...



Simplified cylindrical gear machining

Klingelnberg says its Speed Viper platform machines feature a completely revised, ergonomic design and a simplified operating system.

The company says this removes the need for any modifications or corrections to be entered manually, as theses are now automatically loaded using GearPro Operator. A touchscreen display provides operator guidance.

Other new machining equipment includes the Höfler TM 65 complete processing machining centre, which the company claims can produce gear bodies and gearing systems of any complexity directly from rod material. This is complemented by the P 65 precision measuring centre that it's claimed can perform measurement tasks on axially symmetrical components on one device without additional re-chucking and set-up procedures.

✳ **www.klingelnberg.com**

New software for CAD collision testing

The Simatic PDM Maintenance Station V2.0, enables the monitoring of intelligent field device status independently of the automation and control system used, claims Siemens.

Integration is based on DD (Device Description)/EDD (Electronic Device Description) technology and the collected data can be transferred using an export function for further processing, says the company.

Siemens notes that Version 2.0 has been developed to comply with Namur recommendations NE 105, NE 107 and NE 129. The company says the Simatic Process Device Manager is a universal, manufacturer-neutral tool that will supply diagnostic data, status data and parameter data to the Simatic PDM Maintenance Station, where the information is processed and supplemented by additional functionalities such as overview or work progress lists, etc.

✳ **www.siemens.com/simatic-pdmms**

Mobile bending robot

Bystronic's new mobile bending robot can be retrofitted to any Xpert 40 press brake in the field, says the company.

The automation module can be interfaced to the press brake in a plug-and-play arrangement and only takes a short time for users to set up the robotics and load sheet metal blanks for bending, the maker adds.

Programming is carried out offline and the ByVision bending software allows data to be imported without interrupting the job currently in progress. Bystronic says this mobile bending robot allows automatic production for larger runs of components, but can be quickly set aside for manual bending of smaller batches and one-offs.

✳ **www.bystronic.com**

Automated stream finishing

The SF1-Automation with chain loader is one example of its new range stream finishing machines, says Otec. This unit offers a combination of smoothing, polishing, edge rounding and deburring functions and is capable of achieving roughness values as small as Ra 0.01µm, claims the company.

The SF1-Automation chain loader has 64 positions which can change in diameter according to the workpiece or tool to be processed. Tool change time is claimed to be is 14.5 seconds. Otec says cycle times for each tool depend on the complexity of the geometry and standard of finish required but typically range from 30 to 300 seconds. The SF1 is said to be suitable for both dry and wet finishing.

✳ **www.otec.de**

New measurement software release

The launch of PC-DMIS 2017 R2 is the second of two major releases scheduled in 2017, says Hexagon Manufacturing Intelligence.

This latest version features the Slideshow for INSPECT software, which the company says allows users to create customised layouts with inspection results populated during measurement.

Other improvements include better native mesh resolution from import to visualisation, and an improved outlier filter to better handle noise on small arc segments and at the end points of a line.The company says this requires less manual analysis and rechecking by the programmer.

CAD file import is now multi-processor aware, and a new CAD toolbar puts all the tools for CAD import and GD&T selection in one place.

✳ **HexagonMI.com**

Cleaning and machining

The Bonderite dualCys process has proven its worth in a precision tool, machining project at German customer Mapal, claims Henkel.

The company says the process can be tailored to the customer's needs across their value chain from casting and machining to assembly. One of the stated benefits is the recycling of the cleaner into the lubricant bath rather than discarding it as waste.

The dualCys process utilises the synergy between a lubricant and a cleaner says Henkel: Bonderite C-NE 10466 high-performance, water-based neutral cleaner, and Bonderite L-MR 21466 cutting fluid. Both are claimed free of boron and bactericides and have good bio stability.

The system is suitable for most metal substrates, including steel, stainless steel, cast iron and aluminum alloys, claims the company.

✳ **www.henkel-automotive.com**

New software for CAD collision testing

CoreTechnologies says it has developed a new digital-mock-up (DMU) tool for machine and plant engineering. This module for the 3D_ Evolution series for collision testing is specifically tailored to machine and plant engineering needs, claims the company.

The collision calculation takes place on the exact B-Rep descriptions, so that a precise distinction can be made between contact and penetration and the tool will only indicate collisions that are actually present in reality.

The company says the collisions found can be opened directly from a list in the 3D viewer, where the collision areas are marked by curves and clearly displayed.

✳ **www.coretechnologie.com**

Labyrinth seals with interconnected rings

Schaeffler's CoRX and Twin-Ax deep groove ball bearings (for passenger car drive shafts) have two interconnected sealing rings, effectively protecting the inside of the bearing from contamination.

The company says the CoRX bearings use axial and radial seals, while the Twin-Ax units feature two axial lips made from stainless steel. Both bearings have a third sealing lip with designed for minimal interference to ensure that the lubricant stays inside the bearing and improved wear protection.

Schaeffler claims these bearings are suitable for high-speed drive shafts.

✳ **www.schaeffler.com**

Transceiver light curtain system

The new Allen-Bradley GuardShield 450L safety light curtain system features transceiver technology, according to Rockwell Automation.

The company says that unlike safety light curtains that use pre-defined transmitter and receiver units, this system employs plug-in modules to establish each unit's function as a transmitter or receiver. Once powered up, the transceiver learns its functionality from the plug-in module.

Five-pin plug-ins are available for basic on/off functionality, while eight-pin plug-ins provide manual and auto restart with external device monitoring (EDM). Rockwell says that to simplify setup, advanced function settings are configured through dual in-line package (DIP) switches located on the plug-in module.

Suitable for hand and finger detection and offered in a range of protective heights, it's claimed the active sensing field and compact design allow customers to install the GuardShield 450L light curtain system inside a machine frame.

✳ **www.rockwellautomation.com**

Gear skiving options

Liebherr says its LK 300 and 500 gear skiving machines are supplied on a 'turnkey' basis with individual clamping fixtures for each workpiece.

These machines are based on tried-and-tested components of corresponding large hobbing machines. In addition the company says that its newly developed LHGe@rTec control system contains the mathematical formulas for pressure angle corrections.

Also new is an optional tool changer, which can be used to change between roughing and finishing tools. Liebherr alsoit offers a ringloader as a standard option for the workpiece changing device; other automation solutions, such as belts and robots, are available upon request.

✳ **www.liebherr.com**

Automated welding with QIROX

From special technology modules to the box PC to control technology and drives for robotics, Baumüller provides a wide range of solutions for material handling and robotics applications.

One example of the company's automation capabilities is a QIROX QRH-280 six-axis welding robot from Cloos. The robot is completely automated by Baumüller and is driven by six DSH1 servomotors. The company says these motors were developed specifically for applications requiring smooth operation.

The b maXX 5800 controller can operate up to six drive axes, which can be configured individually and flexibly. This means that users can integrate the correct axis power for every single axis so the device can meet the requirements of a given application.

✳ **www.baumueller.de/en**

more innovations...

Five-axis horizontal machining centre

A new, horizontal-spindle machining centre for five-sided and simultaneous five-axis machining, the HF 5500, will be launched by Heller at EMO 2017 alongside the smaller HF 3500, which was introduced last year.

With a 900 x 950 x 900mm work envelope and a maximum pallet load of 750kg, the larger machine offers approximately 200mm extra travel in X, Y and Z plus 200kg additional load capacity, says Heller.

A 'Speed-Dynamics Package' is an option, which the company claims shortens chip-to-chip times by 10%, and a high-speed lift-and-swivel tool changer that reduces idle times further.

Heller says the HF series allows multiple part workholding or one very large component such as a transmission case to be secured.

This series of machining centres is available with a choice of four different spindles, with either an HSK-A63 or HSK-A100 taper, offering speeds up to 18,000rpm and torques to 452Nm.

✳ **www.heller.biz**

Redesigned milling cutters

Pokolm Frästechnik says it has completely redesigned the overall geometry of the milling system to produce its Fourworx milling cutters.

The company says that even the smallest tool diameter (16mm) features three inserts, which it claims allows cutting depths up to ap 0.75mm and feed rates up to fz 1,2mm/teeth to be achieved.

The company also notes that despite the small tool diameter, the new geometry ensures stability in use.

Pokolm says the design of the inserts offers extended service life and good chip removal. In four different grade/coating combinations and with two chip-breaker grooves, they allow the machining of a broad range of materials and are suitable for the machining of steel, cast iron and SAH materials such as titanium and Inconel.

Fourworx is available in diameters up to 42mm as end mills, threaded-shank mills and with the company's Duoplug system.

✳ **www.pokolm.de**

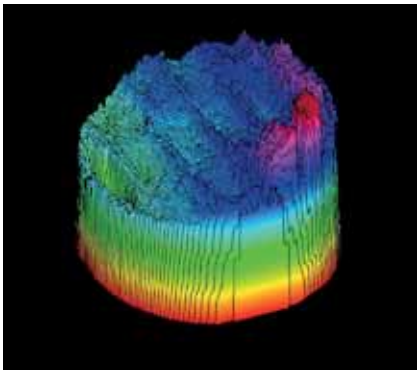
X-ray tech for catalytic converters

3Dx-ray claims its MDXi x-ray system enables manufacturers to check the quality of catalytic converter washcoats inside their metal casings.

The company says its system offers a non-destructive way of viewing internal features and defects of the component, which can be fed back, in real-time, to control the manufacturing process and eliminate problems before they arise.

It is claimed that the image capture and processing software allows users to see and measure sub-millimetre details inside the converter and where needed, it can be tailored to meet bespoke application requirements.

✳ **www.3dx-ray.com/products/industrial-products/**



Primary circuit connectors

Stäubli Electrical Connectors has developed the RobiFix range, a system of primary circuit connectors designed for use on welding robots.

The company says this design allows the power cables to be divided into sections, so that in the event of damage only the affected section needs to be replaced rather than the whole assembly.

RobiFix is designed for single-core, double-insulated cable and requires just a hex screwdriver for assembly. The connector is bolted flat onto the robot or holding plate, so a flange is not necessary.

Another recently introduced component from the company is the RobiFix B-ID a single cable flange-mounted receptacle is angled downwards at 30° to reduce stress on connectors.

✳ **www.staubli.com/electrical**

Air release front-actuated collet chuck

With the elimination of the drawtube Lexair claims its full-bore, fixed length, self-contained collet chuck allows full capacity spindle operation.

The company says, spindle capacity is increased by up to 30%, and clamping pressure is unaffected by centrifugal force, regardless of RPM.

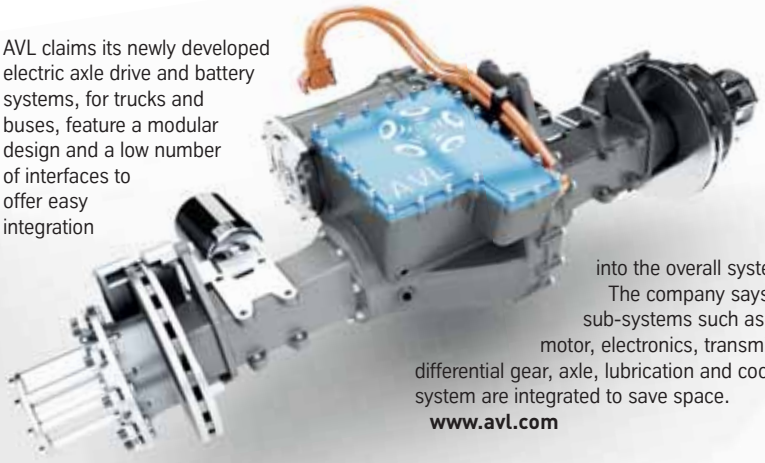
The chuck uses air to release the work, rather than secure it, and spring force holds the workpiece while it is being machined.

The full-bore chuck is available in seven models with body diameters from 6 to 14 inches, and bar capacity from 2 to 5.5 inches. It also features direct spindle mounting for A5, A6, A8 and A11 tooling.

✳ **www.lexairinc.com**

Space-saving E-axle systems for trucks

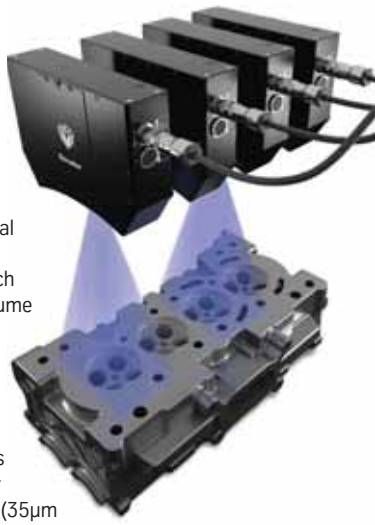
AVL claims its newly developed electric axle drive and battery systems, for trucks and buses, feature a modular design and a low number of interfaces to offer easy integration into the overall system.



The company says that sub-systems such as electric motor, electronics, transmission, differential gear, axle, lubrication and cooling system are integrated to save space.

www.avl.com

3D non-contact volume gauging



LMI Technologies (LMI) has launched the Gocator volume checker – a volume gauging solution suitable for inspecting cylinder heads and piston bowls in small to medium-sized internal combustion engines.

LMI says this approach replaces traditional volume gauging methods (ie. fluids, pressurised air, and acoustics) with a fully automated, non-contact 3D solution.

The system combines the company's Gocator 3210 snapshot sensor (35µm resolution) with custom built-in measurement tools to calculate the volume of engine cylinder heads and piston bowls.

With a claimed cycle time of five seconds, it uses blue LED structured light to take a single snapshot scan and deliver measurement results at ± 0.04cm3 accuracy, claims LMI.

✳ **www.lmi3d.com**

Fluid technology for reaming applications

The proper setting-up of a padded reamer presents particular challenges for the metalworking fluid, says Quaker. The fluid is required to deliver the necessary lubrication in a sufficient film thickness and also emulsion properties that will carry away the fines produced in the cutting process.

The company says it has developed a semi-synthetic fluid technology, Quakercool 7450, designed for reaming applications, that provides the required tapping performance in heavy-duty machining operations such as on automotive aluminium alloys.

Quaker claims the formulation of this metalworking fluid provides the necessary lubrication at the pad/metal interface for surface finish requirements while also maintaining efficient fines handling.

It is free from formaldehyde and boron and meets HSE compliance says the company, and offers foam, emulsion and bio stability.

✳ **www.quakerchem.com**

Mini-spectrometer for colour measurement

The C13555MA is the latest edition to the TF series of mini-spectrometer for colour measurement applications from Hamamatsu Photonics. The company says this USB-powered polychromator contains optical elements, a driver circuit and a built-in 512 pixel CMOS sensor. A USB connection allows any acquired spectrum data to be transferred to a PC.

✳ **www.hamamatsu.de**

more innovations...

Automated welding systems

Cloos says it is developing and manufacturing automated welding systems to meet the specific requirements of its customers. The company says its range offers compact systems as well as complex, chained systems with automated workpiece identification and loading and unloading processes.

The new QIROX QRC-290 welding robot offers an entry into automated welding, while the QIROX Operating System (QOS) and the new programming surface QIROX Technology Interface (QTI) for the robots offer ease of use and a reduction of the programming times claims the company.

Further control system products include the QINEO Data Manager (QDM) software, which the company says offers control and the management of welding power sources from a central PC.

✳ **www.cloos.de**

Pneumatic management development

Festo claims its VTEM motion terminal combines the latest developments in piezo technology and software to offer an Industry 4.0 solution for pneumatic control applications.

The system uses piezo technology, integrated stroke and pressure sensors together with control via motion apps.

Changes in pneumatic functions and adaptations to new formats are controlled via the apps by changing parameters, while the integrated sensors for control, diagnostics and self-learning tasks will eliminate the need for additional components, claims the company.

At launch, the company says the VTEM motion terminal offers ten different functions via motion apps, with more in development.

✳ **www.festo.com/motionterminal**

New 3D measurement and imaging tools

The new QuantumM measurement arm is certified to ISO 10360 -12:2016 and tests to the International Electrical Commission (IEC 60068-2) standards for shock, vibration and temperature stress relief, says Faro.

The system includes the FAROBluTM laser line probe HD, which, it is claimed, enables five-times faster scanning than the previous generation, including complex surfaces comprised of dark and reflective materials.

The new unit is said to be 20% lighter than its predecessors and requires no warm up time.

The company says that the system's industrial grade wireless connectivity and dual, hot swappable batteries allow for continuous operation anywhere on the factory floor without the need for external power.

✳ **www.faro.com**

3D snapshot uses 'Time-of-Flight' technology

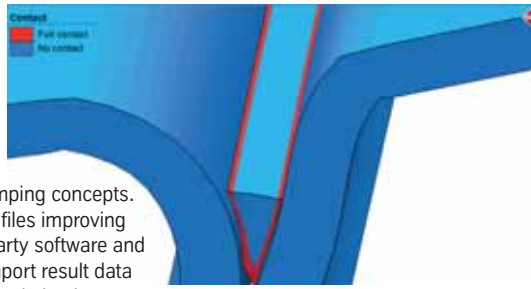
The Visionary-T is an industrial imaging camera that can capture high-resolution 3D data with a single snapshot, says Sick.

The system uses high-resolution Time-of–Flight (TOF) technology to achieve 3D imaging for vision applications and the image is captured with one shot of light, without the need to profile a moving object, claims the company.

Available in two different models, the Visionary-T CX delivers raw data as depth, intensity and confidence values without any post-processing or reduction for in-house processing and program formulation, while the Visionary-T AG outputs filtered data in formats pre-selected by the integrator, OEM or other user.

✳ **www.sick.com**

Welding simulations for sheet metal structures



Welding 7 is the latest version of Simufact's software for the simulation of welding processes, which the company claims offers shorter processing times, more accurate results, and a more intuitive operational use.

Functions include solid-shell elements, simplified calculation methods for resistance spot welding processes and the more flexible consideration of clamping concepts.

The company claims this software can import UNV files improving the compatibility of the welding software with third-party software and interoperability in the process chain. The user can import result data from third parties such as from forming or casting simulation into Simufact Welding in order to edit these files or use them for subsequent calculations.

✳ **www.simufact.com**

Ultrasonic processing of plastics

Weber Ultrasonics and Hufschmied Zerspanungswerkzeuge have developed ultrasonic systems for milling, cutting and sawing brittle lightweight materials.

The companies claim these systems use reduced process forces so in the processing of carbon and glass fibre the material removal rate is higher.

In addition, they claim tool life is increased through reduced strain on the tools.

According to the developers these new resonant systems can improve processing accuracy. Delicate workpieces can be manufactured with gantry systems and it is possible to use industrial robots as alternatives for the implementation of an automated production process.

✳ **www.weber-ultrasonics.com**

Storage technology

As an option for its storage and retrieval systems for long stock and sheet with energy recovery (surplus kinetic energy, produced in braking or lowering of lifting gear, converted into electricity and fed back into the grid) Kasto says it can now supply its automated storage systems with an integrated energy storage unit that allows for flexible use of the recovered power.

The company says this solution, which can be retrofitted to existing installations, can reduce energy costs and also improve the quality of the supply because power is continuously drawn and load peaks are avoided.

✳ **www.kasto.com**

Pulsed fibre laser welding system

An updated version of the LMWS pulsed fibre laser welding system is now available, with Amada Miyachi claiming it is suitable for welding dissimilar metals, including copper to aluminium, aluminium to stainless and steel, and copper to stainless steel. With a change of settings, it can be used to mark welded parts.

The company says the system features a high-power, high-speed laser, available in 20-70 Watt (W) powers for welding metals and plastics, and is available with a variety of integration options to match process needs. It comes standard with an XY galvanometric scanner and integrated stage controllers for up to 4 axes of motion.

✳ **www.amadamiyachi.com**

Tube and pipe bending machines

The CNC 100 E TB MR tube-bending machine is equipped with numerous components, which can reduce downtimes and increase productivity, claims Schwarze-Robitec.

Features include the Quick Tool Unlock rapid clamping system, which allows for a fast change of bending tools.

The company says this machine can be used to bend a wide range of different tube and pipe dimensions.

✳ **www.schwarze-robitec.com**

Digital welding solutions

Fronius says that documenting, visualising and analysing data from welding processes is becoming increasingly important in production operations.

The company claims its new WeldCube data management system makes it possible to record, analyse and evaluate welding data across multiple power sources, and help the user to identify any potential areas for improvement on welding production lines.

The company says it is also offering new technologies to support welder training with its virtual Weldcation app.

✳ **www.fronius.com**

ams november-december 2017

OEMs in focus

MAN

AMS visits the company's Salzgitter plant as it upgrades and expands production in readiness to supply its VW Group stablemate, Scania

MAN has upgraded its Salzgitter plant as it expands production

Jaguar Land Rover

We report on the OEM's growing manufacturing footprint, including its first wholly owned factory outside the UK

Itatiaia in Rio de Janeiro State is JLR first wholly owned plant outside the UK

global focus – South Africa

Despite political and economic challenges, this country has become an important export hub

Development programmes in South Africa hope to get annual production up to 1.2m by 2020

production – paintshop

AMS looks at the latest OEM paintshop projects and new technologies, aimed at improving quality and throughput as well as meeting environmental challenges

Our next issue features a special section dedicated to paintshop technology

technology – additive manufacturing

We examine new developments in additive manufacturing and explore how virtual reality is becoming an important tool for the automotive industry

From assisting prototyping, AM use in volume production is now being explored

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Tel: +44 (0) 1353 665 576 Fax: +44 (0) 1353 669 030
e-mail: ultimacirculation@wyverndm.co.uk
Single copies available at at €30 / $40 / £20.

ULTIMAMEDIA Ltd, 401 King Street, Hammersmith, London W6 9NJ, UK
Tel: +44 (0) 20 8987 0968 Fax: +44 (0) 20 8995 5600

ISSN 1471-6038

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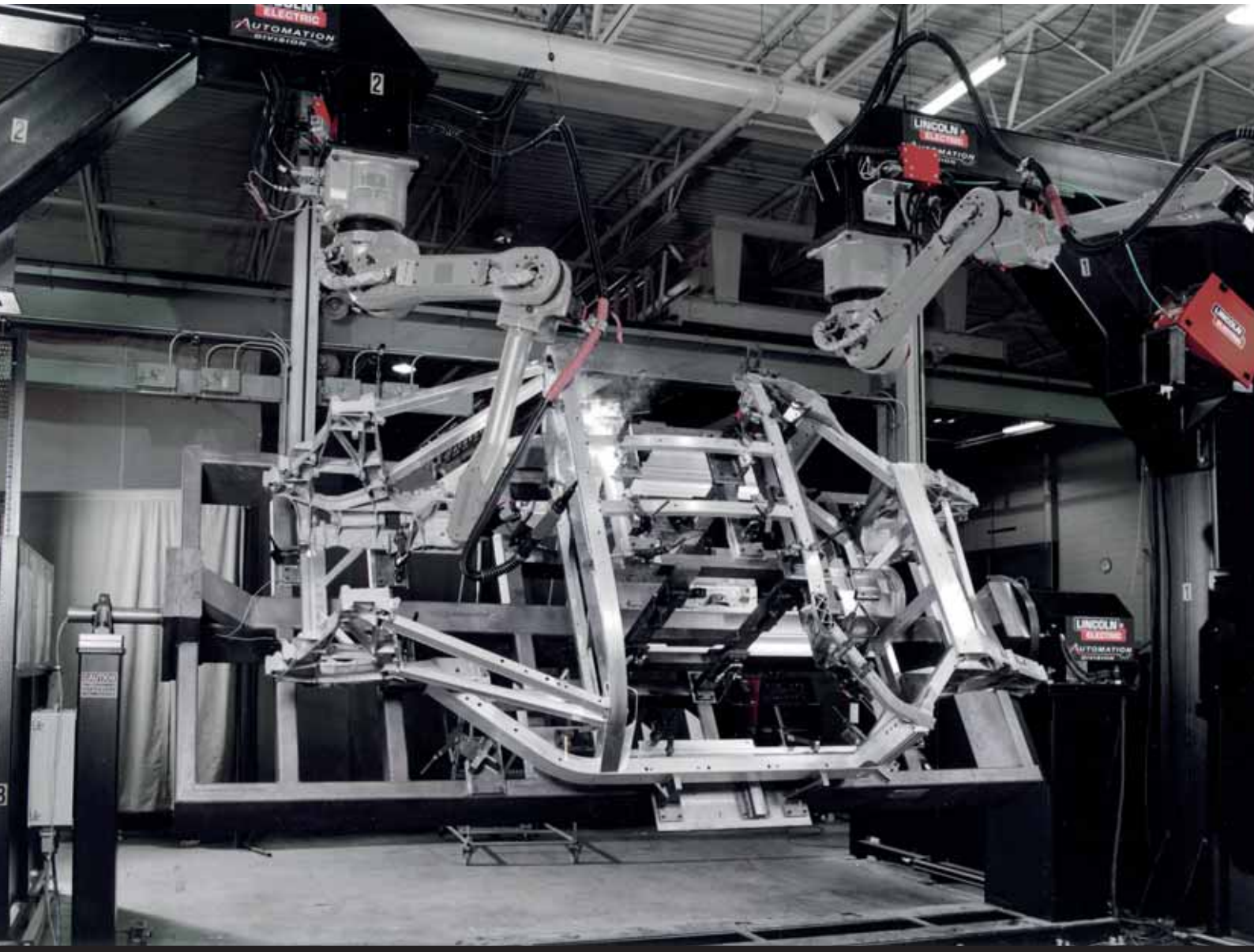

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