THE MAGAZINE FOR INDUSTRIAL VEHICLE TECHNOLOGY, DESIGN & ENGINEERING

SEPTEMBER 2018

iVT INTERNATIONAL
INDUSTRIAL VEHICLE TECHNOLOGY

"New machine forms with artificial intelligence are coming to agriculture"

Mark Von Pentz, president of agriculture, John Deere, Europe, CIS, Asia and Africa

AUTOMATED SWARMS APPROACHING!

International OEMs have prototypes that will transform farming in the next 10 years

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For more information, please visit www.elobau.com

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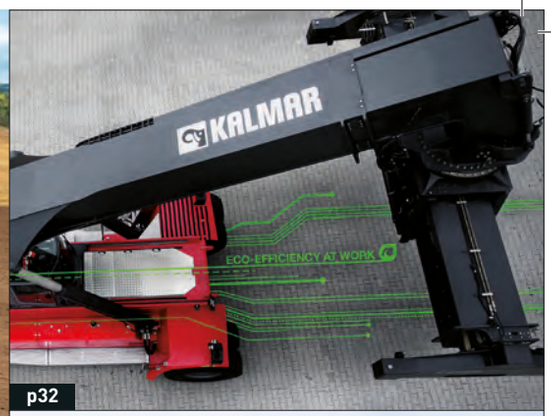
Agricultural machinery OEMs are building autonomous prototypes with swarm intelligence. James Allen reports



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AGRICULTURE SPECIAL

25 YEARS

Vol. 26 No. 3

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Deputy Editor Rachelle Harry
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Circulation Manager Adam Frost *adam.frost@ukimediaevents.com*

Editorial Director Anthony James
Managing Director Graham Johnson
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PRODUCTS & SERVICES

FOREWORD

Listening to the radio today, I heard a DJ wonder out loud whether there will ever be another truly massive rock band. Like this magazine, he was celebrating 25 years in his particular line of work. And, like this magazine, he is well respected for an in-depth knowledge of his field. Old enough, then, to have seen a few small garage bands rise to global domination, and even see some then fade away again, back into relative obscurity. So why did he think that the dynamics of the music business are changing? His argument was that there are now so many different genres of music – and ways to access them – that fans can much more easily develop their own unique taste, making it more of a challenge for one act to capture collective imaginations in the same way that they might have done, even just 10 years ago.

Increasing choice and greater specialization are trends that are seen in virtually all industries today, including in agricultural machinery. Whereas 100 years ago the only vehicle a farmer could even dream of owning was a tractor (see an example of a machine from this era on p112), today there are self-propelled balers, sprayers, spreaders and seeding machines, along with harvesters of all types. And now the predictions from the leaders of the industry (such as John Deere's Mark Von Pentz, whom I interview on page 14) are that vehicles could soon start to get smaller and even more specialized. Artificial intelligence and swarm technology (more on those in our cover feature on p40) will see these smaller machines operating autonomously with only minimal need for human intervention. Does this mean, then, that future farms will be worked by dozens of whirring drones, trundling shoebox-like 'droids' and scuttling spider bots, with no need for the big hero machines of old? It's one vision… but not one that's completely shared by the folks at Tribine Harvester in Kansas.

The Tribine T1000 (see page 64 for a full case study) is very much in the 'bigger is better' camp. The visionary designers at this startup OEM asked themselves, why should a harvester need a tractor and trailer to run alongside it in a support role? Why not just make the harvester itself big enough to hold the grain until it gets it to the next proper unloading point? And so, out of that simple premise, a new breed of harvester has been born. One that can hold 1,000 bushel loads in its grain tank. One that is articulated and yet keeps compaction levels lower than in smaller rivals. One that is, in short, a strong contender for becoming an agricultural 'rock star' of the future.

In a world of ever-increasing specialization, there's still room for true genius to shine through and capture the imaginations of millions. We await the Springsteens of tomorrow…

Tom Stone, Editor, iVT International

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JAMES ALLEN, IVT INTERNATIONAL

Automation collaboration

FOR ITS LATEST CONCEPT VEHICLE, VOLVO CE SOUGHT INSPIRATION FROM AN UNORTHODOX SOURCE, HELPING IT CREATE AN AUTOMATED WHEEL LOADER THAT PUSHES THE BOUNDARIES OF CURRENT DESIGN THINKING

Volvo Construction Equipment's latest concept vehicle – the Zeux – is an autonomous electric wheel loader, designed in collaboration with toy range Lego Technic.

"This is a journey we started two years ago with a very open session with Lego," explains Volvo CE emerging technologies engineer Joakim Unnebäck. "It was good for us because we know our business but we can become blind to fresh ideas.

"At Volvo I'm usually the creative guy, but this time Lego was also bringing lots of ideas to the table and my role was more to consider the engineering perspective and implications. I had some good ideas as well, but most came from Lego!"

The fresh insights led to some of the quirky designs included in the vehicle. The most prominent of these influences is the scorpion-tail-like tentacle protruding from the rear of the machine. At its tip is a camera for observing humans who happen to be in the immediate vicinity.

"When you cross a road, you watch for dangers and try to make eye contact with drivers. It's instinctive and helps you evaluate your next move," says Andrew Woodman, senior design manager for Lego Group.

"Should you stay where you are, or is it safe to move? It's usually an easy assessment. But with autonomous vehicles you don't have that interaction because you can't see all the sensors that allow them to navigate around both stationary and moving objects.

"It's not intuitive for us as humans to decode what the vehicle's next move will be, where it's going, or if it has seen us. While the Zeux would not be driving on roads, it would be interacting with workers at a construction site. So we set out to create features and functions that make the interaction between humans and machines as safe and intuitive as possible."

Currently only a concept vehicle, the Zeux will serve as an inspirational tool for Volvo CE engineers in bringing to market autonomous electric vehicles that will make the construction sites of tomorrow safer places. **iVT**

On the Web

For more images of the Zeux from Volvo CE, visit **www.ivtinternational.com/zeux**

NEW BUCKET DYNAMICS

The scissor frame design means that the bucket can be held closer to the front axle in the carry position when the rear end is low. "The rear end of the machine is raised to achieve reach and dump height, to unload the material onto a truck," explains Unnebäck.

DRONE
The drone supports the autonomous system on the Zeux by mapping the wider surrounding area.

THE EYE
Intentionally visible, the camera at the tip of the tail 'sees', but also serves as a visual aid for interacting with pedestrians in the immediate vicinity.

LIGHTS
The lights indicate the machine's status – whether it is in or out of operation and available to work or not. Together with 'the eye', the lights indicate what the machine is up to and its intended direction.

INNOVATIVE SCISSOR FRAME
"My favorite feature is the scissor frame [patent pending], which includes the suspension," says Volvo CE's Joakim Unnebäck, who specializes in machine applications and concepts. "It gives the bucket greater freedom of movement than in a conventional wheel loader. This is only possible on an autonomous machine, as you don't have to consider operator comfort."

STABLE STEERING
The operator benefits that come with center hinge steering are not needed on an autonomous machine. Thus the Zeux has Ackerman steering on both axles to replace the center hinge steering, which helps further improve stability and capacity.

Lego has produced a scale model of the Zeux, which is available to buy

POINTS IN HISTORY

IN THIS ISSUE YOU'LL FIND SOME OF THE LATEST ADVANCEMENTS IN AGRICULTURAL MACHINERY TECHNOLOGY. SO, AS THE CELEBRATIONS FOR *iVT*'S 25TH ANNIVERSARY YEAR CONTINUE, WE DECIDED TO TAKE A LOOK BACK TO WHEN PRECISION FARMING WAS STILL IN ITS INFANCY TO SEE HOW FAR WE'VE COME

25 YEARS

1998

The price and specialist nature of a Massey Ferguson Fieldstar terminal meant you were unlikely to have one in each machine – you needed to move the terminal around

"The solutions may require utilization of another implement; therefore the Fieldstar system can be easily transferred from one machine to another. The terminal is reprogrammed for a tractor, using the Fieldstar data card, and then transferred to the tractor, for which a fitting kit is necessary. The transfer will take about 15 minutes, and when complete, will only display information relevant to the implement being used on the tractor."

2001

By 2001, GPS systems, as found on New Holland's new CX harvesters, were becoming more common

"The DGPS antenna, receiver and datalogger are modular. The receiver and datalogger clip into wiring looms in the roof, so no additional boxes or wiring are needed."

Precision farming was a buzz phrase of the nineties and early noughties. Following the declassification of military GPS in 1983, companies such as Massey Ferguson had been working on ideas and prototypes that would put this new technology to profitable, civilian use. By 1991, its trials were complete and Massey Ferguson launched Yield Mapping – a system that enabled farmers to record varying yield across a defined area as they harvested it, thereby creating maps that could be used in the future to inform soil treatments.

Tests proved that the theory worked. And, even though three years' harvest data was recommended for accurate maps, the system was an instant hit. Massey Ferguson reported steady growth in the sales of combine harvesters that featured the technology right through the 1990s.

It was in 1998 that *iVT* reported on a new development in Massey Ferguson's Yield Mapping – the addition of the all-new Fieldstar system that included a touchscreen terminal in the cab, linked to GPS. The system helped to automate more of the precision farming tasks, creating application maps based on yield, which could then be used to automatically control later fertilizer usage.

Some of the processes involved are archaic by today's standards. There was no cloud computing or cellular connectivity available, and data had to be laboriously transferred from harvester, to data card, to office desktop PC for processing, back to data card, and back into the terminal of next machine that required it. Also application maps were fairly general, covering relatively large areas of land. Nevertheless, the seeds were sown for the much higher-precision, more fully automated systems of today, which now stand on the threshold of not simply area-specific field analysis, but plant-by-plant crop care. **iVT**

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BELAZ LAUNCHES A RANGE-COMPLETING DUMPER

New 290-ton machine means BelAZ is now represented in all weight classes

BelAZ, the Belarusian manufacturer of haulage and earthmoving equipment, has officially launched its BelAZ-75320 290-ton dumper. The vehicle is designed for the transportation of rocks in open-pit mines on haul roads, as well as in the difficult mining conditions of deep quarries.

The launch of the dumper means BelAZ has filled a niche for dump trucks with a lifting capacity between 240 metric tons and 360 metric tons. It is a totally new weight class for the company, meaning it is now represented in all recognized classes of payload capacity for mining dump trucks.

The new truck is equipped with 2,125kW (2,850hp) Cummins engine and a new-generation AC drive system by General Electric. Together they ensure maximum traction on slopes. The drive system also includes a brake-track master system, an anti-skid system, speed control while descending, automatic speed limitation, and a diagnostics and monitoring system.

The BelAZ-75320 is 15.5m (51ft) long, 8.58m (28ft) wide and 7.06m (23ft) high. The distance between the front and rear bridges is 6.5m (21ft), while its minimum road clearance is 0.72m (2.4ft). The total weight of the vehicles is 500 metric tons, of which 165 metric tons is on the front axle and the remaining 335 metric tons is on the rear axle. The maximum (technically permissible) load is 290 metric tons.

BelAZ states the new truck can operate in extreme climates – anywhere between -50°C and +50°C (-58°F and 122°F).

SATELLITE-GUIDED **AUTONOMY**

BelAZ plans to start mass production of a robotic dump truck this year, according to the company.

General director Petr Parkhomchik has announced that the autonomous dump truck will have a payload capacity of 130 metric tons.

"This is a fundamentally new design, harnessing the concept of self-controlled technology," he says. "The system of satellite navigation, based on GPS/GLONASS, will ensure movement of the vehicle from the place of loading to unloading."

To ensure safety in the movement of the truck it will also be equipped with an opto-electronic system for obstacle avoidance.

Parkhomchik adds that autonomous vehicles are becoming more in demand in mining due to a lack of qualified drivers and the challenges represented by the unsafe conditions found in mines.

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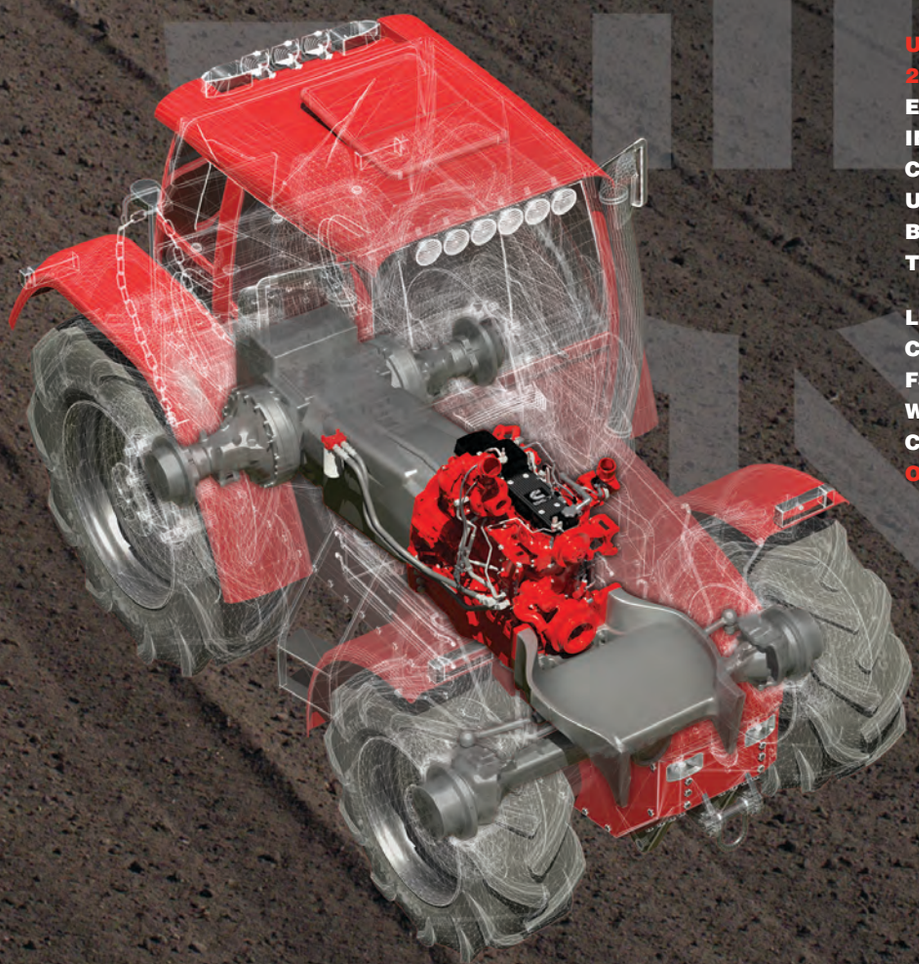

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Best Utility Nominees

The new contenders

At the EIMA International Agricultural and Gardening Machinery Exhibition in Bologna, Italy, November 7-11, the Tractor of the Year awards will be announced. Here, we size up the contenders in the Best Utility and Best of Specialized categories. For the main category nominees, turn to page 72

Steyer Kompakt 4115 HD

3.4-liter
four-cylinder engine, providing 114hp (84kW)

1,670kg
Front hitch lift capacity (3,682 lb)

Standard transmission: 12 x 12 Synchroshift with mechanical shuttle

40km/h
Maximum speed (25mph)

Case IH Farmall 75A

2.9-liter
three-cylinder engine, providing 75hp (55kW)

Fendt 313 Vario

4.4-liter
four-cylinder engine, providing 130hp (97kW)

Massey Ferguson MF 6713

4.4-liter
four-cylinder engine, providing 130hp (97kW)

5,200kg
Maximum lift capacity of electronically controlled rear linkage (11,464 lb)

TRACTOR OF THE YEAR AWARDS 2019

Best of Specialized Nominees

Landini Rex 4-120 F/GT

Ideal for use in orchards and vineyards, the Landini Rex 4-120 F/GT series tractor is available with a comfortable, fully air-conditioned cab, which has been designed to offer improved vision, more functionality and more precise controls, compared with previous models.

The cab is also available with Protection Class 4, guaranteeing total protection for the operator during spraying operations by sealing him in a pressurized environment monitored by sensors.

Innovations can also be found in the front axle, which is now offered with central suspension system for the very first time. The Rex 4-120 can offer 112hp (82kW) from its Deutz 2.9-liter TCD engine.

Antonio Carraro TTR 7600 Infinity

The TTR 7600 is a wide-track reversible drive tractor with hydrostatic, infinitely variable transmission and an ACTIO frame. Its Kohler 2.5-liter engine has a maximum power output of 74hp (55kW).

A multifunctional contender, it is suitable for use in a wide variety of situations, including on steep inclines. It can be used for edge cutting, mountain or hill haymaking; and maintenance work on green or urban areas, roads and sports grounds.

The short wheelbase and tight steering radius make the tractor extremely agile. To further reduce the turning radius, the steering brakes can be used, while accentuating the steering effect obtained thanks to the double-acting constant velocity joints.

Same Frutteto CVT 115 S

Innovative features of the new Same Frutteto CVT S specialized tractor – designed for work in orchards and vineyards – include a continuously variable transmission, a completely redesigned cab with MaxCom armrest, and a hydraulic system with 100 l/min load-sensing pump.

The vehicle is powered by a 3.8-liter FARMotion engine that delivers 113hp (83kW) at just 2,200rpm, and is very compact and economical to run. The new CVT transmission also enables the tractor to attain a top speed of 40km/h (25mph) at low engine speeds, for significantly lower fuel costs when transporting by road.

The machine can be controlled not only without selecting gears, but also without touching the clutch, throttle or brakes, using just the new joystick and a dedicated dial to select engine operating mode. **iVT**


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New machine forms with artificial intelligence are coming"

IN A FRANK DISCUSSION, **MARK VON PENTZ** – PRESIDENT OF JOHN DEERE'S GLOBAL TRACTOR PLATFORM AND ITS ENTIRE AGRICULTURAL AND TURF DIVISION ACROSS EUROPE, CIS, ASIA AND AFRICA – CHARTS HIS CAREER AT THE COMPANY AND LOOKS FORWARD TO THE DISRUPTIVE TECHNOLOGIES OF THE NEAR FUTURE

Thirty years ago agricultural vehicles were unstreamlined boxes on wheels that belched diesel fumes indiscriminately into a world largely unconcerned by questions of air pollution – at least in the open fields where such machines operate. The functions of vehicle attachments were set using levers and switches (mention a 'communications protocol' to a farmer and you might have been suspected of being an industrial spy from behind the Iron Curtain) and artificial intelligence was confined to sci-fi movies of the era, such as *RoboCop* and *Aliens*.

It was at this time that a young Mark Von Pentz got his first apprenticeship at John Deere, the company he now helps to lead as president of its agricultural division in Europe, CIS, Asia and Africa. When *iVT* recently caught up with him at his office in Mannheim, Germany, he was happy to reflect on how far the industry has come since those days in the late 1980s. But he was much more excited talking about the future and was brimming with ideas about how farming machinery will soon change, possibly beyond recognition, driven by an increasing rate of innovation.

"When I look back over the past 30 years I think the most important changes have been on the emissions side," says Von Pentz. "But also, in vehicle design, the overall efficiency there has had to improve, too. The third big change has been the move into digital farming, which has been going on now for the past 10 years."

"WE WANT TO HAVE AN OPEN ARCHITECTURE SYSTEM SO THAT WE BECOME LIKE THE APPLE APP STORE, WHERE OTHER PEOPLE'S APPS CAN RUN ON OUR SYSTEM AND CONNECT TO THE MACHINE"

Mark Von Pentz

Navigating through history

Indeed, John Deere was paving the way for digital farming even before the turn of the millennium, with satellite navigation tools. "We grabbed the bull by the horns on this 20 years ago when we introduced – based on a purchase in California [of NavCom] – our own systems and satellite rights," says Von Pentz. At the time some questioned whether a tractor manufacturer needed to be investing in space technology. "People were shaking their heads about our move and wondering why we had done it. Nobody discusses that now. These GPS-based steering systems started with a 20cm [8in] accuracy and got down to 10cm [4in]. Now we're below 2cm [0.8in] with RTK [real-time kinematic] systems."

While the level of GPS accuracy is clearly a huge selling point, it is having a proprietary system that really helped Deere to steal a march on the competition. "The beauty is we have it all in-house," says Von Pentz. "It is still the only in-house system in the whole industry. These systems function better when we don't have to share them with others. Whatever advances we make we keep them in the 'green-yellow line'. For our customers it means we are a one-stop shop. If something goes wrong, they go to their John Deere dealer to fix it. With the

LEADING THE WAY IN CONNECTIVITY

The first industrial revolution was characterized by the advent of steam power and mechanization. The second saw the harnessing of electricity and the development of methods of mass production through assembly lines. The third was driven by the rapid uptake of computers and digitization and was well underway when Mark Von Pentz began his career at John Deere back in the 1980s.

Many now believe we are entering a fourth industrial revolution – or Industry 4.0 as it has been tagged. This is characterized by the ongoing revolutions in connectivity, enabled by the Internet of Things, cloud computing and cyber physical systems. It's a brave new world where agricultural machinery has a head start over many other sectors.

"We have the ISObus norm – standardized communication where everything can be connected," says Von Pentz. "That's the advantage in the agricultural sector, compared with most other players in Industry 4.0. For at least 15 years it has been the basis of precision farming, which means we're 5 to 10 years ahead of Industry 4.0. When I look into our factory halls, the machine centers, the CNC centers, they don't have a common language. They don't have that connectivity. It's bizarre to think that sometimes they're still run by spreadsheets! To bring everything together will take much longer. We laid the foundation in our sector with the ISObus norm."

For more of the latest on ISObus turn to page 48

ABOVE: **Keeping farmers connected while they are at the wheel is one of the new aims of John Deere**

competition, you're sent between different parties and they might say, 'It's not our problem, it's theirs."

Open source code

But just because the system is proprietary, doesn't mean it's also closed. Having an accurate, reliable guidance system is the foundation for precision farming, and now that is in place, John Deere is happy to work with other developers. "Everything that comes on top is software," says Von Pentz. "Connectivity is built around positioning, so having that all in-house is the beginning. But when it comes to opening source codes of the machines and the CANbus systems, we can do that. We want to have open architecture so we become like the Apple app store, where other people's apps can run on our system and connect to the machine."

He also has a clear picture in his mind of how precision farming systems must be developed, supported by three key elements of innovation. "Firstly, you have machine optimization, with remote surveying and maintenance. That's where all our activity started. Globally we already have more than 200,000 machines 100% connected, which means customers have better machine availability. The second 'leg of the stool' is job optimization. How do you improve fertilizer applications and spray with higher precision? That involves AI.

"The third 'leg' is agronomic optimization and that connects with job optimization. We call it decision support, because there are a number of players in that area with whom we don't want to compete – we want to enable them. To do this we have developed what we call the John Deere Operations Center. It is open to hundreds of thousands of applications that we connect with so-called 'advanced protocol interfaces' that are available free. We do development workshops to attract companies to join us, and provide them with free access to the system, which is kind of an ecosystem on its own."

Spray AI

Returning to the second 'leg of his stool', that of job optimization, Von Pentz is excited about some of the developments underway in spraying technology. "In the herbicide sector 90% of what you spray is wasted. Less than 10% hits the weeds," he says. This startling, environmentally alarming statistic is part of what prompted John Deere to make another Silicon Valley acquisition last year – Blue River. It's one that could prove as valuable to its business as the NavCom purchase in the late 1990s. "Blue River is

KILLING WEEDS WITH AI

In September 2017 Deere & Company bought out California-based Blue River Technology for US$305m.

Blue River is a leader in applying machine learning to agriculture and has designed and integrated computer vision and machine learning technology that will enable growers to reduce the use of herbicides by spraying only where weeds are present.

"Blue River is advancing precision agriculture by moving farm management decisions from the field level to the plant level," says Jorge Heraud, co-founder and CEO of Blue River Technology. "We are using computer vision, robotics and machine learning to help smart machines detect, identify and make management decisions about every single plant in the field."

At the time of the deal, John May, president of agricultural solutions and chief information officer at Deere, said, "We welcome the opportunity to work with a Blue River Technology team that is highly skilled and intensely dedicated to rapidly advancing the implementation of machine learning in agriculture. As a leader in precision agriculture, John Deere recognizes the importance of technology to our customers."

Deere has kept the 60-person firm in its home in Sunnyvale, California, with the objective of continuing its rapid growth and innovation with the same entrepreneurial spirit that has led to its success.

"IF YOU ONLY NEED 5% OR 10% OF THE ORIGINAL SPRAY VOLUME, THEN YOU CAN START THINKING ABOUT WHETHER YOU REALLY NEED THE MACHINE IN ITS CURRENT FORM"

Mark Von Pentz

ABOVE: **Drones are already being tested for spraying, but John Deere believes precision techniques could make them more effective**

a company that's deeply into artificial intelligence," explains Von Pentz. "They actually reduce the amount of spray that has to be used, by having decisions taken in a millisecond behind the camera, using AI and high-speed processing. The Blue River system can identify if it's seeing a plant that shouldn't be sprayed, or if it's a weed that needs to be sprayed. So you only spray where needed, not the entire field."

John Deere has demonstrated the amount of herbicide required with this new system is 10% of what would traditionally be required. Engineers are optimistic they can get this even lower, perhaps to just 5% of the previous chemical load.

The Blue River system consists of a high-resolution camera that can be mounted on the reinforced boom of an existing sprayer, along with a processing unit that also needs to be incorporated on the machine. It is then able to harness individual nozzle control systems – which already exist on modern spraying equipment – to target application of the herbicide. "There's room for further optimization that could eventually mean multiple channels of liquids go into multiple chambers, so that you have different herbicides sprayed with the same machine," says Von Pentz. "But that's in the future. Eventually it will require a different boom and machine form.

"If you only need 5% or 10% of the original spray volume, then you can start thinking about whether you really need the machine in its current form, with its level of compaction and all those undesirable things. Maybe you can put it up in the air, perhaps in a drone, because whereas you previously needed a 5,000-liter tank [1,320 US gallons], now you only need a 500- or 250-liter tank [132 or 66 US gallons] tank to do the same work. Maybe it could still be on wheels, at half or a quarter of the size, but it will still be able to do two to three times the surface area you get now. New machine forms with artificial intelligence are coming to agriculture. Could they work in swarms? Yes, because we have demonstrated that is possible." (See page 40 for more on the growing possibilities of swarm systems.)

Alternative fuels

As new machine forms take shape, another key question is how they will be powered. Rumors of the demise of the internal combustion engine may have been somewhat exaggerated in recent years, but that doesn't mean engineers should write off the continuing advances in electric power. "Electrification is coming. The only question is, in which form?" says Von Pentz. Last year John Deere's prototype SESAM tractor hit the headlines as the first heavyweight contender in the all-electric agricultural sector. "It has pretty tough duty cycles of one to two hours in the field," says Von Pentz. "But we need 12 hours, right? Eventually even 15. So the question is, can battery technology improve by 10 times? Two to three times, yes, everybody predicts that, but to

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ABOVE: **The complexity of the new 9000 series self-propelled forage harvesters from John Deere would have baffled a young Von Pentz, who liked to help repair farm machines as a boy**

THE MAN BEHIND THE TRACTORS

Mark Von Pentz is clearly an astute businessman who has risen to his position after many years of hard work – but he had a head start. His career journey began in childhood."I grew up on a farm, and my forebears have been nothing but farmers for hundreds of years!" he laughs.

It was on his parents' farm that Von Pentz first got the agricultural machinery bug, as well as an understanding of business. "I was the person on the farm at home who was interested in the tractors as well as agronomy, which is now part of precision farming. I always had that technological leaning.

"I was put to work in the workshop to help service the tractors and combines – it helped lower the repair costs! Today that kind of thing is no longer thinkable, but when I grew up it was still possible and I always loved it and asked the mechanics how stuff worked and connected. So I had a natural tendency and passion for it growing up."

achieve greater improvements quickly there may be other, more viable optimization models – such as fuel cells and hybridization. For small lawn tractors that only need to be used for four hours at a time, is full electrification possible? For sure, yes. It greatly depends on the duty cycle that you're facing."

As always, John Deere is not afraid to try new things. "Recently there has been stuff online about how we tested electric tractors on a long cable," says Von Pentz. "Is that practical? Can that be done? We don't know, but we are reaching out to those extremes."

"YOU COULD SAY WE'RE 'BETTING THE FARM' ON PRECISION FARMING!"
Mark Von Pentz

Despite the rise of alternative fuels, John Deere still has big hopes for the combustion engine, and Von Pentz believes there is plenty of scope for further optimization. Already, he points out, the newest engines act, in a way, as air purifiers. "From a particle point of view, the air they take in is often dirtier than what comes out," he says. "But we can further improve efficiency. There's more opportunity for the combustion engine because it can be used everywhere. And the fuel cell as an alternative right now is much easier to handle than electrification, as again you're more independent."

Deere diary

The next big event in Von Pentz's calendar is the EIMA agricultural machinery show in Bologna, Italy. "It's an important fair for us," he says. "We will make some big announcements. There will be new harvesters and tractors and also more announcements in the area of precision farming. We will continue to introduce new solutions that connect machines together to make jobs easier and help connect the tractor, farmer, dealer and agricultural advisers. These are the themes we're driving toward at full speed. You could say we're 'betting the farm' on precision farming!"

Up in the air

But EIMA is just one event in a hugely busy schedule for Von Pentz. As a member of the John Deere board he regularly has to fly to all corners of the globe. "I spend a lot of time on planes and working remotely – sometimes three out of four weeks," he says. "Often I have to attend board meetings in the USA. That takes me over there 16 times a year and there will usually be a few more times for other reasons."

Then there are factory visits. "The global platform responsibility I have is for tractors," he says. "So I visit factories in South America, Asia, Europe and North America. The other responsibilities I have are in Europe, Africa, Asia and CIS, so that keeps me in those markets. It's a lot of traveling but I've always liked this industry. It's a privilege to work for a company like John Deere, with its values and the way we do business.

"It has been said, 'Choose a job you love and you'll never have to work another day in your life.' And I love to talk to farmers and dealers and to compare manufacturing techniques – Asia versus South America versus North America. There's always genuine excitement around farming."

Given he's so deeply immersed in his work, you'd be forgiven for thinking Von Pentz is a workaholic who rarely takes time off. But you'd be wrong. He takes a vacation each year and enjoys watching and playing sports in his spare time. But, ironically for a man who spends a great deal of his working life on planes, what he likes doing most in his time off is flying.

"It's crazy, right?" he laughs. "I fly like almost nobody else, all around the world, and then I look up in the sky and say, 'It's beautiful weather today. Time to get up in the air!'"

But he finds there's something about piloting your own plane that makes it the ultimate escape. "When you're flying you have to focus and you can't think about work or any other problems. You have to fully concentrate on flying the plane."

And yet, as Von Pentz banks away into the blue, toward the continuously unfolding horizon, we can imagine him snatching a quick glance at the patchwork of fields below and thinking about the machines that work them – and how to make them better. "Actually," he says, "you do see a lot from up in the air. It's good to get a bird's-eye view..." **iVT**

On the Web
The launch video for Deere's new 9000 harvesters is at **www.iVTinternational.com/jd9000**

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CHRIS McCULLOUGH, IVT INTERNATIONAL

WHAT MAKES A CONSTRUCTION VEHICLE DIFFERENT FROM AN AGRICULTURAL ONE? SOME COMPARABLE WHEEL LOADERS IN THE SCHÄFFER RANGE DIFFER ONLY IN PAINTWORK, BUT OTHERS HAVE KEY DESIGN FEATURES TAILORED TO THEIR TARGET MARKETS

Reds

Yellows

Manufacturing wheel loaders to suit both the construction and agricultural industries can be a challenge, but one German company seems to have perfected the formula and is witnessing an increase in demand from both sectors for its new machines.

Based in Erwitte, Germany, Schäffer has a long history of wheel loader production and today produces two ranges – in two color schemes, red and yellow – specific to agriculture and construction.

The family company produces around 5,000 machines a year for direct sale – not for stockpiling – adding to the already 70,000 Schäffer loaders in operation around the world today.

Schäffer was founded in 1956 by Heinrich Schäffer, who launched a harvesting fork for front-end loaders in 1960. He progressed into manufacturing front-end loaders in 1963 before developing Schäffer's first compact wheel loader, the D25, in 1979. It was a crucial moment in the company's history.

Now producing loaders from 20hp right up to 157hp (15-117kW), Schäffer exports them all around the world and is moving with the times to meet customer demands with new models in both sectors, as well as dipping its toe into the electric loader sector.

"CONSIDER HOW THE RESPECTIVE MACHINES ARE LIKELY TO BE USED AND THESE DIFFERENCES BECOME THEIR STRENGTHS"

Sebastian Bertelsmeier, product specialist, Schäffer

While Schäffer naturally enjoys a strong market share in its home territory in Germany, around 65% of its production is for export. With that market expanding, Schäffer is currently establishing new export markets in the USA, Turkey, Israel and South Africa.

Farming today

Schäffer changed the image of its agri spec wheel loaders in January 2018 and since then all machines for this sector have been finished in a new red and gray color scheme.

Agri spec models range from the smaller compact range of loaders starting with the 2020 model at just 20hp up to the largest telescopic 9660T wheel loader at 157hp.

There are 15 models available in the agri spec compact loader range, a further four as wheel loaders, and an additional 10 telescopic models and variations.

The compact range of agri models is one of Schäffer's most successful series, offering models from the 2020 to the 4250, using Kubota three and four cylinder engines.

Developed primarily for work in confined spaces, these compact machines are also very sturdy and can be used even at extreme temperatures – from -30°C (-22°F) in Iceland to 45°C (113°F) in Australia.

The wheel loader range offers models from the 4350Z to the 8600Z, the latter capable of lifting loads up to 3.8m (12.4ft), making it one of the highest lifting loaders in its class.

If a telescopic loader is required in agri spec then the models from

KEY **DIFFERENCES**

Though they may, on the face of it, look similar, there are key differences between Schäffer's machines for agricultural and construction industry use.

Sebastian Bertelsmeier, product specialist for Schäffer, says, "As those with experience of the Schäffer brand will know, features, functions and technologies are developed to meet the needs of operators. This philosophy has shaped the company's success.

"As performance requirements of the two markets are different, so too are the machines. One of the most noticeable differences between the machines is that for the construction sector the front part of the machine is lower.

"If you consider the smaller loaders, the 24 series for construction and the equivalent 23 series for agriculture, in addition to a lower front section, the 24 series has a stronger lifting cylinder as standard.

"For example, the construction sector 2445 has a tipping load of 1,700kg with pallet fork and a lifting height of 2.5m (8.2ft). The agricultural sector 2345 has a tipping load of 1,100kg but a lifting height of up to 3.11m (10.2ft).

"Consider how the respective machines are likely to be used and these differences become their strengths. In the construction sector there is likely to be far more heavy lifting at relatively lower heights, such as when loading pallets of bricks onto a truck, as opposed to stacking relatively light straw bales as high as possible in agriculture."

2.5m
Maximum lifting height

1,700kg
Tipping load

1,100kg
Tipping load

3.11m
Maximum lifting height

WORLD'S FIRST **LITHIUM-ION BATTERY YARD LOADER**

Also introduced at Agritechnica in 2017 was Schäffer's entry into the electric loader market, the Schäffer 23e model, which the company claims to be the 'world's first yard loader with a lithium-ion battery'.

Two electric motors with high-voltage technology are responsible for the working and driving hydraulics on this machine.

As with all these electrically operated machines, they can potentially offer major savings in maintenance and operating costs compared with diesel models and other battery concepts.

The new electric 23e from Schäffer delivers emission-free operation, eliminating exhaust gases and noise, which is a great advantage in sectors – such as agriculture – that require work in closed environments.

Schäffer offers an onboard charger as standard, which is operated with a standard 230V power supply. Customers can add an optional 400V external charger for even faster charging as the power battery system is charged in just 30 minutes.

This means that a quick charge, for example during a lunch break, gives the machine enough energy for the entire working day. The battery can be charged at any time without affecting its lifetime, which is another advantage of lithium-ion technology.

Schäffer guarantees 5,000 charging processes or five years of operation, whichever comes first.

"Thanks to this pioneering technology, we can guarantee this extraordinarily long battery lifetime," says Friedhelm Brede, head of development at Schäffer. "In addition, lithium-ion batteries are absolutely maintenance-free, there is no danger of lead or sulfuric acid and the 23e works reliably even at low temperatures.

"The 23e's maintenance requirements are much lower than those of the diesel model. Much higher efficiency and considerably lower energy costs per hour of operation give additional savings potential.

"The 23e is likely to be of particular interest and benefit to those generating electrical energy in the form of a biogas or photovoltaic system," adds Brede.

Schäffer claims the 23e is the only battery operated loader available on the market that reaches a speed of 20km/h (12.5mph).

"THANKS TO THIS PIONEERING TECHNOLOGY, WE CAN GUARANTEE THE EXTRAORDINARILY LONG BATTERY LIFE"

Friedhelm Brede, head of development, Schäffer

4.2 metric tons
Lifting capacity of the 8620T

the 2345T right up to the largest 9660T will satisfy demand. All the wheel loader and telescopic wheel loaders are powered by Kubota and Deutz diesel engines.

Schäffer's latest model for the agricultural sector is the 8620T loader that was introduced at Agritechnica 2017 and replaces the popular 8610T model.

The machine boasts a wealth of options, including a choice of two engines and various speeds and heights, so Schäffer is confident that it provides a tailored solution for larger farms, biogas plants and agricultural contractors.

The two engine options are a 75kW/102hp or 90 kW/122hp Deutz engine. Both meet the Tier IV final emissions standard without the need for a maintenance-intensive diesel particulate filter.

BELOW: **The electric 23e yard loader is designed for closed working environments**

While the standard driving speed is 20km/h (12.5mph) the 8620T is also available with a maximum speed of 40km/h (25mph). An additional option allows the telescopic wheel loader to be used as a towing vehicle with a permissible towing capacity of up to 12 metric tons.

The 8620T drive concept is also new and includes High Traction Force and SPT (Schäffer Power Transmission) as standard, even on machines with the smaller engine.

HTF is an automatic thrust-control system that enables the loader to deliver the highest thrust, even in high gear. This means manual downshifting is not necessary when driving uphill or into a pile. SPT is the electronically controlled drive from Schäffer that improves agility and offers the driver a number of new possibilities. One of these options is cruise control, to keep the machine at a constant driving speed regardless of engine speed, which is particularly advantageous when working with feed dosing devices, straw distributors, mulchers and brushes.

The 8620T is particularly efficient in Eco driving mode, a fixed component of the 40km/h version. When the maximum speed is reached and maintained, the engine speed is automatically reduced, giving lower operating costs, reduced noise levels and more environmentally friendly use.

With an operating weight between seven and eight metric tons, a lifting height at the tool pivot point of 5.2m (17ft) and a lifting capacity of 4.2 metric tons, the

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FAR LEFT: **The yellow line (construction vehicles) was introduced in 2014**

LEFT: **Schäffer is headquartered in Erwitte, Germany**

2.5m

Maximum lifting height of the construction spec Schäffer 2445 wheel loader

ABOVE: **The company produces loaders from 20hp to 157hp (15-117kW)**

8620T telescopic wheel loader offers an ideal combination of features for demanding loading work.

Silence, comfort, view

A further highlight of 8620T is the new SCV-Plus cab, which is now also used on the 96 series machines. SCV stands for 'silence, comfort, view'. Generous glazing provides the driver with optimum all-round visibility, and a new airflow concept and adjustable side windows ensure a good supply of fresh air. The loader is optionally available with a low cab, with a total height of 2.67m instead of the standard 2.77m.

Schäffer's construction range of models has been manufactured since the 1980s but its 'yellow line' range of construction machines was introduced in 2014 and the latest model in the range, also a 8620T, has virtually the same features as the agri spec model.

Although Schäffer has been building wheel loaders for the construction industry since the company was founded, the range was given a revamp in 2014 with the arrival of the yellow line.

Built at the Schäffer factory in Erwitte, the yellow line is a modern series of wheeled models and wheeled telescopic models ranging from 26hp to 157hp (19-117kW).

The construction range starts with the 2428 model, rated at 26hp and powered by a Kubota three-cylinder engine, up to the 9640T model, powered by a 136hp (101kW) four-cylinder Deutz Common Rail Turbo with Intercooler, meeting Tier 4 final.

There are 12 models that make up the construction spec wheel loader range and a further nine with telescopic booms.

Schäffer says all its loaders lift relatively heavy loads despite low operating weights. Specific to the construction spec machines, the tipping load of the smallest 2428 loader is 1.7 metric tons, thanks to a specially designed front end that is lower than on the standard machine and a stronger lifting cylinder.

On the construction models, the thicknesses of the swinging fork and supports were increased to match the performance gains. The lifting height of these loaders is between 2.3m (7.5ft) and 3.8m (12.5ft).

To give the construction machines better maneuverability on building sites and in farmyards, the SLT versions in both the lines have a low overall height (1.89m for the 2428 SLT and ag-spec 2028 SLT) and width (just 0.9m in the 2428 SLT and 2028 SLT).

The loaders can thus also drive through very low passages and are suitable for use in underground car parks. Plus, the SLT machines' low center of gravity results in higher tipping load and better stability.

For the larger telescopic wheel loaders in the construction spec, 10 models have an operating weight between 2.9 and 13 metric tons.

Depending on the model, the maximum lifting height is between 3.75m (12.3ft) and 6.1m (20ft). Schäffer says the Ferro-Form sliding members of the telescopic arm are virtually indestructible. The tool cylinder is located within this arm and thus protected from damage.

The machines achieve very good break-out forces via the integrated Z-kinematics, and so are the ideal workhorse on the building site. **iVT**

On the Web

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DAVID SMITH, IVT INTERNATIONAL

AS EMISSIONS REGULATIONS TIGHTEN AROUND THE WORLD, KALMAR IS KEEPING ONE STEP AHEAD OF THE COMPETITION WITH AN ALL-NEW RANGE OF ECO-EFFICIENT REACHSTACKERS – AND ONE EYE ON AN ALL-ELECTRIC FUTURE

Global re

Kalmar, part of Cargotec, has an impressive track record of innovation, helping it to maintain its position as one of the market leaders in cargo-handling equipment and port automation for several decades.

With the industry now moving toward more fuel-efficient vehicles, Kalmar's latest step is to introduce an Eco Reachstacker – the first in an all-new range of Eco machines. It's part of an ambitious program that means that by 2021 all Kalmar mobile equipment will be available in electronically powered versions.

The reachstacker is one of Kalmar's most iconic machines, in production since the 1980s and still one of the company's most used products, with sales dominated by the European and Asian markets. There have been many advances over the years, but Dan Pettersson, senior vice president of mobile equipment at Kalmar, says the Eco range represents one of the biggest leaps forward. "It's just the start of a far-reaching process," he says. "Our ultimate target is to become fully electrical with no internal combustion engine, so there would be a huge saving on fuel as well as lower maintenance costs. As with all technologies, it might be more expensive initially, but the cost will fall over time."

Perfecting the technology

The Kalmar Eco Reachstacker is a combination of new and old technologies. It uses proven HVT transmission, smart programming, intelligent controls and a small but highly efficient engine.

"This new system operates by splitting the power sources depending on the operational needs of the machine," says Pettersson. "The hydrostatic slow-speed drive delivers

ABOVE: **First-phase Eco Reachstacker will meet EU Stage 4/EPA Tier 4 Final emission levels**

smooth, efficient power, while the mechanical high-speed drive activates when additional power is needed. The smart control system splits the power in the most intelligent way to maximize drive and lifting efficiency for every move you make.

"This enables the machine to operate with a much smaller engine than other reachstackers, providing dramatically reduced fuel consumption, less noise and much lower emissions."

Kalmar is so confident about the Eco Reachstacker's performance that it is offering guarantees to customers that it will considerably reduce fuel consumption and emissions. The company's calculations suggest that an average 5- to 10-year-old Kalmar reachstacker consumes 47,145 liters (12,454 US gallons) of fuel a year compared with 41,067 liters (10,848 US gallons) for a one- to five-year-old machine, but consumption drops to 33,270 liters (8,789 US gallons) for the new Eco version. The figures for carbon emissions are 155, 135 and 109 metric tons respectively.

"The fuel guarantee will relate to the customer's specific application, says Pettersson. "The guarantee will be reviewed after 12 months of use. If the agreed reduction is not met, Kalmar will pay back the difference in fuel."

Pettersson says that the stabilization of operations in a fast-moving regulatory environment is an important matter for many customers, as well as for Kalmar as the manufacturer. Increasingly stringent regulations have forced constant redesigns of older models, meaning greater stability will be achieved when all machines are fully electric and emissions are reduced to zero. The Eco Reachstacker is an important step on the way.

One eye on the future

The decision by Kalmar to go down the electric route for reachstackers makes a lot of sense when one considers the wider context. Many manufacturers believe new container handling equipment will be electrically powered by default in 10 years' time. There are parallels with other industries, especially automotive, that have even more ambitious roadmaps. For example, Volvo has pledged to cease developing new-generation diesel engines for cars because the cost of reducing NO_X emissions is becoming too high.

There are, of course, regulatory pressures to reduce emissions. The container industry may be a little behind other sectors because of the relatively small volumes, but it is catching up fast. "One reason we

"THE NEW SYSTEM OPERATES BY SPLITTING THE POWER SOURCES DEPENDING ON THE OPERATIONAL NEEDS OF THE MACHINE"

Dan Pettersson, senior vice president of mobile equipment, Kalmar

took the decision to introduce a complete Eco range over the next few years is because our industry is evolving at a remarkable pace," says Pettersson. "Governments, local and regional authorities around the globe are rapidly deploying regulations and initiatives to support the adoption of eco-efficient technologies. A prime example is the Clean Air Act in California, according to which, by 2020 the state is dedicated to reducing emissions to what they were in the 1990s, and 40% below that a decade later. As a result of the new regulatory environment, more customers are asking for electrically powered equipment and solutions that cut emissions."

2020
The year by which California is aiming to reduce emissions to 1990s levels

Although the biggest source of emissions at ports is the ships, followed by road vehicles, container machines must also do their bit. Several container ports, including Los Angeles, have unveiled roadmaps to reach zero on-site emissions. Meanwhile the APM Maasvlakte II Terminal in the Netherlands is aiming to achieve 100% sustainably sourced energy use.

One way port authorities are seeking to reduce emissions is by increasing automation, which means using fewer reachstackers. This could result in fewer sales for Kalmar at some major ports, but Pettersson says that any reductions will be more than offset by the increase in globalization and trade.

"The number of smaller terminals is growing, and more or less all goods are transported in containers today, so we will see the total number of reachstackers increasing rather than declining," he says.

Investing in the future

Confidence in the market has given Kalmar the faith to invest in the new electric technologies, although few of its competitors have been so bold. Nevertheless, the future will require some adjustments and Pettersson strongly advises special training for operators. Kalmar offers a range of courses for technicians and operators to help them get the most out of the machines. They are shown how to optimize their driving and what functions need to be checked daily.

"Once they've had the training, the operators will find the Eco Reachstackers much easier to drive than other machines, as their smart programming does a lot of the work. Drivers will no longer need to rev their engines to get the lifting and handling speeds they want, nor will they need to hold the brake when lifting and lowering while stationary. This will dramatically reduce the strain and stress on their bodies," says Pettersson.

Similarly the ecological performance should reduce the stress and strain on the machines, meaning total lifetime costs of electrically powered reachstackers will be far lower than for diesel-powered equipment. In a recent white paper on how to reduce container industry emissions, Kalmar suggested these benefits held even when taking into account the need to replace battery packs at the end of their expected 10- to 15-year life. Its research suggested the main reason for improved lifetime costs for fully electric equipment was the simplified drive installation. It meant there were fewer wearing parts, as well as a decrease in the use of consumables, such as engine and lubrication oils. **iVT**

On the Web
Watch the launch of the Eco Reachstcaker at **www.iVTinternational.com/eco**

CUSTOMER REACTION

The Eco Reachstacker was launched as recently as June 2018, but customers have already reacted enthusiastically. The Dutch transportation logistics company Cabooter Group has had a long-standing partnership with Kalmar and recently upgraded many of its reachstackers to the Eco range.

Peter Pardoel, manager for business development and operational excellence at Cabooter, says, "Compared with the old ones, it's like giving the operators a Ferrari when before they were using an old Volkswagen. Everything is better, including the environment, the usability, the noise reduction, and even the view. It will give us a competitive advantage, but it's also eco-friendly and cost effective because it will stabilize our processes."

Kalmar's Dan Pettersson says that early adopters of Kalmar technologies have been especially vocal in demanding electric technologies. The trend has been apparent for several years in the smaller forklift classes, with the majority of customers switching to electric. Last year Kalmar introduced fully electric machines for its heavier forklifts (9-18 tons).

Kalmar is providing two options for customers wanting to acquire the Kalmar Eco Reachstacker. They can either buy the machine or lease it. If they purchase one outright, it comes with the Kalmar Fuel Saving Solution, which guarantees a reduction of fuel consumption, as well as operator training and a three-year license of the Kalmar SmartFleet remote monitoring solution. The leasing option involves paying a monthly fee for a fixed period.

"Leasing is not something new for Kalmar," says Pettersson, "but what is a first is that we are offering a 'full operational' lease that includes everything: the preventive maintenance, corrective maintenance, and even tires and fuel. We want to simplify things for the customer, with one invoice, predictability and cost control."

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AGRICULTURE SPECIAL

FEATURING

Swarm technology: Will miniature robot armies take over the farm? **p40**

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EXCLUSIVE
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JAMES ALLEN, IVT INTERNATIONAL

Illustration: Sean Rodwell

Swarm w

AGRICULTURAL ROBOTS USING SWARM INTELLIGENCE HAVE BEEN DISCUSSED FOR AT LEAST TWO DECADES, BUT NOW, WITH AT LEAST ONE MAJOR OEM GOING PUBLIC WITH ITS TECHNOLOGY AND MANY MORE SMALLER RESEARCH PROJECTS IN PROGRESS, COULD THE TIME FINALLY BE RIGHT FOR REAL-WORLD DEPLOYMENT? AND WILL FARMERS ACCEPT THESE NEW MACHINES?

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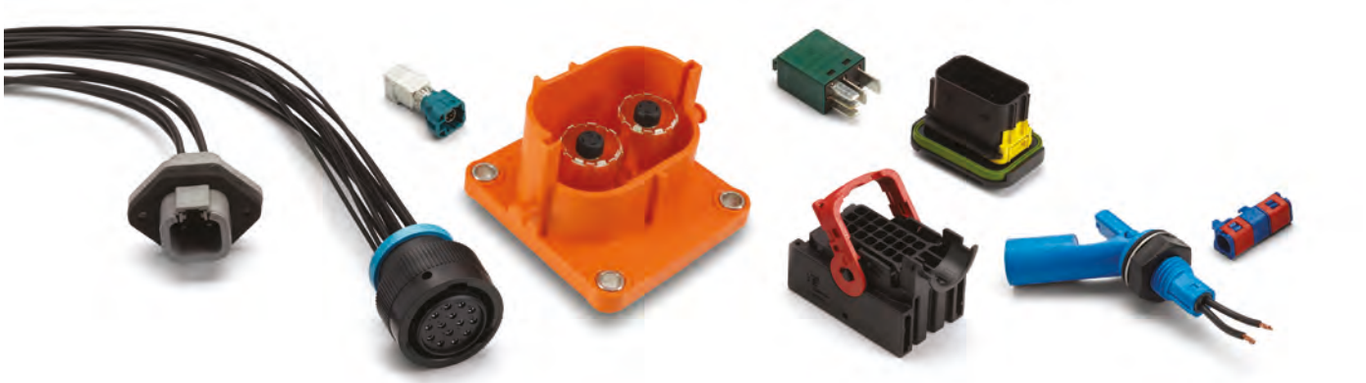

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The expression swarm technology (or swarm intelligence) was coined in the 1980s. Only now, however, as knowledge and technology around the subject have progressed, are the benefits of such systems beginning to reach farmers.

The concept is derived from the natural world, and refers to the "collective behavior of decentralized, self-organized systems", according to electrical engineers Gerardo Beni and Jing Wang, who introduced the idea in a 1989 paper on cellular robotics.

Kit Franklin, an agricultural engineer at Harper Adams University, UK, who has developed an autonomous harvesting system with swarm possibilities (more on that later), explains why the technology is much more than simply a nice-to-have for the farming industry.

"Given the costs of farming, we have ended up with large machines that allow one person to cover a lot of ground quickly. But they treat huge areas of land exactly the same, which is not ideal. A field of crop is like any population; it is varied and these big machines aren't very good at precision farming.

"Also, being heavy, they aren't good for crop growth, as they compact the soil and reduce water filtration, therefore limiting the deep rooting of plants.

"If a tractor doesn't have to carry a person, it can become smaller to the point it doesn't even look like a tractor anymore. These small machines are then better able to treat plants as individuals and will do far less damage to the soil."

The dream becomes real

Turning the theory into reality has proved challenging, but, nearly three decades after the publication of Beni and Wang's paper, a revolution of tiny proportions is taking place. Breakthroughs are being made in the agricultural industry. Foremost of these is the Xaver system from Fendt – previously known as MARS (mobile agricultural robot swarms).

These small robot units autonomously plan, monitor and accurately document the planting of seed. Relying on satellites and cloud-based data management, the exact position and sowing time of each seed is recorded and specific requirements regarding seed patterns and density can be managed via a smartphone app.

"The Xaver is a system platform for light, high-precision tasks," says Peter-Josef Paffen, chairman of the AGCO/Fendt management board. "It is set to supplement the intelligent, large tractor by carrying out certain tasks, such as sowing, mechanical weed control, fertilization and plant observation, in a more productive, flexible and precise manner."

Starting out as an 18-month research project, Xaver was aided at this exploration stage by Ulm University of Applied Sciences, which specializes in refining technologies to prepare them for real-world applications.

"We were responsible for the algorithms and all the mechanisms you need to schedule such a robot fleet, while Fendt was responsible for the design and building of the robot, so it was a real collaboration in a way that brought mutual

"WE'RE BEHIND ANY TECHNOLOGY THAT HELPS FARMERS IMPROVE THEIR LIFESTYLES, MAKES FARMS SAFER AND GENERATES BETTER RETURNS"

Ethan Cleary, agriculture tech policy and innovation executive, Irish Farmers Association

WHAT DO FARMERS THINK?

While farming associations can see the clear benefits of automated robot swarms, convincing farmers that they need such technology could be more difficult.

The Irish Farmers Association (IFA), for instance, is broadly supportive. "We're behind any technology that helps farmers improve their lifestyles, makes farms safer and generates better returns than they are currently getting," says Ethan Cleary, agriculture tech policy and innovation executive for the IFA.

"What's great about the Xaver swarming technology is that it will reduce potential issues around farm safety and accidents. And because these robots can go 24 hours a day, farmer fatigue is reduced, while there is low noise and low light so there's less of a social impact as well." Nevertheless, with the average age of Irish farmers being 57, Cleary is unconvinced people from that demographic will embrace the idea of less time out on their fields.

He says, "With that generation, there is a tendency to have a lot of farm machinery, they love getting into a tractor, physically driving it and seeing the progress on the field. So there could be a tension there, as these technologies are trying to complement and even compete with the sacrosanct role of a farmer."

He envisages a situation where, if farmers are temporarily unable to do the planting themselves, the robots could be rented out to carry out the task on an ad hoc basis.

Jack Ward, chief executive of the British Growers Association, on the other hand, is not so much concerned with the aversion to new technology, but whether such systems are a realistic option at all.

He says, "The big challenge is to change the current situation where the technology might be affordable to the top 5% of producers, and make the systems available to someone growing five acres [2ha] of strawberries. We are dealing with a lot of micro-industries rather than even small- or medium-sized businesses, so it will be a long time before it's viable for everyone."

benefit," explains Dr Christian Schlegel, a professor in the German university's Department of Computer Science who led its contribution to the MARS project.

Creating a new path

With little in the way of existing swarm technology to help gauge the progress it was making, the team quickly recognized the need to approach the challenge with a blank sheet. It was even a case of unlearning things.

"A typical academic approach would be to concentrate on getting the robot to recognize an object such as a plant, but that is of no use here," says Schlegel. "If we know where the seed is meant to be planted in the ground, with a 2cm [0.2in] gap between it and the next one, then it needs only to detect whether something is already in the ground or not. A lot of know-how is needed, of course, both knowledge in robotics and application knowledge, but bringing it all together in a balanced way was more important.

"Look at each component of the robot and you may not really understand why it is there or what is so special about it. The same goes for the algorithms, the software and the hardware, but when you see the full picture, you realize it is a step change toward a completely embedded system driven by the needs of the agricultural industry – not just robotics technology."

Resisting the temptation to spend too much time focusing on small details, ultimately the MARS team went from a theoretical concept to a real-world field experiment, with a fleet of machines fully integrated within the cloud, in just 18 months.

Autonomous harvesting

Being a large OEM, Fendt's Xaver is by far the most prominent example of swarm technology in the sector, but is by no means the only one.

A partnership between Harper Adams University and a York-based farming business, Precision Decisions, is garnering significant publicity with a project that is thought to be a world first.

Launched in October 2016, the Hands Free Hectare ambitiously set out to plant, grow and harvest a crop using only driverless machines.

"The idea of farming with robots is one that's been toyed with for nearly 20 years, but no one has really got it off the page or out of the car park demonstration," says the university's Kit Franklin.

"Many people would tell you that to achieve the entire farming process with only robots was at least 20 to 30 years in the future, and we wanted to move the conversation along.

"People seem to accept that cars will drive themselves soon but with farming there is a tendency to think that something like our project is still decades away."

Within a year the team managed to get a driverless Iseki TLE3400 tractor and Sampo Rosenlew 130 combine to complete the harvesting of barley from a hectare-sized field.

The project was so successful that further funding has covered the harvest of a second crop – wheat – as well as creating space to develop the system further.

Currently, the 1.5-liter turbocharged tractor has to be manually transported or driven to the field, but the aim is to ultimately have it drive from the workshop where it is stored, to the field, without any hands-on involvement from humans, meeting the requirements laid out by the Society of Automotive Engineers (SAE) for Level 4 autonomy in the process.

Franklin admits that a 3m-long, 1,250kg tractor tests the boundaries

WHAT'S IN XAVER?

Powered by a 400W electrical motor, a single battery-operated Fendt Xaver robot weighs 50kg (110 lb) and combined with its tire design, ground pressure is negligible at approximately 200g/cm². Being autonomous and producing minimal noise, the machines are capable of operating around the clock, day or night. Not needing diesel or oil, there is no possibility of leakage, nor are there direct CO_2 emissions.

Once deployed in a field, 12 robots are capable of precision seeding of an area of 1 hectare (2.5 acres) in approximately one hour. It is an impressive feat, but Christian Schlegel, professor of computer science, Ulm University of Applied Sciences, Germany is quick to point out that some of the 'secrets' are actually relatively straightforward.

"If you look at the robots from a robotics perspective you might be disappointed at how simple they are, but that is exactly why they work. Nowadays it is all about the systems and software and embedding them into the relevant environment to work with infrastructure.

"We keep the robots simple and gain from the infrastructure which, in this case, is the mobile networks, cloud systems and making the information accessible to the farmer via a smart device," he says.

Each robot is in constant contact with the control intelligence, while data buffering and redundant communication alleviate any network coverage problems.

If one robot malfunctions, the paths of others are automatically re-optimized, and the remaining units finish the work.

"THE XAVER IS A SYSTEM PLATFORM FOR LIGHT, HIGH-PRECISION TASKS SUCH AS SOWING, MECHANICAL WEED CONTROL, FERTILIZATION AND PLANT OBSERVATION"

Peter-Josef Paffen, chairman, AGCO/Fendt management board

RIGHT: **Up to 12 units can precisely seed a 1-hectare (2.5-acre) field**

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HANDS-FREE MACHINE SPECS

The Hands Free Hectare research project being undertaken by the UK's Harper Adams University has created two autonomous machines with the potential to operate in swarms. They are based on normal production models. The specs are as follows:

Combine: Sampo Rosenlew 130

Engine: 2.0 liter, 4-cylinder

Power: 64hp (47kW)

Weight: 2.6 metric tons

Top speed: 12km/h (7.5mph)

Cutting width 2.0m (6.5ft)

W=2.2m **L**=6.0m **H**=3.6m (7.2ft/19.6ft/11.8ft)

Tractor: Iseki TLE3400

Engine: 1.5 liter, 3-cylinder turbocharged

Power: 38hp (28kW)

Weight: 1.25 metric tons

Top speed: 25km/h (15mph)

W=1.5m **L**=3.0m **H**=2.6m (4.9ft/9.8ft/8.5ft)

"PEOPLE SEEM TO ACCEPT THAT CARS WILL DRIVE THEMSELVES SOON, BUT WITH FARMING THERE IS A TENDENCY TO THINK THAT SOMETHING LIKE OUR PROJECT IS STILL DECADES AWAY"

Kit Franklin, agricultural engineer, Harper Adams University, UK

of conventional notions of swarm technology, but he still considers Hands Free Hectare to be at least a close relative.

"Swarm technology is associated with very small machines, and many of them; however this tractor is first of all much smaller than a normal one, and second, I do see three or four of these working together in the not too distant future – although there are some really interesting engine control challenges around developing an intelligent swarm of tractors."

Nevertheless, while Fendt's Xaver robots fit under the swarm technology banner in a truer sense, the use of tractors in the Hands Free Hectare project was crucial due to the practical implications of smaller swarm technology.

"While being smaller, we still have the versatility advantages that tractors bring, whereas agricultural robotics like Fendt's are going down the road of dedicated machines – one machine developed for one task. If you then need four or five tasks, that quickly becomes a lot of machines to look after and quite pricey.

"Such dilemmas are why agricultural robotics hasn't progressed for a decade. People were put off – the industry saw concept images of these tiny futuristic machines and said, 'That isn't going to work, we're not interested.'

"The other point is that Fendt still hasn't solved the problem of what to do regarding harvest.

"A harvested hectare of potatoes is about 40 tons – so huge masses of material – and doing that with tiny machines is going to be difficult. Larger machines are always going to move it quicker – that's where I think traditional swarm technology fundamentally falls down."

As yet, no company has shown any sign that they're working on swarm technology able to perform a harvest, making Hands Free Hectare not simply a halfway house to more futuristic-looking Xaver robots, but a complementary technology – if not direct competition.

An affordable solution

Franklin describes the open-sourced software the system relies on as 'developed by geeks in bedrooms around the world'. This helps to make it a comparatively cheap alternative to typical farming methods, giving it another advantage over systems from larger OEMs.

"Even accounting for some profit, there should be no reason that one of our 38hp tractors should be sold for more than £40,000 [US$51,700]," says Franklin.

"Considering a typical 250hp tractor – which is not particularly big – costs approximately £200,000 [US$257,600] you could get five of mine for the price of one of them.

"It'll cover the same land; it'll be more precise; it'll be better for the soil; and the people now not driving the machines can be doing more valuable parts of farming.

"If an employee paid to drive up and down all day in straight lines now doesn't have to do that, they can be checking crops, making agronomic decisions or looking at the markets deciding whether to buy or sell inputs, and all those other things that are actually more valuable to the business owner."

In spite of all the benefits Hands Free Hectare could provide to the farming industry globally, Franklin is realistic about the prospects of commercial success, being aware that many OEMs may already be developing competitors to his system behind closed doors.

"We have more work to do to show it is viable, but the minute we do, these very large companies with very large R&D budgets and very big brand names will suddenly come out of the woodwork. Some have made their stuff public, others haven't – but that doesn't mean they're not working on it.

"If we tried, we may get a little market share but then the big guys will just come out and swamp us. There are also the startups that are out there with projects of their own, which means it all boils down to the fact that ag robots are really a thing and will happen quite soon."

Soon any OEMs with no swarm robot projects could begin to look decidedly behind the times. Don't say you haven't been warned. **iVT**

On the Web

Watch a simulation of Fendt's Xaver swarm bots at **www.iVTinternational.com/swarm**

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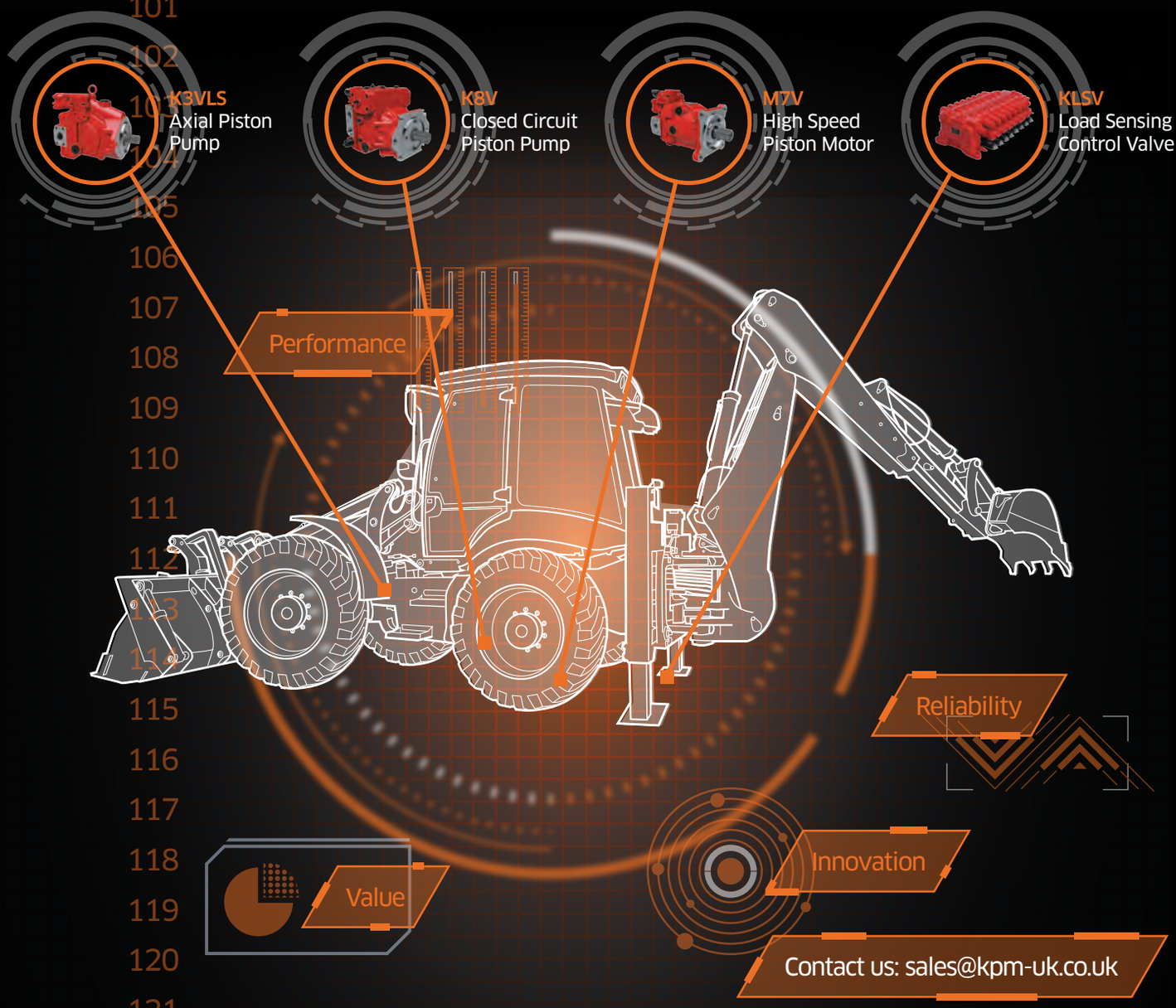

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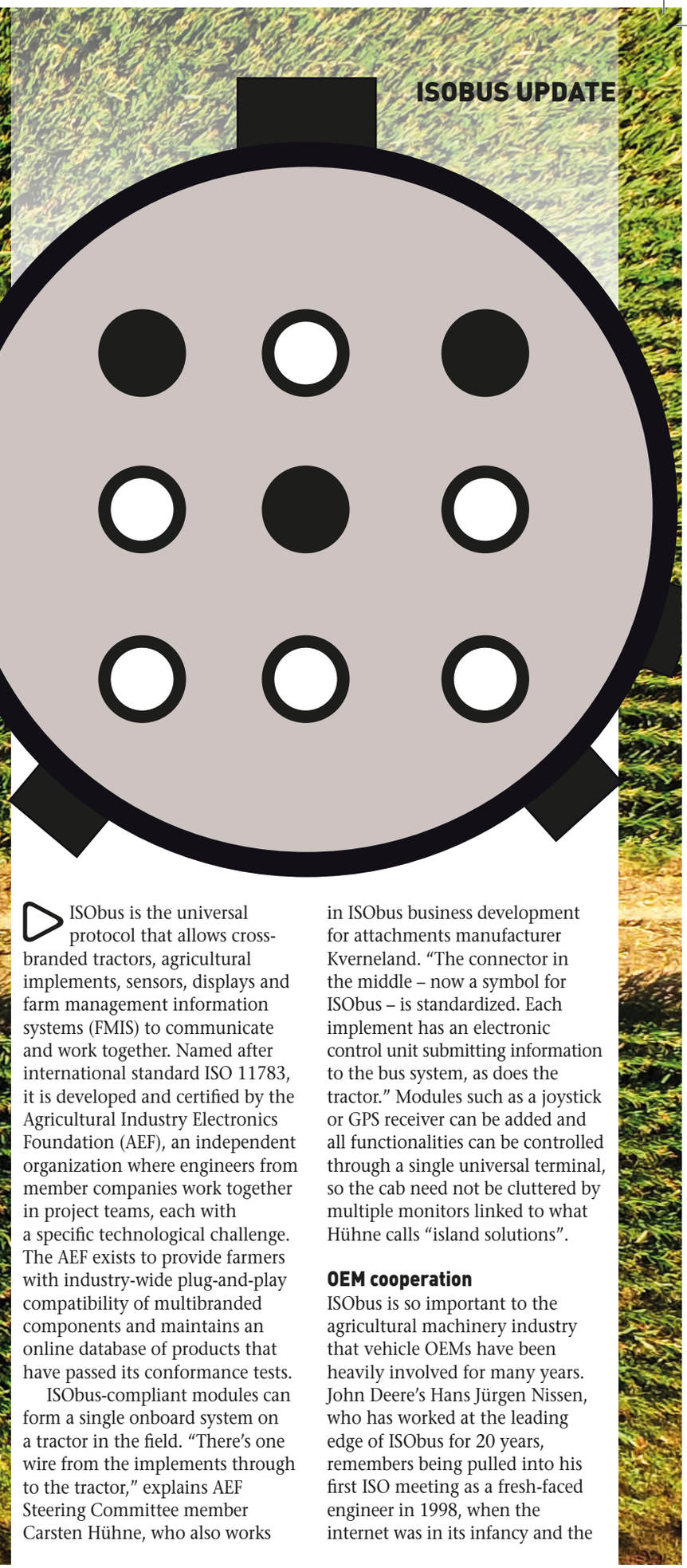
JOINING THE DOTS

FOR NEARLY 20 YEARS ISOBUS HAS ENABLED AGRICULTURAL MACHINERY COMPATIBILITY, BUT NOW IT FACES THE COMPETING CHALLENGES OF AN ACCELERATING RATE OF INNOVATION AND OEM DEMANDS FOR MORE STRINGENT CERTIFICATION. CAN THE MUCH-RESPECTED PROTOCOL SURVIVE?



ISObus is the universal protocol that allows cross-branded tractors, agricultural implements, sensors, displays and farm management information systems (FMIS) to communicate and work together. Named after international standard ISO 11783, it is developed and certified by the Agricultural Industry Electronics Foundation (AEF), an independent organization where engineers from member companies work together in project teams, each with a specific technological challenge. The AEF exists to provide farmers with industry-wide plug-and-play compatibility of multibranded components and maintains an online database of products that have passed its conformance tests.

ISObus-compliant modules can form a single onboard system on a tractor in the field. "There's one wire from the implements through to the tractor," explains AEF Steering Committee member Carsten Hühne, who also works in ISObus business development for attachments manufacturer Kverneland. "The connector in the middle – now a symbol for ISObus – is standardized. Each implement has an electronic control unit submitting information to the bus system, as does the tractor." Modules such as a joystick or GPS receiver can be added and all functionalities can be controlled through a single universal terminal, so the cab need not be cluttered by multiple monitors linked to what Hühne calls "island solutions".

OEM cooperation

ISObus is so important to the agricultural machinery industry that vehicle OEMs have been heavily involved for many years. John Deere's Hans Jürgen Nissen, who has worked at the leading edge of ISObus for 20 years, remembers being pulled into his first ISO meeting as a fresh-faced engineer in 1998, when the internet was in its infancy and the

gathered engineers relied on paper documents. He is now standardization and partnering manager for Deere's Intelligent Solutions and was honored with the VDI-MEG (Society of German Engineers Max-Eyth-Gesellschaft Agrartechnik) Award in 2012 for his career contribution to agricultural electronics.

Since its inception, Nissen has led the AEF's Project Team 5: ISObus Automation and Tractor Implement Management (TIM) – tasked with facilitating cross-branded functionality for implements capable of guiding tractors – and, through wireless TIM, combine harvesters that can drive tractors running alongside them.

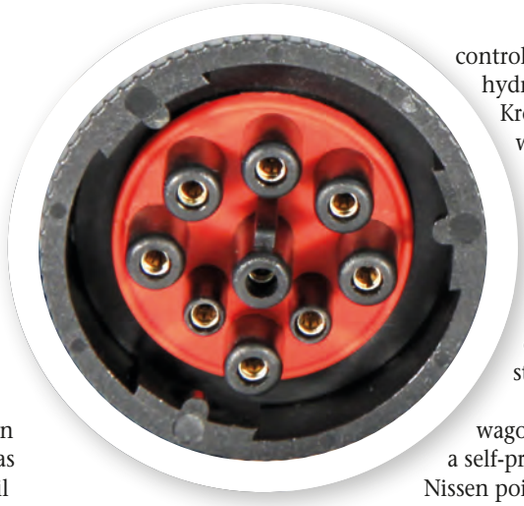
TIM will soon enable intelligent implements to assume control of tractor power outlets over an ISObus connection for precise, automated cooperation of the two machines.

"The first product John Deere identified for this type of interface was a round baler," Nissen recalls. "The tractor has sensors measuring windrow mass and the implement can control the tractor's ground speed accordingly. When filling sensors, see that the chamber is full, the baler can stop the tractor and activate its hydraulic flow to start the tying process, before opening and closing its rear gate." At high flow-rates, manual operators perform an arduous cycle of swivelling, filling, stopping, tying and working the gate every 40-50 seconds. "Now the operator simply monitors the process, while automation brings the whole system to the edge of its capabilities."

Multibrand compatibility

TIM works across brands on a plug-and-play basis, such as a Kverneland spreader controlling a John Deere tractor. "Grimme has a potato planter to put soil down in perfect dams, where the potatoes grow," Nissen continues. "It controls the height of the tractor's rear hitch. If there's a ditch and the tractor dips down, the implement maintains its height so that the dam is perfectly even."

Tillage implements equipped with sensors and hydraulic drives can perform automated depth-control using the tractor's hydraulic outlets and valves. Krone or Pottinger loading wagons can control a tractor's ground speed using windrow sensor data. Steering manufacturers Trimble and Topcon offer interfaces that can commandeer a vehicle's steering system.



ABOVE: **The standard ISObus connector helps components from different manufacturers to work together**

"A tractor and loading-wagon are competing with a self-propelled forage harvester," Nissen points out. "The difference is, it's a modular system. Modularity is important in agriculture because field conditions and the details of cultural practice vary so widely. Through TIM, we can increase productivity in a modular system."

Accident liability protection

However, multibrand TIM functionality gives rise to new and complex liability ramifications. "If someone gets hurt when an implement is controlling a tractor's power outlets, as long as it's John Deere with John Deere, then it's John Deere who pays. But when

"COMPETITORS BLAMED US FOR EXCLUDING THEM FROM AN ISO FUNCTION, BUT WE DID IT TO PROTECT OURSELVES"

Hans Jürgen Nissen, standardization and partnering manager, John Deere Intelligent Solutions

"THE SPEED OF ISOBUS DEVELOPMENT HAS TO BE INCREASED. THE AEF IS THE PLATFORM FOR THAT"

Carsten Hühne, ISObus developer for Kverneland and AEF steering committee member

ABOVE: **TIM (Tractor Implement Management) enables precise automated cooperation between two machines**

it's different brands and the tractor believes the implement told it to brake or speed up or lift or lower the implement, then who is to pay? Is the tractor guilty? Or the implement? Or both? It's a question of which way the pendulum swings."

Such uncertainties prompted John Deere to introduce a security layer on top of the ISO specification for TIM functionalities, rendering it a proprietary solution. "Competitors accused us of excluding them from an ISO function, but we did it to protect ourselves," Nissen says. "You have safety, security and liability – a triangle, if you like. We put in some security to make sure only trusted products can work together. Only when we know a manufacturer has taken all appropriate steps to fulfill our safety specifications will we open up our tractor so that they can access the power outlets. Only then can we swallow this joint liability."

To avoid implement vendors having to submit products for separate testing with every tractor manufacturer across an insupportably vast matrix, in 2012 AEF Project Team 5 started work on a standardized security layer for TIM. "We developed a system like https on the internet," Nissen explains. "When you access your internet banking, you add an 's' to your 'http' and suddenly you trust it. Something magical happened in the background, right? We do something similar over CANbus. When manufacturers follow the safety rules and pass the AEF Conformance Test, they get an electronic security certificate to put in their software. Their products can come together in the field, exchange certificates and say 'OK, now I will switch on my automation.'" The technology is currently in its testing phase and Nissen expects it to be showcased in a crop of new products at Agritechnica 2019.

Remote systems

The AEF is also working on wireless in-field communication between two machines in the field, whereby a combine can control the steering and ground speed of a tractor running beside it, moving the grain cart into optimum position beneath its auger.

"This is the new puzzle-piece," says Nissen. "We are working on a standardized interface so that multibrand tractors and combines or forage harvesters can control each other. Sounds like TIM, doesn't it? It's just wireless TIM. We add another module – the wireless connection of two networks – and suddenly the combine looks like a client, like an implement, to the tractor. These modules open out new possibilities for functionality."

And right now, communication over even greater distances is possible via ISObus. Kverneland's Hühne is excited about the potential for satellite biomass imaging to inform precision farming.

AEF PLUGFEST

Plugfest is the AEF's gathering of engineers from across the agricultural equipment industry who are engaged in ISObus standardization. Meeting in the USA in the spring and in Europe in the autumn, Lincoln in Nebraska and, as we go to press, Bologna in Italy, were this year's venues.

"They are doing a kind of 'speed-dating' there!" laughs the AEF's Carsten Hühne. "Around 300 come together with their terminals and new implements – but only the ECUs, not the physical implements. You see a lot of desks. The implement people get a set time limit of 30 minutes – and they are 'speed-dating' with the terminal. They plug in their implement, and see if the whole system works. If not, they make a protocol of that and then they can go home and do some more work."

Testing cross-branded combinations of tractors, implements, terminals and other attachments for compatibility in the field can be an involved process entailing negotiation, air travel and finding a farmer – after which only one combination is tested. Plugfest, by contrast, allows over 1,000 possible combinations to be tested over a three-day period. "At Plugfest you present products nearly ready to be certified," says Hühne. "You meet competitors there and it's a good opportunity to make contact and find solutions."

"The speed of innovation, based on proprietary solutions, makes it hard for standardization to come alongside," he continues. "But it has to keep pace, otherwise companies cannot profit by selling to a wider market, because farmers will no longer accept island solutions. ISObus development has to be quicker. The AEF is the platform for that but, despite agriculture being a big industry, we have limited resources. We are a club of enthusiastic engineers across all brands, working voluntarily."

"PEOPLE GET A SET TIME LIMIT OF 30 MINUTES – AND THEY ARE 'SPEED-DATING' WITH THAT TERMINAL"

Kverneland Group already produces fertilizers and sprayers that, by linking with a FMIS (farm management information system) and a tractor-mounted GPS controller via ISObus, can perform automated section control. This involves turning given sections of the fertilizer on or off as needed, eliminating overlap and reducing costs by an estimated 10%.

"Now we are talking a lot about variable rate control, where you use a colored map of your field and define, for each location, a different amount of fertilizer to spread. Providers are using Sentinel satellites' biomass images, to get a new view of their field every fifth day."

Next-generation ISObus

But multiplying functions are beginning to overwhelm ISObus systems that use CANbus 250Kbps wiring, with the AEF now exploring options for the next-generation, high-speed ISObus.

"The physical layer today is reaching its edge," explains Nissen. "We're looking at Ethernet solutions, to provide space to live in for the data volumes ahead."

Meanwhile, standardization toils to keep pace with new capabilities created by the rapidly accelerating growth of electronics.

BELOW: **ISObus is reducing fertilization costs by as much as a tenth**

"In the past you wrote a specification for a three-point hitch on a tractor, standardized, published it, and it was done. But the ISO11783 series of standards can never be done," says Nissen. Standardizing physical connections – involving hydraulics or PTO – merely had to be written and published but electronics, which are evolving and becoming more sophisticated at an accelerating rate, mean ISO 11783 will never be written and finished in the same way. It must constantly evolve.

Is there an inherent tension between standardization and the impulse to innovate?

"Innovation won't happen within the standard," Nissen maintains. "It happens on top of the standard. But it needs to be done carefully so as not to disturb the standard and other functionalities running in the network."

New products emerge first in proprietary form and, for a time, manufacturers will want to protect their market, earning money from their own innovation, but eventually they work with competitors on standardizing similar solutions.

"There's the tension: when do they do that?" Nissen continues. "You want to have your market advantage, of course, but as an implement vendor you need a tractor, and vice versa. Only a few have both and can leverage the whole value of an innovation."

Leading the way

In 2015, Nissen was invited to speak about ISObus at an automotive conference and was afterward approached by delegates from Audi, agog with disbelief at what agricultural technology has achieved across brands. While vehicle-to-vehicle (V2V) communication is heralded as the next big thing in the automotive sector, the road remains unclear, with rival brands all using closed, proprietary CANbus.

"On German autobahns today, car-to-car works between Mercedes and Mercedes or BMW and BMW, but when you want the cars to talk to each other we are light years ahead. For their whole industry, they need a system similar to what we are already doing with the security layer. You saw their eyes grow wide at what we, as an industry, do across manufacturer borders for the sake of our customers." **iVT**

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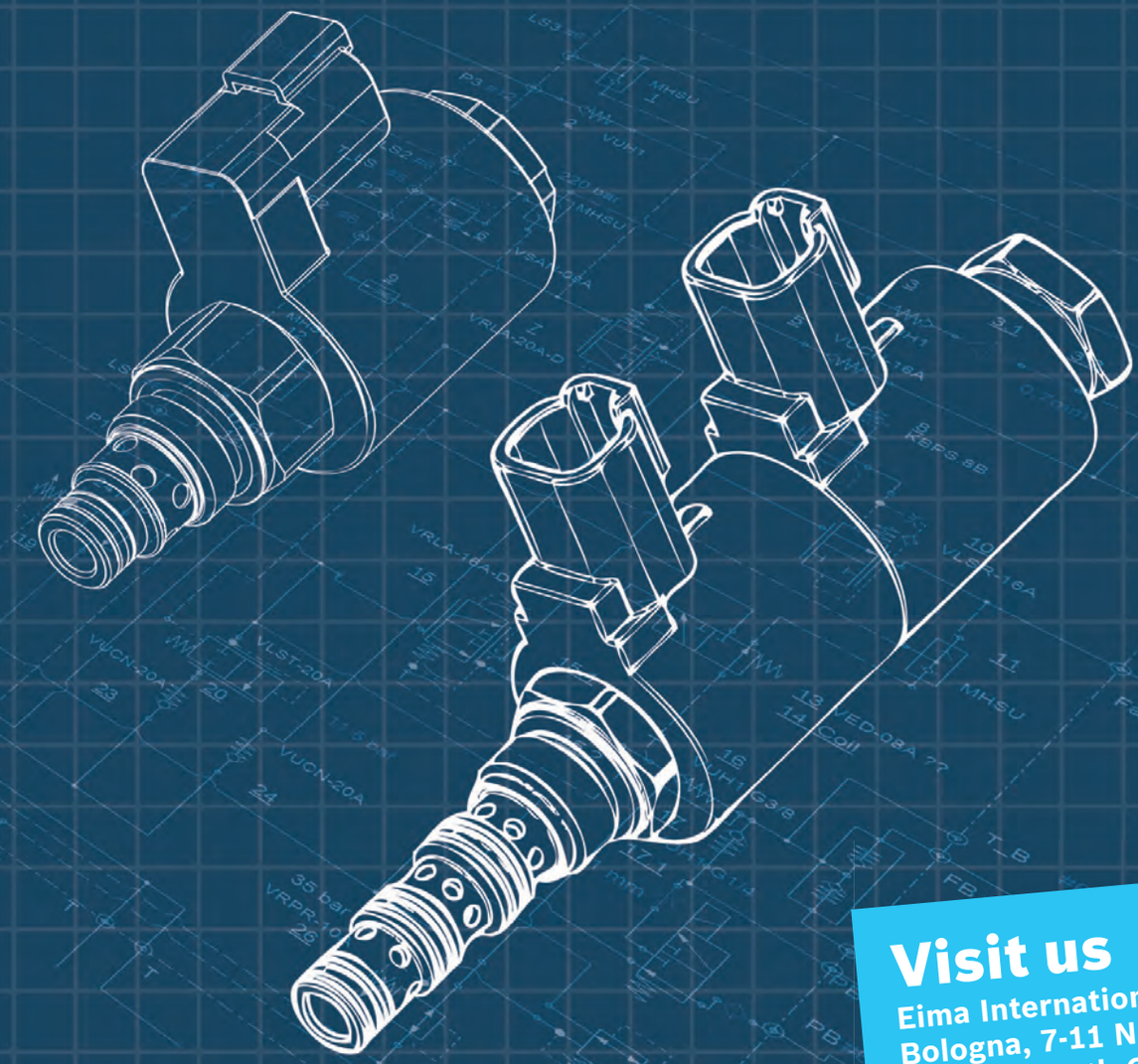

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THE INSIDE STORY

MAIN IMAGE: **The Claas Lexion 700 passenger seat can be folded to form a table**

LEFT: **The John Deere S700 controller has 30% more functions than any in the combine market**

BELOW: **The Case IH Axial-Flow 250 provides 3.67m³ of operator space**

COMBINE HARVESTERS DO WORK THAT DEMANDS SOME OF THE LONGEST HOURS ON ANY FARM, SO THEIR CABS ARE AT THE CUTTING EDGE OF ERGONOMICS AND COMFORT. *IVT* TAKES A LOOK AT THREE OF THE BEST

Short weather windows for harvesting crops often demand working from before dawn until after dusk, meaning combine drivers regularly put in longer shifts behind the wheel than any other agricultural machine operator.

A comfortable working environment to help drivers stay alert and work efficiently is therefore a key requirement in these huge vehicles. It's no surprise, then, that it is an area for intense competition between manufacturers.

A good cab design should have a comfortable seat and seating area, providing easy and free access to all the controls, good visibility, and the space to easily get in and out of the seat as well as the cab itself.

Another important consideration is ventilation and air-conditioning. Hot harvest days tend to involve a lot of dust, which can enter the cab, so efficient filter systems that can be easily cleaned are essential.

Excessive noise levels are also a major health issue for combine operators. These need to be kept well below regulatory levels to increase operator comfort.

Even taking all this into account, there is a final over-arching consideration: operators come in all shapes and sizes, so there's no one-size-fits-all solution. Designers must ensure cab setups are as adjustable as possible, enabling them to accommodate all drivers comfortably.

Over the next few pages, we take a look at three leading cab designs in this sector and compare the ways in which designers have overcome these unique challenges.

CASE IH AXIAL-FLOW 250 SERIES

With 3.67m³ (129ft³) of space and 6.3m² (68ft²) of glass area, the cab on the recently launched Case IH Axial-Flow 250 Series combines is designed to offer operators a comfortable working environment.

The ergonomic design is further enhanced by air-suspension on the operator's seat and low noise levels. Essential functions are integrated into the right-hand 10.4in AFS Pro 700 console and the multifunction control lever.

When harvesting extends late into the night, the combine rolls on, as halogen stadium lights are fitted to its roof to illuminate the working area ahead of the machine. As extra options, the operator can choose an HID stadium lighting package, which consists of halogen and two HID lights. Another option is a complete set of six high-definition HID lights; or a distance option adding two LED lights, which can be mounted to the left and right mirror brackets.

"A key point, which we believe makes the Axial-Flow competitive in the cab area, is the spacious environment that offers great visibility of the header and grain tank," says Sam Acker, global product manager for Case IH combines. "Furthermore, only one display is needed for all functions related to the combine. A key design aspect of the Axial-Flow combine is simplicity – it is simple to service and simple to operate. The cab is designed with this in mind.

"The steering column has dual pivots and a telescopic steering wheel, so it can be positioned anywhere the operator wants it for comfort and visibility."

Case IH offers two cab versions on its Axial-Flow 250 Series – the 'comfort' cab and the 'luxury' cab. 'Luxury' upgrades include electrically adjustable heated mirrors, more storage options and a refrigerated box to keep lunch fresh. The luxury cab also comes with a leather-wrapped steering wheel, three storage bins, two storage shelves, extra seat padding, window shades, and a high-backed leather chair.

ABOVE: **The luxury option includes a leather-wrapped steering wheel**

3.67m³
Total cabin space

10.4in
Display screen size

6
High-definition HID stadium lights

On the Web

Watch a full demonstration of an Axial-Flow 250 at **www.iVTinternational.com/axial**

CLAAS LEXION 700

A three-position adjustable steering column and advanced soundproofing are two of the key design features of the updated Claas Lexion 700 Series cab.

Claas places great emphasis on its Cebis onboard information system, which is distinguished by its clear, logical function menu.

A brief glance at the 8.4in Cebis display (upgradeable to the new 12in version) gives an overview of current processes and conditions. Warning messages are given audibly as a buzz tone and visually as icons and text, to keep the operator fully aware of any issues, should they arise.

Moving on to the main controls, the Cmotion multifunction control lever, which is integrated in the right armrest of the operator's seat, plays a key role in making the Lexion user-friendly. It has been specially developed for ergonomic operation by the right hand. The innovative, three-finger control concept means several functions can be controlled intuitively without having to reposition one's hands.

Another toggle switch is situated on the back of the multifunction control lever. With three functions assigned to it, this switch enables manual lateral control of the cutter-bar, changes to values in the hot-key menu, or manual adjustment of the Vario cutter-bar table.

On the back wall there is a large horizontal grain tank window to make it easier for the operator to see the grain as it fills into the tank.

There is a climatized storage compartment in the cab roof, a further compartment in the armrest, a drawer under the operator's seat, a bottle holder, a cell phone compartment, and a net behind the seat. The full-size passenger seat with backrest folds down to form a table. There is another 43-liter storage compartment in which it is possible to fit a fridge.

"Our key features include a simple and user-friendly design to fit all sizes of operator. Plus the cab is easy to clean and look after, and is very functional," says Adam Hayward, combine product specialist at Claas. "In addition there are 16 work lights on the cab, all with high-end LED bulbs."

3.94m³
Total cabin space

8.4in
Display screen size (upgradeable to 12in)

16
LED work lights

On the Web
Watch the new Lexion 700 in action at
www.iVTinternational.com/lexion

ABOVE: **It is possible to fit a fridge in the 43-liter extra storage space**

JOHN DEERE S700 SERIES

While John Deere's new S700 combines are full of new automated harvesting technology, it was in the cab that customers saw the main physical differences compared with its S600 predecessors.

The new CommandPro joystick incorporates up to seven programmable shortcut buttons that can be customized to operate the most useful functions. Meanwhile, the CommandPro hydrohandle was designed following extensive research into a wide range of controllers, from games consoles to aircraft controls. As a result, the new controller is said to have 30% more functions than any other combine controller.

The cab on the new S700 Series has more space, better visibility and a touchscreen color display for ease of use. It has been designed to ensure all the controls are integrated into one place, so that operators do not have to search around the cab for various displays or switches.

The Generation 4 10in touchscreen display has been redesigned and functions much like a smartphone with apps to help run the machine in the way the operator wishes. "The cab also delivers superb visibility, and huge amounts of operator and storage space, as well as exceptionally low noise levels down to 71.5dB," says Charles Grey, product specialist for John Deere.

Operators have clear views both ahead of them and to the side, as slimmer corner posts allow for an unobstructed view for easier grain unloading. An underfloor heating system ensures the operator has a constant working temperature if required.

The operator's seat now swivels 7.5° to the left to help with visual checks when unloading, without having to stretch over to look out the window, and 15° to the right. As the cab is one of the widest on the market, there is also a spacious passenger seat to the side.

Practical comforts include cup holders, two closed compartments, a number of storage areas, power outlets and a 37-liter fridge. The machine also has 10 LED work lights at the front as standard, to enable operators to harvest night and day. **iVT**

3.36m³
Total cabin space (119ft³)

10in
Display screen size

10
LED work lights

On the Web
Watch the S700 in action at
www.iVTinternational.com/s700

ABOVE: **Noise levels have been minimized to as low as 71.5dB**

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JACK ROPER, IVT INTERNATIONAL

HARVEST 3

FIRST CAME HORSE-DRAWN REAPING MACHINES, THEN MOTORIZED 'COMBINES' ADDED THRESHING AND WINNOWING TO THE PROCESS. NOW A THIRD REVOLUTION IS UNDERWAY, LED BY ONE MACHINE: THE TRIBINE T1000. THIS IS A VEHICLE SO LARGE, AND WITH SUCH A FAST UNLOADING RATE, THAT IT ELIMINATES THE NEED FOR A TRACTOR AND GRAIN CART RUNNING ALONGSIDE

There's thunder in the Corn Belt and the prairies are shivering in its restless breeze. Something big is rumbling out of Kansas, coming to shake the windows and rattle the walls of traditional combine markets in America's agricultural heartland. The new Tribine T1000 (an updated version of the 2016 launch model) is a giant of a harvester with the world's largest threshing and cleaning system. It heralds possibly the greatest revolution in combine architecture since the 1940s through an articulated design that enables it to incorporate an integral 1,000 bushel grain cart.

"Look at a red or green machine from the 1960s and put it against its modern relative. There's little change apart from horsepower and electronics," says Greg Terjesen, Tribine Harvester's vice president for marketing. "Corn is now trading at around US$3.30 a bushel, and farmers have to do more with less. We started with a blank piece of paper and came up with a revolutionary concept. We are the only ones with the ability to show farmers how they can make money from corn at US$3 a bushel."

The Tribine's rear-module grain cart can carry double the grain of a competitive combine and boasts a discharge rate of 500 bushels per minute. It thus eliminates the need for a tractor and grain cart running alongside, which would leave additional tracks in the field. Moreover, despite its size, the Tribine itself leaves only two tracks per pass, compared with a combine with dual front tires that leaves six.

"Compaction removes water and air voids in the soil," explains Terjesen. "Before the next season, the farmer has to till the soil because it gets so densely compacted. We are advocating the no-till principle: by compacting less, you can eliminate the costs associated with tilling the field before next year's harvest."

Compaction is further reduced by the use of Goodyear Titan low-sidewall (LSW) tire technology, offering a 40% reduction in inflation pressure. "Those tires go down about 7in [18cm] when the grain bin is full," explains Terjesen. "But, more importantly, their footprint expands sideways and lengthways. The formula for compaction is ground-contact area over weight – the larger the footprint, the more the weight is dispersed." And according to Tribine, LSW technology has delivered some startling unforeseen benefits during field testing.

"Of course, the major feature is the big grain bin – and the change in harvesting logistics that goes with that," says engineering vice president Bob Matousek. "But after we've run it in the field, we understand it has a whole different aspect. We seem to be able to 'float' on soft, wet ground. The perception was: 'Huge machine – it's gonna sink!' But in wet stuff we've just motored right past a conventional combine that's stuck. Our cleats sink in and leave an imprint, then the major part of the tire takes over. The footprint doesn't exceed the tensile strength of the soil and we don't sink any further. We've been places where we've run for two days before they can put their machines back in the field."

Turning on a dime

The vehicle's radical architecture hinges on a Tribine-patented 'bridge' featuring a full-oscillation articulated joint, while rear-wheel steering underwrites a tighter turning radius than most rival machines. "Our steering geometry allows us to pull straight out and back in on a head of 38.5ft [11.7m]," says Matousek, "with no keyhole in the turn whatsoever."

Perhaps counterintuitively, the key to spinning a tight circle proved to be positioning the pivot not midway between the two axles, but close to the front. "It really came together when we decided to move the grain to the back through the drawbar. Historically we elevated the grain like a typical combine with an

A BRIEF HISTORY OF THE MACHINE

Before the T1000 came a prototype of Tribine's harvester, known as Sally, which toured agricultural shows throughout the Midwest, garnering a cult following on social media. Launched at the Farm Progress Show in Boone, Iowa, in August 2018, the T1000 is the first market-ready model – and definitely unrelated to the movie *Terminator 2,* featuring a robot of the same name.

"'T' is for Tribine," explains Greg Terjesen, "and '1000' refers to the grain bin capacity."

"The T1000 is the improved first-production model of what we've been working on," says Bob Matousek. "There's been a lot of learning about grain handling – moving the grain to the back. We now have a rock-beater drum where everybody else does, at the top of the feeder house – we tried to avoid that, but we couldn't."

"We've rearranged the cameras, to give 360° visibility," continues Terjesen. "We moved the cab forward a little, permitting us to put a walkway in behind." The cab has no steering wheel and replaces this with a single joystick for control. In the traditional steering column area, the glass cab floor provides unrestricted visibility down towards the header and field.

"The first few models were 590hp with one 9-liter and one 7-liter engine," says Terjesen. "but we've upgraded to two 9-liters. One is primarily focused on threshing and cleaning, and the other on the drive system. To hit some of our metrics, we've given a bit of horsepower from one to the other. One key goal was a road speed of 30mph [48km/h] when towing a header. Custom harvesters starting are often very close to their next job. Instead of waiting for a lowboy to come and load, transport and unload the machine, you can do it just as quickly by roading the machine yourself."

"BY COMPACTING LESS, YOU CAN ELIMINATE THE COSTS ASSOCIATED WITH TILLING THE FIELD"

Bob Matousek, vice president for engineering, Tribine

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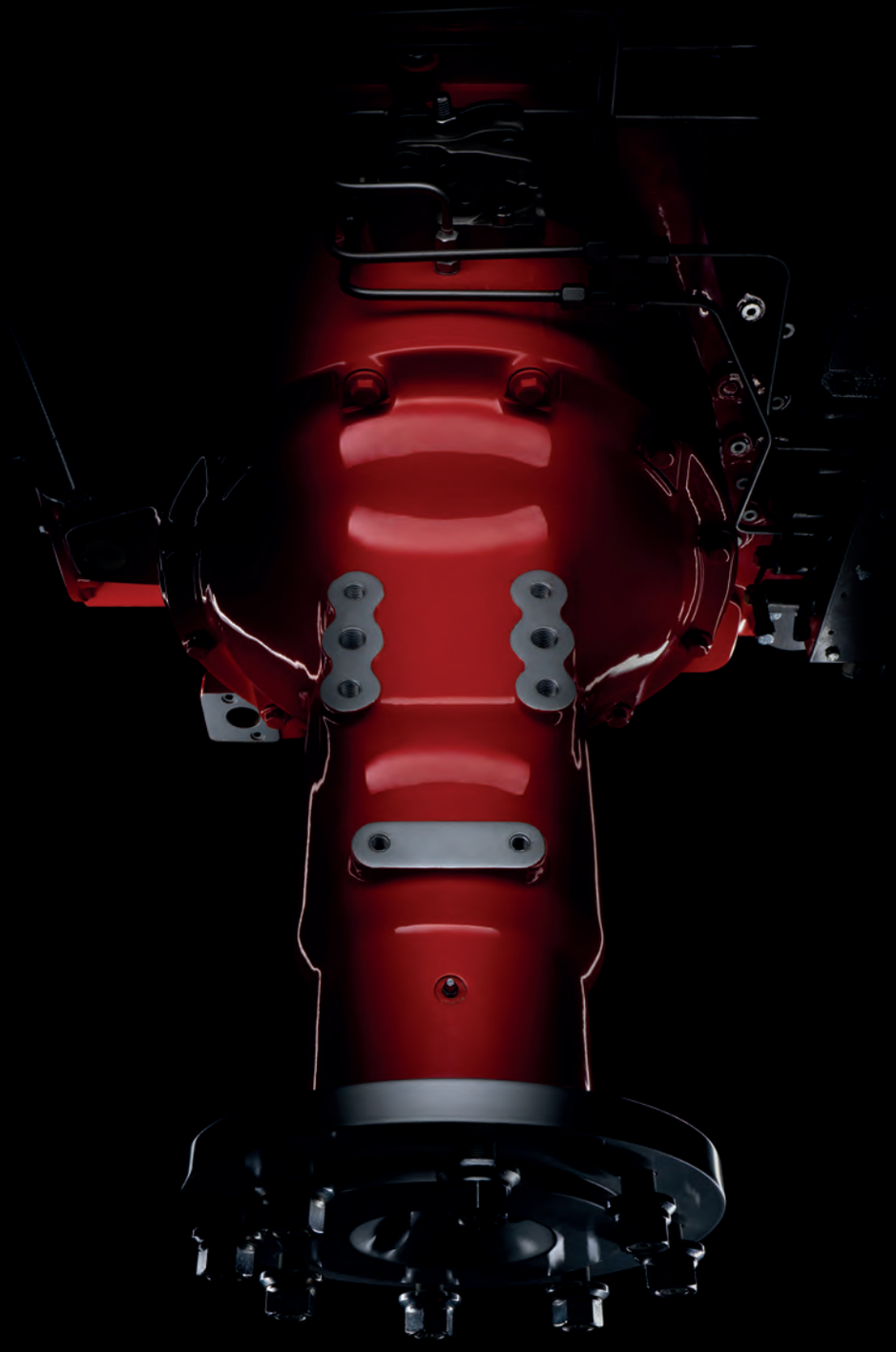

CARRARO

carraro.com

ABOVE: **The grain cart can hold 1,000 bushels**

RIGHT: **The combine is powered by a twin 9-liter engine**

auger up there. But when the front end turns one way and the back end another, that auger has to do a lot of gymnastics. If you move the grain down low, through the hinge line, you can flip your back end without affecting the front."

Looking inside

The front module houses a threshing and cleaning system that Tribine believes is the world's biggest, with a separating area of 24.7ft² (2.3m²) and total cleaning area of 92.4ft² (8.6m²).

Whereas harvester concaves typically wrap 180° around the rotor, the Tribine's concave sections wrap 270° around a mammoth 38in-diameter (96cm) rotor. "It's a three-section concave, so each 90° has a different concave with an actuator on it," Matousek explains. "The top 90° has adjustable vanes. It's very special to be able to micro-control the rate at which stuff goes through the rotor."

For the concave, Tribine has adopted electric linear actuators – instead of hydraulic or h-bridge alternatives – as being reliable, precise and capable of communicating with the vehicle's CANbus on a 'set it and forget it' basis, rather than requiring external relays for control and feedback.

As farmers look to maximize profits, the current market trend toward twin-row planting is resulting in yields of up to 250 bushels/acre, requiring the massive capacity a 38in rotor provides. "At 66in [168cm], our feeder is certainly wide enough to accommodate it," says Terjesen. "The limiting factor, if there is one, is the speed of the header."

"IT REALLY CAME TOGETHER WHEN WE DECIDED TO MOVE THE GRAIN TO THE BACK THROUGH THE DRAWBAR"

Bob Matousek, vice president for engineering, Tribine Harvester

Heavy future

The Tribine features John Deere standard mounting, with kits available to fit alternative headers. According to Matousek, the modular architecture may lend itself well to the gigantic 20,000 lb (9,000kg) headers of the future. "A header adds 1.6 times its own weight to the front axle, where a typical combine

HOW THE COMPANY BEGAN AND WHERE IT'S GOING

Tribine Harvester is unusual among industrial vehicle OEMs as a startup manufacturing only one machine. It was the brainchild of company president Ben Dillon, who reputedly nurtured the concept over 20 years and sold part of his family farm in Indiana to finance it.

In 2016 Tribine moved to its current headquarters in Newton, Kansas, attracted by a pool of qualified engineers and competitive local manufacturing. So original is the new machine that 52 patents protect it, with more pending. These include overseas patents, which aim to pre-empt possible imitations emerging from Europe or the Far East.

Though it may one day conquer the world, for now the T1000 will be marketed across just five states: Kansas, Illinois, Indiana, Iowa and Nebraska. "The USA is a big country," emphasizes Greg Terjesen. "If we say, 'Okay, today we're going to blanket the country with Tribines,' that's a recipe for failure. You have to target your markets – and those five states represent approximately 60% of the Midwestern grain market. We have to crawl before we can walk. Targeting five states, we can work logically and give customers the aftersales support they want, to make sure they're successful."

"The idea's got to be alive 10 years from now," adds Bob Matousek. "We don't want it to be the great idea that shot itself in the head!"

"We're still a small company today and everybody wears many hats," continues Terjesen. "Everybody's fairly flexible and it's a good team atmosphere. Half our engineers are part-time farmers and everybody's worked for a competitor at some time. And our response time is so quick. At Fortune 500 companies it takes years and years and committees and panels and reviews before you get anything approved. Here, it's a matter of, 'Hey guys, let's sit down, let's do it! Boom – done!' Decided. No bureaucracy – that's the best way to put it."

The size of the fuel tank allows for
18 hours
of continuous working

ABOVE: **The T1000 leaves only two tire tracks per pass**

puts 70-80% of its weight when fully loaded – so it's been hard to lift a 12,000 lb [5,400kg] header. We'll only have 40% of our weight on the front axle fully loaded, because the grain goes to the back, so a big header isn't significant compared with what the tires can handle."

Prime mover

Powering the Tribine are twin 9-liter Cummins engines with a combined rating of 650hp, weighing and costing less, and providing better fuel efficiency, than a single enormous one. The reimagined machine structure positions them on each side of the rotor, providing a low and balanced center of gravity. Fuel comes from two 500-gallon (1,900-liter) tanks, also located low down for ease of refilling, and allow over 18 hours of continuous working, according to Tribine, against fewer than 13 hours on rival combines.

"What's unique is that we've got two engines going into one cooling system," continues Matousek. "A center-mounted cooling box pulls air from the top and blows it out the sides. We're able to blow our charge air, which has to be intercooled, out of the radiator straight onto each engine's exhaust manifolds, so we're not getting any trash build-up there." This alleviates the risk of fire, while the design of the cleaning system may even obviate the need for hillside leveling technology.

"The reason is, the system doesn't drop the chaff or MOG [material other than grain] onto the sieves. When the stuff comes out of the rotor, the air blows it out immediately and completely. Sieves work well with only grain on them. It's when you put MOG on them that you need things like leveling."

They're building a dream in Newton, Kansas, and according to Terjesen and Matousek, are only just starting to perceive the unfenced prairies of invention that their brave new vehicle design makes possible. Whether, in time, a tornado will rise out of the Midwest to blow away the established norms of worldwide combine harvester design remains to be seen. For now, the corn is high and these are heady days for Tribine Harvester. **iVT**

"WHAT'S UNIQUE IS THAT WE'VE GOT TWO ENGINES GOING INTO ONE COOLING SYSTEM"

Bob Matousek, vice president for engineering, Tribine Harvester

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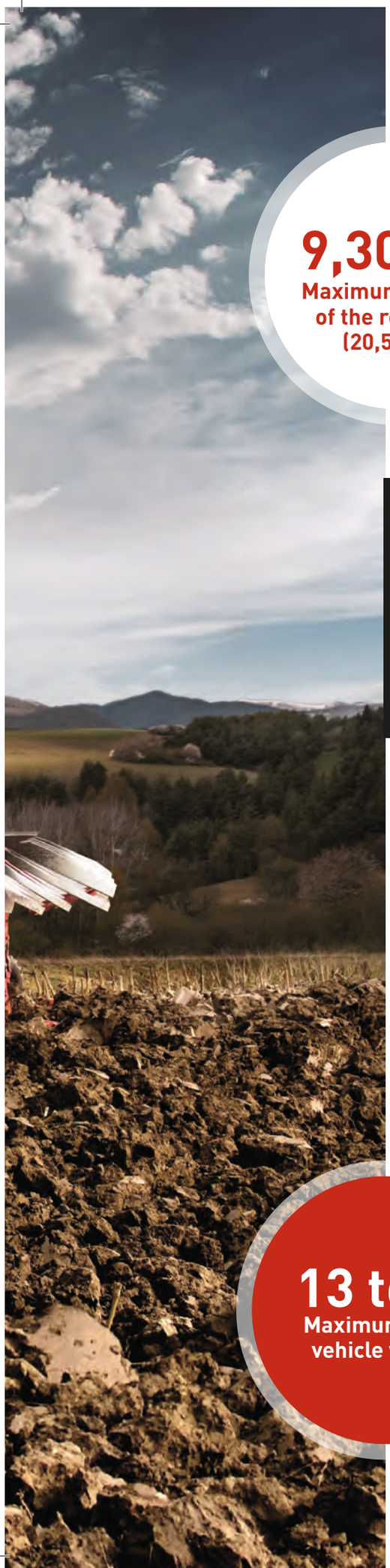
LEADING THE FIELD



9,300kg
Maximum capacity of the rear hitch (20,500 lb)

13 tons
Maximum gross vehicle weight

X7 SERIES McCORMICK TRACTORS WERE THE FIRST ARGO MACHINES TO USE THE PARENT COMPANY'S DISTINCTIVE STYLING. NOW A NEW MODEL – THE X7.690 – HEADS THE RANGE, WITH INNOVATIVE TECH INSIDE THAT HAS EARNED IT A 2019 TRACTOR OF THE YEAR NOMINATION. THE WINNER WILL BE ANNOUNCED AT THE EIMA EXPO IN BOLOGNA THIS NOVEMBER

Few industrial vehicle sectors are as diverse as that involving agricultural tractors. The huge variety of farms, with their differing livestock and cropping enterprises, size, soil types, location, climate and topography – to name but a few variables – means vehicle manufacturers have their work cut out to satisfy the requirements of every potential customer.

Italy's Argo Tractors meets the challenge through its own diversity, offering three brands – Landini, McCormick and Valpadana – featuring a range of transmission types. But, with the 2019 Tractor of The Year award winners due to be announced at EIMA in Bologna this November, it's the McCormick X7.690 that's currently attracting the most attention.

The latest flagship mid-range model, nominated for the main Tractor of the Year award, is a prime example of how the demand for choice is driving design decisions in this sector.

When McCormick launched the X7 series five years ago, it was the first tractor range from the brand to offer a continuously variable transmission (CVT), on models from 143hp to 175hp (107-130kW). These were released to complement the X7 Series Pro Drive models, with their 24 forward/24 reverse or 40F/40R four-step semi-powershift transmission. With the introduction of the latest upgrades and a new

flagship model, however, Argo has developed its transmission offering to include a new P6-Drive six-step semi-powershift option.

Customer demands

"Farmers are seeking more power from lighter tractors with good fuel economy, capable of demanding field work and fast road transport," says Giovanni Esposito, innovation director at Argo Tractors. "To meet this need, we developed a new model to head the X7 line, to fulfill not only the new Mother Regulations [EU type approval] and new Stage IV emissions rules, but also to meet developing market demands."

With 205hp (153kW) for draft work and up to 225hp (168kW) for PTO and transport operations courtesy of a Power Plus boost, the X7.690 represents the natural evolution and growth of the McCormick X7 tractor line that was born in 2014.

"Since then, all our tractor ranges have adopted this distinctive styling," says Esposito. "We are very proud of the team of designers that developed the style of all our current tractors, and we're investing in this group, which has further interesting developments in the pipeline."

5
The number of automated synchro ranges in the ZF TPT20 powershift transmission

Engine and transmission

Continuing its long-standing association with FPT as its power provider, Argo fits a new generation of NEF6 six-cylinder turbocharged and intercooled engine to the McCormick X7.690. The meeting of Stage IV emissions rules was achieved primarily by adding a new diesel oxidation catalyst to the aftertreatment system and replacing the old selective catalytic reduction system with a newer version capable of greater nitrous oxide reduction. A new electronic injection control system supervises fuel and DEF/AdBlue dosing, with Argo claiming improved consumption of both.

"THE ENGINE PRODUCES HIGH TORQUE AT LOW SPEED, BUT IT'S ALSO BEEN CHOSEN FOR ITS LOW FUEL CONSUMPTION, AND FOR ITS DESIGN – BEING SUSPENDED WITH DAMPERS IN A STRONG FRAME"

Giovanni Esposito, innovation director, Argo Tractors

"It's an engine producing high torque at low engine speed, that peaks at 1,400rpm," says Esposito. "But it's also been chosen for its low fuel consumption, and for its design, being suspended with dampers in a strong frame.

"Farmers are increasingly asking their tractors to perform more demanding haulage tasks, and in recognition of this we have fitted the new tractors with an exhaust brake, which acts on the exhaust gas output to aid braking downhill."

Argo stayed with existing supplier ZF to broaden its powertrain offering. Replacing the previous ZF T-7200 with its four powershift steps, the new ZF TPT20 brings two additional powershift gears and five automated synchro ranges, reducing the overall need to use the clutch pedal. Governed by a dedicated electronic controller, the Smart APS (auto-powershift) system allows the P6-Drive transmission to automatically select the most suitable range and speed gear according to the operator's chosen engine speed.

Would a full powershift not be the next natural step on from a four-step semi, though? Esposito says that's not the McCormick approach.

"We still see a strong market for a modern semi-powershift of this type. It offers the best possible combination of high efficiency, low fuel consumption, high field load capabilities and, together with the latest technologies, very good comfort. We aren't fans of full powershift transmissions, for efficiency reasons. But the X7.690 is ready for a CVT option…"

Power take-off redesign

To account for the X7.690's greater power output from the new FPT NEF6 Stage IV engine, Argo worked with ZF to add some extra specifications.

LEFT: **The X7.690 powertrain is equipped to perform demanding haulage tasks**

BELOW: **A new electronic injection control system to help meet Stage V emissions legislation**

"We completely redesigned the rear PTO cartridge to manage – with a strong safety margin – the higher power," says Esposito. "The braking system and the 4WD output line were reinforced to fulfill the new Mother Regulations, and we further improved the hydraulic circuitry, working with our suppliers, including Bosch Rexroth, Danfoss and Hydac, to guarantee maximum comfort by minimizing any residual noise coming from the pumps and valves, while increasing maximum flow rate to create a new 160 l/min option in addition to the 123 l/min standard fitment, supplying up to seven remote valves and a 9,300kg [20,500 lb] capacity rear hitch."

Comfort built in

On the comfort side, in addition to a suspended Carraro front axle, one of the major new developments – specially engineered for the X7.690 – is the semi-active cab suspension. This alternative to the standard mechanical system adds a new feature that allows the cabin suspension damping to be dynamically altered.

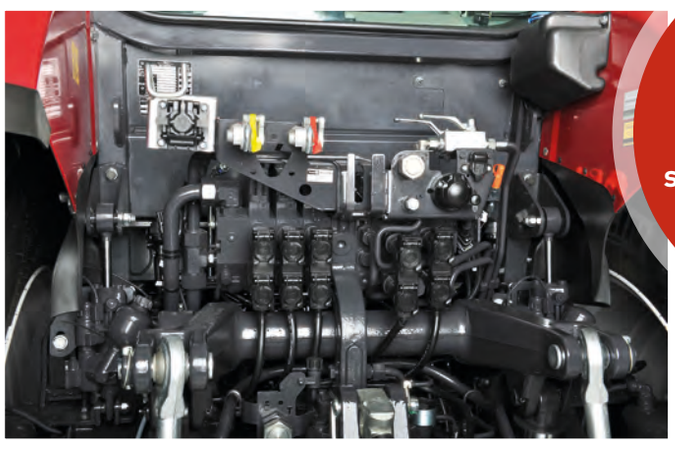
"Tractors with a conventional suspension system have dampers tuned on a single point, and as such are compromised for the tractor's different tasks," says Esposito. "With our new system, the result of a three-year development program conducted in collaboration with the Italian university Politecnico di Milano, by means of accelerometers and position sensors, a mechatronic system continuously detects the working condition of the vehicle and is able to modify shock absorber firmness to suit changing terrain."

Also on the operator comfort front, Argo has developed a new brake/clutch feature for the X7.690, allowing easier temporary stopping. Called Stop & Action, it allows the driver to disengage drive and brake the tractor simply by pressing the brake pedal.

"There is no need to depress both the clutch and brake pedals simultaneously," explains Esposito.

"For example, if approaching a traffic light when the system is switched on and the driver presses the brake pedal, the main clutch opens automatically. To move off again, removing the driver's foot from the brake pedal also automatically modulates the main clutch, re-engaging drive smoothly."

Driver comfort improvements don't stop there. In the Premiere cab, the Data Screen Manager (DSM) control terminal fitted to premium-specification X7 models now feature upgraded software with additional functions such as a feed from a rearview camera and advanced headland management functions to ease the end-of-row turning process.



160
Maximum hydraulic flow rate (in l/min), supplying up to seven remote valves

McCORMICK X7 TIMELINE

2000
Argo purchases certain Case IH product lines, factories and the McCormick brand name from Case New Holland

2009
XTX range launched to replace MTX series design inherited from CNH sell-off

2011
X70 series launched to replace XTX and TTX, with design based on smaller X60 series launched the previous year

2013
McCormick X7 tractors replace X70 series

2017
X7.690 added to line

2018
X7.690 nominated for Tractor of the Year 2019

Creating the new model involved relying heavily on simulation technology, says Esposito, including multibody simulation, and computational fluid dynamics for the engine compartment and cooling and hydraulic systems.

"Extensive use was also made of field tests across a wide range of working conditions, using telemetry and remote monitoring technologies to record in real time the working conditions of the test tractor fleet.

"With that combination of development and testing, we hope to have created a tractor that blends the wide range of features required by mid-power tractor buyers in this diverse sector with the reliability demanded by all types of farm business." **iVT**

BELOW: **A new diesel oxidation catalyst was added to the aftertreatment system**

225hp
Maximum power output (168kW)

HOW McCORMICK BECAME ITALIAN

The McCormick name comes from the American inventor of the mechanized grain harvesting machine, which was first demonstrated in 1831. The business Cyrus McCormick founded merged with a number of others in 1902, to form the International Harvester Company (IH). IH phased out the McCormick brand some decades later. In late 1984, IH sold its farm equipment interests to Tenneco, then the parent of fellow tractor maker Case.

Fast-forward to 1996 and Tenneco had floated its farm equipment interests, forming Case Corporation.

When, in 1999, Fiat made an offer for Case, including its Case IH farm equipment business, it was required by the competition authorities to divest certain assets to avoid a combination of Case IH and Fiat's New Holland business having too much market share in certain sectors.

The mid-range Case IH tractor line and the factory where it was made, in Doncaster, England, were therefore put up for sale.

The eventual buyer was Argo, the Italian farm equipment business that already owned Landini. They also purchased the McCormick brand name, which although long defunct, was still well-respected, especially in North America.

Argo continued to produce Landini tractors in Italy and McCormick models based on former Case IH designs, largely covering the same power band, until midway through the last decade, when the contraction in the farm equipment industry, among other factors, led it to develop dedicated platform strategies at the firm's Fabbrico factory in Italy.

TRACTOR OF THE YEAR 2019 NOMINEES

The McCormick X7.690 is one of three tractors nominated for the main 2019 Tractor of the Year award. The other two contenders are...

Case IH Maxxum 145 ActiveDrive 8
Mid-spec Case IH Maxxum Multicontroller tractors, including the largest four-cylinder model, the Maxxum 145, now feature a new ActiveDrive 8 semi-powershift transmission, offering eight powershift steps in each of three ranges. For road travel, the transmission is designed to start in range three, with skip-shift and auto-shift functions for quick progress through the powershift speeds. A further eight creep speeds are available.

Zetor Forterra HSX 140
The largest model in the latest incarnation of its four-cylinder Forterra range, Zetor's Forterra 140 HSX features a new Eco 40 transmission with a top speed of 40km/h (25mph), achieved at a lower engine speed to reduce fuel consumption. There is also a suspended front axle to improve driver comfort, and a set of features designed to improve operator safety. These range from more efficient brakes to panoramic rearview mirrors and a new dashboard.

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SLIMTITAN

7” rugged touch screen display

M-CLUSTER

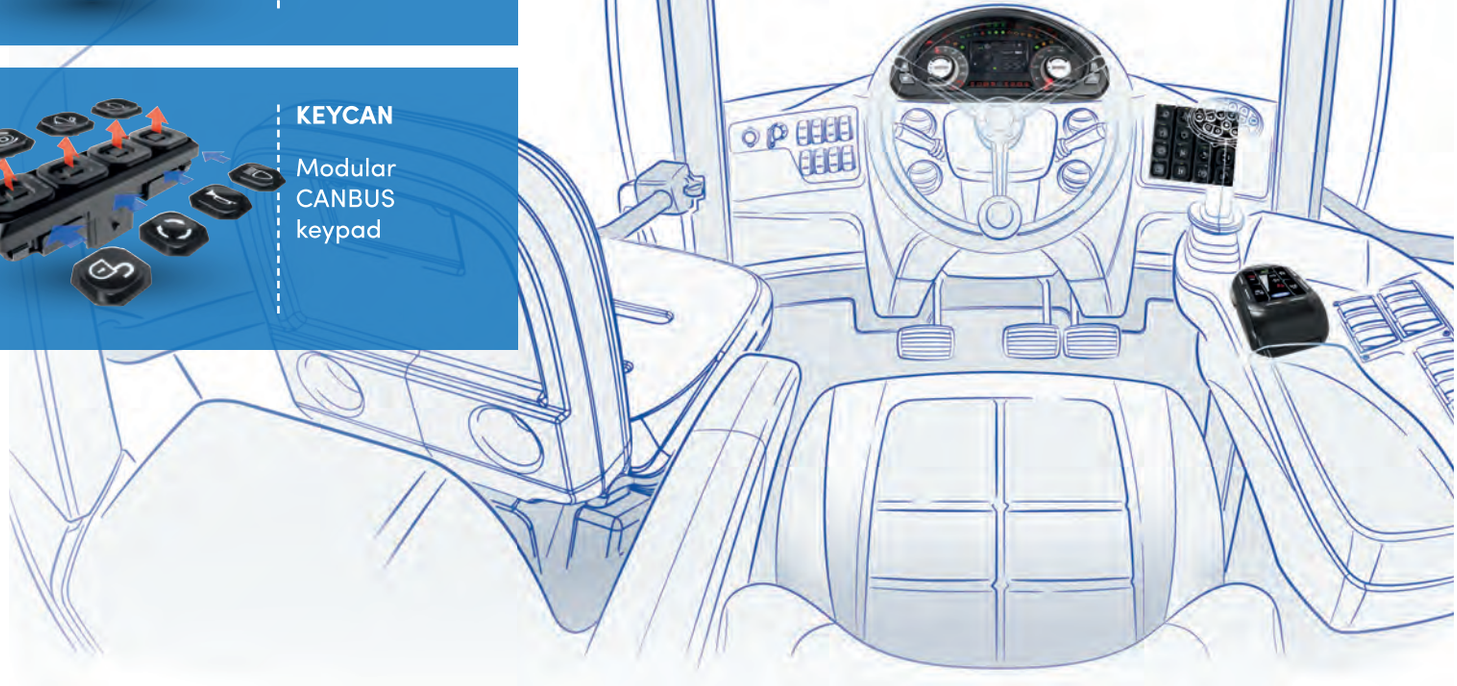
Deep innovation on traditional cluster

DASHCONTROL

Ergonomic and multifunction CANBUS control encoder

KEYCAN

Modular CANBUS keypad



The new line of Ama Instruments devices has been engineered for all applications requiring compact and maximum versatility along with high performance and structural strenght. Thanks to its innovative and minimal design, the whole range of instruments by Ama Instruments fits different applications perfectly.

ama INSTRUMENTS

VISIT US AT

FEDER UNACOMA cima international DUEMILADICIOTTO

HALL 18
STAND B8

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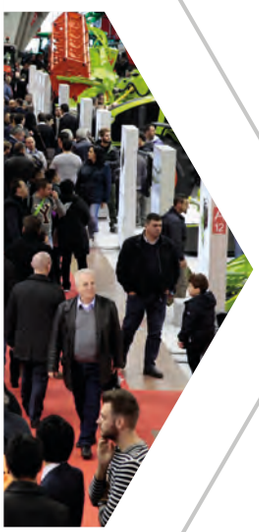
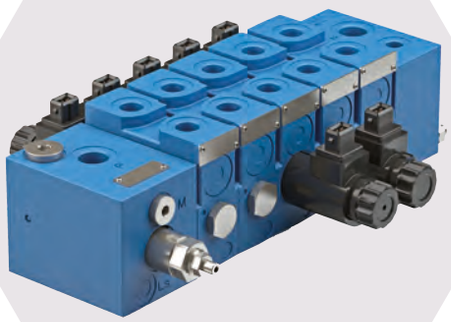
F. +39 0522 695753

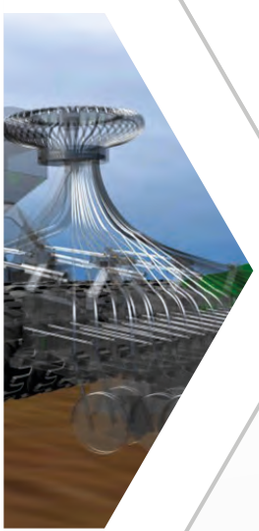
www.amainstruments.it
info@amainstruments.it

Viva Italia!

TAKING PLACE ONCE EVERY TWO YEARS IN BOLOGNA, ITALY, EIMA INTERNATIONAL BRINGS TOGETHER PROFESSIONALS IN THE AGRICULTURAL FIELD AND PROVIDES THEM WITH BOTH BUSINESS AND NETWORKING OPPORTUNITIES. OVER THE NEXT SIX PAGES, WE COLLATE KEY INFORMATION AND NOT-TO-BE-MISSED HIGHLIGHTS







Industry professionals planning to attend the EIMA International Agricultural and Gardening Machinery Exhibition have a lot to look forward to.

The event, which is taking place from November 7-11, 2018, at the Exhibition Center in Bologna, Italy, will include a trade fair where more than 700 leading agricultural organizations will showcase their latest innovations.

Salon showcase

To help visitors find the products they are looking for at the exhibition, FederUnacoma, the event organizer, has divided it into five themed halls (also known as 'salons').

The largest of the salons, EIMA Components, will showcase mechanical innovations, as well as spare parts and accessories, for agricultural machinery. EIMA MIA (multifunctionality in agriculture) will present alternative farming methods and machinery for agriculture on a small scale. EIMA Green ('the green salon') will contain mechanical innovations and equipment suitable for use in gardening and grounds maintenance. EIMA Energy will highlight technology used as part of renewable energy processing within agriculture. Technologies used for plant irrigation and the management of water will be located in the EIMA Idrotech room at the show.

Helpful info for visitors

In addition to the exhibition, EIMA International visitors will also be able to experience the EIMA Digital space and the all-new EIMA Campus.

The EMIA Digital Space is an area within the venue for organizations that produce software and advanced electronic

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systems for agricultural machinery. It will showcase new innovations designed for connected-vehicle initiatives in the field.

The EIMA Campus will showcase key agricultural research carried out by universities and educational centers, as well as training events for university students and researchers.

EIMA will also run its Mech@agriJobs project. Organized by UNACMA (the National Agricultural Machinery Dealers Association) and first introduced at EIMA International 2012, the project aims to educate attendees of agrarian schools and technical institutes about job opportunities within the field, including manufacturing, marketing and sales and engineering.

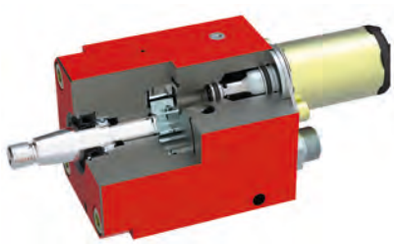
Awards ceremony

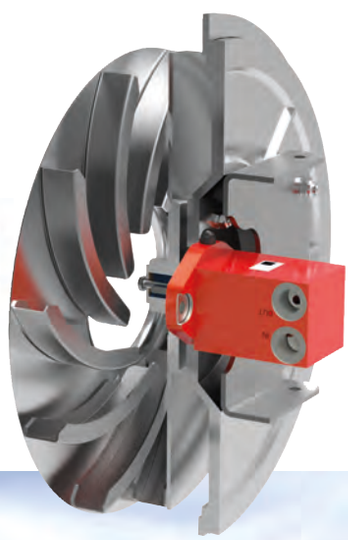
At its Technical Innovation Contest award ceremony – which has taken place at every EIMA International event since 1986 – FederUnacoma will present awards to organizations that have developed the most ingenious products. Products eligible for entry into the competition include machinery, accessories and components, produced by exhibitors, that are capable of improving production and the quality of work for operators in the agricultural sector.

To book your place at EIMA International, visit: www.eima.it/en

Leading organizations will showcase their latest innovations at the event

Bucher Hydraulics
Hall 20
Stand C24





POWERFUL **BLOWER DRIVES**

With rising seed costs and ever-tighter environmental protection regulations, precision dosing and distribution are becoming increasingly important in sowing technology. Combining very high speeds with extremely quiet operation and maximum service life, the innovative QXM-Mobil internal gear motors from **Bucher Hydraulics** deliver impressive performance in seed drills.

Self-propelled and towed machines share a common requirement for a reliable and low-noise motor with high working speeds. Bucher Hydraulics supplements the tried-and-tested QX series with two new internal gear motors for the mobile sector: the QXM12 and QXM22, with displacements of between 2.5cm³/rev and 8cm³/rev. They have a maximum working pressure of 210 bar and speeds of up to 6,000rpm.

Thanks to their design, QXM motors also offer significantly higher levels of operating reliability and longer service life than other drives typically used in sowing technology. These internal gear motors therefore support the goal of increasing efficiency through faster filling of the machine and shorter sowing times. Quiet running, stable torque and good startup performance are further strengths of the internal gear motors, which enable the QXM concept to score heavily over conventional drive technology such as external-gear or axial-piston motors.

By incorporating an outboard bearing directly into the body, the user is saved the effort, costs and space of specially fitting the outboard bearing that would otherwise be required with external gear motors.

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To learn more about this advertiser, visit www.ukimediaevents.com/info/ivm
Quote Ref: **501**

Perkins
Hall 15
Stand C13

COMPACT, **LIGHTWEIGHT STAGE V**

The **Perkins** 1706J is a 6-cylinder, 9.3-liter engine that combines a high-pressure common-rail fuel system and advanced aftertreatment technology to produce up to 456hp (340kW) of power and 1,540 lb·ft (2,088Nm) of torque out of a compact, lightweight package.

The 1706J is certified to Stage V and Tier 4 Final and equivalent emission standards and will be followed by an engine for less regulated countries (LRC), expanding the offering of worldwide engine platforms.

The 1706J offers power density up to 49hp/l (37kW/l), which enables OEMs to downsize their engine platform without sacrificing performance or reliability. It is designed to allow simple, low-cost installations with low heat rejection for optimal cooling package sizing and features such as engine-mounted aftertreatment to reduce installation cost.

Typical applications for the Perkins 1706J include air compressors, hydraulic excavators, ag tractors and rock crushers/screeners.

End users benefit from a low cost of ownership, thanks to low fuel consumption and an aftertreatment system designed and validated to regenerate transparently.

Regeneration functions do not have any impact on engine performance and are completely transparent to the operator, enhancing both uptime and productivity.

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To learn more about this advertiser, visit www.ukimediaevents.com/info/ivm
Quote Ref: **502**

ELECTROHYDRAULIC VALVE BLOCK

Bosch Rexroth has developed the new EDG electrohydraulic valve block for the implementation of hydraulic systems on agricultural machinery. It has a modular sandwich design and is intended to be the main valve block for trailed and self-propelled machines. Its special feature is the optimal flow pattern, enabling improved efficiency. This was realized by using cast-iron sections, which allow a much higher degree of freedom in channel design than drilled variants. Another feature is the load-pressure-independent load-sensing (LS) technology in each section. Additionally the LS pressure for each function can be set on the A and B ports using pressure cut-off valves LSA and LSB.

The pressure compensator and the secondary valves with their anti-cavitation function are integrated into the housing. The maximum flow rate for the directly actuating controlled variants is up to 40 l/min, and for pilot operated valve slices up to 60 l/min with a maximum operating pressure of 350 bar. The complete valve block is assembled with a standard inlet plate suitable for use with a variable or fixed displacement pump.

Flow volumes of up to 120 l/min are possible for the inlet element. Due to the modular design of the valve block, it is possible to implement almost every customer requirement regarding function and assembly space. As an option, the inlet element can be integrated into a priority function such as steering or brake systems.

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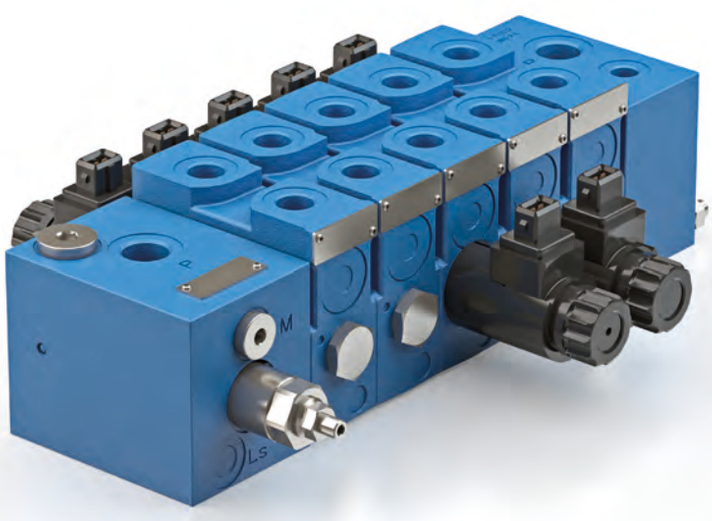
Quote Ref: **503**

Bosch Rexroth
Hall 18
Stand C46



ADVANCED **DASHBOARD CONTROL**

AMA Instruments, a division of the AMA Group, is launching a product dedicated to off-highway applications for remote control of displays.

DashControl is an innovative device in its flexibility, functionality and highly ergonomic design. It allows the operator to manage the dashboard display direct from the armrest or from the command console.

Using the encoder with high-grip rubber wheel, the operator can set predefined parameters, set the positions of the actuators, navigate through remote display menus, and configure the work mode.

The high-brightness and high-definition color display, in a scratch resistant anti-reflective polymethyl methacrylate (PMMA) casing, can be used to add extra features and assign dynamic functions to the seven backlit keys.

DashControl also features a CANbus port and eight 3A power outputs, with protection against short circuit.

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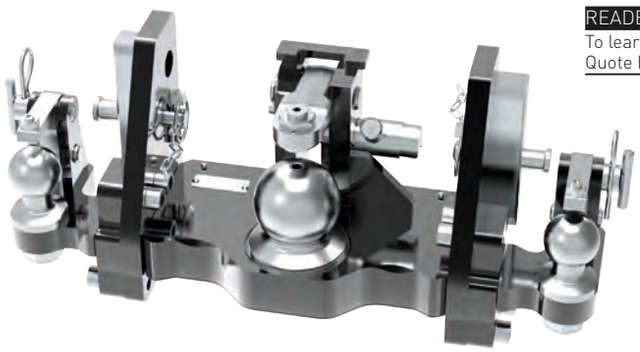
To learn more about this advertiser, visit www.ukimediaevents.com/info/ivm
Quote Ref: **504**

AMA
Hall 18
Stand B8

CBM
Hall 20,
Stand C49-C53



HIGH-RESISTANCE COMPONENTS

In order to satisfy the increasing requirements of the agricultural market in terms of loads and resistance, **CBM** has developed, over the past few years, a new HDPlus version of the EEC Trailer Hitch Slider Clevis and modular bracket complete with an 80mm diameter ball.

This latest version has been designed and tested to resist a D value of 120.9kN and a vertical S load of 2 tons for the EEC Trailer Hitch Slider Clevis and 4 tons for the 80mm diameter ball, for speeds higher than 40km/h (25mph).

CBM has also enhanced its very wide range of drawbars with the introduction of a Cat.5 HDPlus version. This special HDPlus version is intended to be used on tractors from 250hp up to 450hp (186-335kW).

CBM's main aim is to constantly strive to design and develop new solutions, in line with the latest market needs, with particular attention to research into new materials and the latest technologies.

Innovation has always been a winning formula for CBM and this has been passed on to the OEM tractor manufacturers and end users through its wide range of products.

CBM's intention is to provide end users with a resistant and reliable product and the new HDPlus version successfully achieves this.

READER INQUIRY SERVICE

To learn more about this advertiser, visit www.ukimediaevents.com/info/ivm
Quote Ref: **505**

FPT Industrial
Hall 15
Stand B13

EASY **STAGE V UPGRADES**

FPT Industrial will exhibit its Stage V engines – dedicated to agriculture applications. These solutions combine emission compliance and perks that make each engine the perfect solution for OEM needs.

Visitors will be able to see part of FPT Industrial's offer, which starts at 73hp (55kW), with the F34 engine. Without needing an SCR, it has a DOC+DPF mounted on the flywheel, delivers a maximum torque of 424Nm at 1,200rpm and has a 600-hour oil change interval. At the other end of the scale, maximum power is reached with the V20, which can deliver up to 910hp (678kW) and is best-in-class for compactness and power-to-weight ratio.

Between these sit the F36 Stage V engine – the perfect fit for light machinery, delivering an increased power of 143hp (107kW) – and the Cursor 9 Stage V engine, a high performer with up to 7% higher power density than its competitors. Plus, being EGR free and adopting a maintenance-free HI-eSCR2 technology, it gives reliability, low fuel consumption and high efficiency.

The FPT Industrial line-up features also a PowerPack, the new installation solution that encloses all key aftertreatment components into a single package, thus allowing an easy upgrade to Stage V regulations.

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To learn more about this advertiser, visit www.ukimediaevents.com/info/ivm
Quote Ref: **506**

HIGHER PERFORMANCE FOR OPERATORS

Siroco designs, develops and manufactures air-conditioning, ventilation and air diffusers for industrial vehicles. Drawing on 35 years of experience, the company responds to the needs of OEMs which are constantly seeking to offer more comfort and higher performance for operators.

A global manufacturer of thermal solutions, Siroco works collaboratively with its customers, from initial design to serial manufacturing, via qualification tests, prototyping and industrial roll-out. A subsidiary of Sintex NP group – a European leader in plastic transformation – Siroco benefits from expertise in plastic injection, precision cutting, electronics and cable harnesses. Thus Siroco is able to customize its products to fit cabin designs as perfectly as possible.

Siroco applies its high levels of individual quality control to all of its projects. In this way the company has built up a strong position in Europe and Asia and is currently developing its HVAC business in the Indian market, through close ties with Sintex-BAPL.

Among its new products, the electronic control panel CP2 is intended to regulate the performance of HVAC units and to autonomously adapt the cabin temperature. Siroco also develops system cards to manage vehicle CAN. All of Siroco's current products will be showcased on its stand.

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To learn more about this advertiser, visit www.ukimediaevents.com/info/ivm
Quote Ref: **507**

Siroco
Hall 15
Stand G2

THE **BIGGER PICTURE**

Vincenzo Perrone, president of the diesel division of off-highway engines at Kohler, delivers his verdict on the future of industrial vehicle powertrains

Kohler Lombardini
Hall 15
Stand A17

Recently manufacturers of both on-road and off-road diesel engines have come under scrutiny as significant contributors to high pollution levels, especially in urban areas. However, as president of the diesel division of off-road engines at Kohler, I would like to provide some additional context to demonstrate how diesel technology has improved over the years and how the technology continues to have a bright future in the off-road sector.

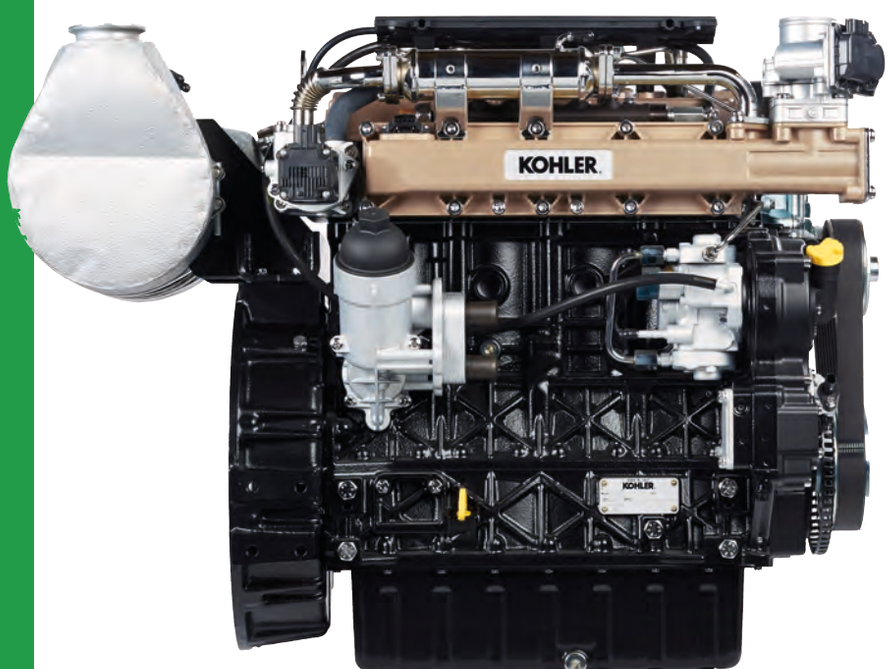
Both diesel equipment manufacturers and the end users they serve continue to seek high performance, compact and modular engines with low cost of ownership. These evolving market requirements have been an invisible force that has pushed engine manufacturers to constantly upgrade the technology they provide to be more efficient and deliver better overall performance.

At the same time, off-road diesel engine manufacturers have been working closely with environmental agencies, both in Europe and the USA, to define and release new emissions regulations for cleaner air.

The latest step in EU regulations (Stage V) requires diesel engines to adopt aftertreatment systems, namely diesel particulate filters, that dramatically reduce the number of particles emitted by internal combustion.

With these new systems, Stage V off-road diesel engines have fewer particles in their exhaust than in the air in most cities. They are clean!

"I BELIEVE HIGHLY EFFICIENT DIESEL TECHNOLOGY WILL CONTINUE TO BE THE BEST POSSIBLE SOLUTION FOR THE INDUSTRIAL VEHICLE POWERTRAIN"



The challenge for diesel engine manufacturers has been how to meet evolving market requirements, to remain relevant for manufacturers and end users, while also developing engines that comply with increasingly stringent emissions regulations. This challenge has required huge investment in terms of time, money and other resources.

Unfortunately the off-road sector has also been included in the recent public scrutiny of on-road vehicles, even though our sector is separate from the automotive market, with a different set of regulations and technical challenges.

One of the main reasons for the recent uproar against diesel engines is that the emissions levels of vehicles on the road can be much greater than what is measured in the lab. In the case of off-road machinery, the emissions test cycles reflect very closely the actual duty cycle, so the emissions measured in the lab are in line with real-life operation experiences.

Over the past 20 years the different stages of emissions regulations progressively reduced the environmental impact of diesel engines. NO_x and particulate matter released into the air have been reduced by nearly 90%.

Meanwhile the performance of diesel engines for off-road applications has only improved and has helped to enhance a wide variety of construction and agricultural equipment all around the world.

Many alternative technologies have been presented recently as the 'next step' when it comes to minimizing emissions from off-road equipment. But it is very important to analyze each of these alternatives thoroughly before jumping on board to blindly support the newest options.

While reducing environmental impact is very important for all industries, for alternative engine technologies we must make sure they address the root cause of emissions rather than simply move the impact further down the product's life. We must all continue to look at the bigger picture and exercise critical thinking when considering the possible paths to a cleaner environment, especially in terms of CO_2.

For the foreseeable future, I believe highly efficient diesel technology will continue to be the best possible solution for the industrial vehicle powertrain. At Kohler we remain committed to doing our part, with passion and integrity, for the benefit of equipment manufacturers, end users and the global environment we all share.

4.0

The future, today.

INTERNATIONAL AGRICULTURAL AND GARDENING MACHINERY EXHIBITION

Bologna, 7.11 November 2018

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eima@federunacoma.it

MATTEO MICHELIN & MARCO COSTAGGIU

Hydrostatic design revolution

THE LATEST VARIABLE DISPLACEMENT TECHNOLOGY IS HELPING TO REVOLUTIONIZE THE DESIGN OF HYDROSTATIC TRANSMISSION SYSTEMS, OPTIMIZING PERFORMANCE, WEIGHT, NOISE AND OVERALL EFFICIENCY

SAI Hydraulic Motors
Hall 15
Stand A8

In all mobile machinery, energy must be transferred from the prime mover (usually a diesel engine) to the end users – either the wheels to drive the machine or the tools and equipment installed. When using a hydrostatic transmission, the operational performance maximum tractive effort (torque) and travel speed – of the machine is defined by the pump, the motor and the mechanical setup.

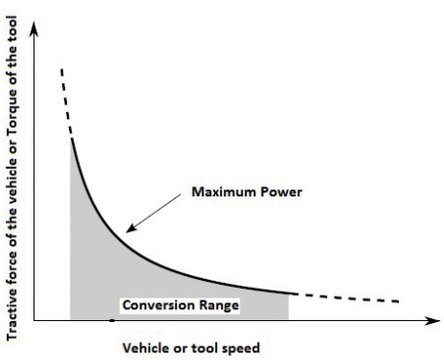
Hydraulic energy conversion is defined by three key factors. First, the theoretical range – the ratio between the maximum tractive effort (torque) and the maximum travel speed – which is defined by the performance requirements of the vehicle or tool. Second, the efficiency of this conversion in all the ranges of torque and speed needed. And finally, the transmission layout and characteristics.

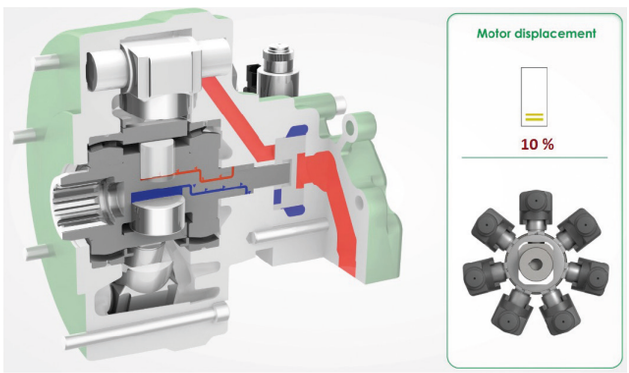
Effects of a variable displacement motor

A variable displacement motor can have major effects on the performance of a hydrostatic transmission. For example, it can enable complete control of the motor speed and torque.

The machinery's theoretical performance is related to the ratio between the maximum and minimum displacement of the hydraulic motor. Variable axial piston motors are commonly used in minimum displacement between 35% (swash plate) and 0.25% (bent axis) of the maximum displacement. Below these values, the motor efficiency and controllability are severely compromised.

Therefore where the application's theoretical range is wide, the traditional transmission setup requires a variable displacement axial piston motor, plus a mechanical multispeed gear reduction (different gear ratio and/or clutches) to cover the whole range.





ABOVE: **The radial piston motor displacement can be easily regulated from minimum to maximum**
RIGHT: **The transmission requires no gearbox or clutches so saves space and weight**
BELOW: **A variable displacement motor can improve hydrostatic transmission performance**

The SAI variable displacement radial piston motor can transition seamlessly from maximum to minimum displacement, for complete motor speed and torque control. The motor can be used with a minimum displacement 0.10 of the maximum displacement, while still offering high efficiency and controllability.

This offers the capacity to cover the full required range of the machine simply by adjusting the pump output flow and the SAI variable displacement motor, without adding gear switches, clutches, or any other form of mechanical transmission.

High accuracy, low emissions

The SAI variable displacement motor provides high levels of efficiency, from creep speed in maximum displacement, to top speed in minimum displacement. This innovative solution is favored over the traditional gearbox/motor combination as the efficiency of the drive is greatly increased by decreasing the gearbox reduction ratio. The SAI motor gives direct access to the machine's whole operational range.

The efficiencies achieved result in reduced fuel consumption and power losses – a critical factor for meeting stricter emissions regulations.

The high efficiency throughout the entire displacement variation range results in very accurate power delivery, from very low-speed positioning to very high-speed travel.

Gearbox-free transmission

SAI components allow the designing of a transmission without gearboxes and clutches, therefore saving space and weight, and increasing robustness.

Removing the mechanical gear selection, clutches and reduction gearboxes has many benefits, including the removal of high-wearing components that are costly to maintain, and are prone to failure. There are also gains in efficiency, usability and noise.

SAI's solutions maximize all the key requirements of a hydrostatic transmission, improving efficiency while optimizing the performance, weight, maintenance and noise of the machinery.

The benefit of this breakthrough technology has been proven in mobile vehicles, drilling machinery, marine and industrial applications. **iVT**

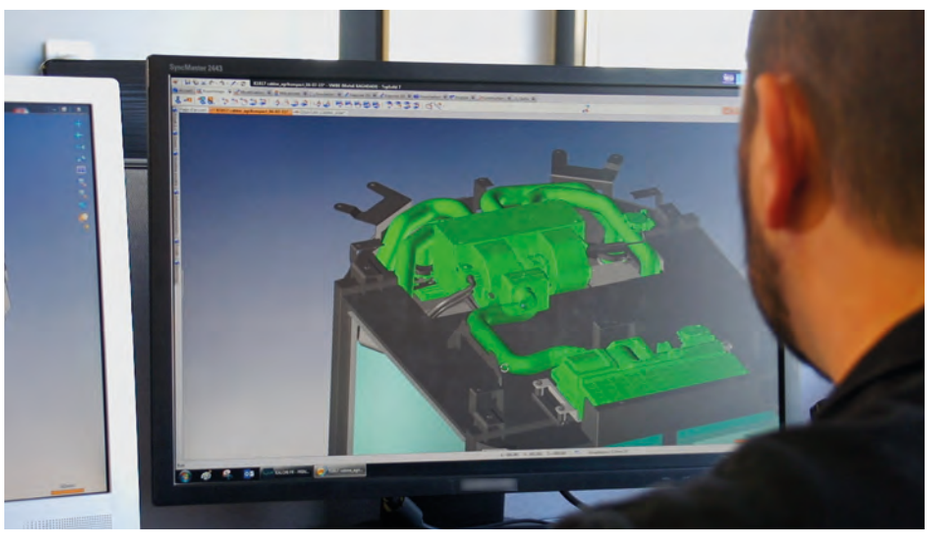
Matteo Michelin – sales manager
Marco Costaggiu – OEM specialist
at SAI Hydraulic Motors

STÉPHANIE LE FAUCHEUR

Great returns

A BRAND-NEW SERVICE OFFERS VIRTUALLY INSTANT AIR-CONDITIONING SOLUTIONS FOR THE OFF-HIGHWAY INDUSTRIAL VEHICLE MARKET, BASED ON YEARS OF EXPERTISE AND EXPERIENCE

Kalori
Hall 15
Stand E11



LEFT: **Engineers are familiar with all configurations**
BELOW: **Systems can be fitted in a variety of locations**

Boomerang, a new free service from Kalori, makes air-conditioning simple. Manufacturers can send a digital model of their cab to the Kalori design office and, like a boomerang, it (almost) instantly comes back, updated with multiple alternative solutions for the integration of standard or specific HVAC components, providing the comfort level required.

The rapidity of the service takes nothing away from the serious intent of the concept. Fully costed, multiple solutions can be offered, with the final decision up to the customer.

Kalori's catalog is rich with proven solutions, covering a wide range of site machinery and agricultural vehicles, used by some of Europe's largest manufacturers. These, along with the expertise of the Kalori design office, and supported by thermodynamic calculations carried out using its specially designed Simulka software, help to inform installation designs.

Guided by experience

Kalori has designed HVAC systems for all kinds of industrial vehicles. This long history of installations enables its experts to quickly visualize and rapidly suggest potential options.

"The majority of the time we can instantly identify the solution that will be chosen," says Frédéric Ferreira, an HVAC systems expert in the Kalori design office. "After the verifications by calculation, we can rapidly point the manufacturer toward a reliable offer in terms of performance, and a highly efficient one from an economic standpoint."

To optimize the performance of an air-conditioning system, the manufacturer must set aside enough space, as the equipment takes up considerable room. You may know the story of the wise old man who shows his students that to put sand, gravel and pebbles in a jar, you need to start with the pebbles.

The HVAC unit and the air-diffusion ducts are the equivalent of the pebbles. So, the HVAC system must be chosen before other, smaller components. This will ensure optimum performance levels in terms of comfort, and avoid undesirable outcomes, such as lack of cabin space, which is a cause for user dissatisfaction. In an air-conditioned vehicle, a certain level of comfort is expected – especially when the weather is hot.

Installation

The HVAC systems available all meet certain dimension restrictions, so they can be installed in a dashboard, under a bench seat, or even within a low-level roofing space.

When required by specifications, pressurization systems (meeting the requirements of EN 15695 – Class 4) can be integrated into the cab.

HVAC control can be automatic or manual, via the CANbus using the Kalori Kanbox, or simply controlled mechanically using cables for a cost-effective solution. Kalori also designs air-distribution components, with finishing touches added by the TrimLine range of diffusers.

The global solution makes procurement simple, while assuring a coherent plan for the completion of the design of your industrial vehicle. **iVT**

Stéphanie Le Faucheur is engineering manager for Kalori

SAUL WORDSWORTH

The man behind the technology

Carraro
Hall 36
Stand D3

CARRARO CEO ALBERTO NEGRI TALKS EXCLUSIVELY TO *IVT* ABOUT SOME OF THE COMPANY'S LATEST TECHNOLOGICAL DEVELOPMENTS AND GIVES SOME OF HIS PREDICTIONS FOR THE FUTURE OF OFF-HIGHWAY VEHICLES

ABOVE LEFT: **Alberto Negri has been CEO of Carraro since October, 2014**

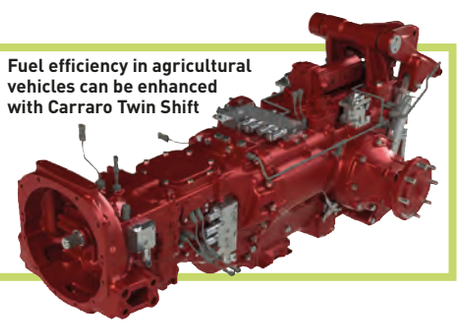
ABOVE RIGHT: **Carraro's VLB 75 features the company's new Twin Shift transmission**

Carraro is launching a dual clutch transmission for agricultural tractors – the Carraro Twin Shift. It is advancing this new product with a greater number of automation features, and it will make this technology available to manufacturers in emerging markets, and to small customers that do not have the financial or technical clout to develop such a creation.

"We think it will have a strong impact on the market," Carraro CEO Alberto Negri tells *iVT*. "We already have prototypes available. The first one launched will be a dual clutch 100hp (75kW) on our specialized tractor and this will create a reference for us to sell this product to new customers."

The new hardware will take advantage of Carraro's unique position in the market, selling small components, such as gears, right up to sophisticated transmissions and complete vehicles to customers all around the world. "Aside from a few Japanese and Korean companies, we serve everyone in the off-highway world, from the biggest blue chip – the likes of John Deere and Caterpillar – to small tow tractor manufacturers in China," says Negri.

Also in the area of specialized tractors, Carraro's OEM arm will be launching a new vineyard and orchard tractor at EIMA in Bologna, Italy, this November. "This 75hp [56kW] compact tractor is equipped with an axle and transmission manufactured by ourselves," says Negri. "It is designed to work in the most complicated and difficult orchards, especially in the Mediterranean."



Fuel efficiency in agricultural vehicles can be enhanced with Carraro Twin Shift

Transmission evolution

Another Carraro development is its continuously variable transmission (CVT) for specialized tractors, along with a new application known as the hydraulic super creeper (HSC).

"The HSC solution enables the tractor to operate with equipment requiring very low working speeds such as milling of logs, grinding stones for soil remediation and harvesting, and it can be retrofitted," explains Negri.

"We also have new transmissions for construction equipment. We are a leader in the backhoe loader drivetrain arena today and we have developed a new transmission for telehandlers, which will be launched with one of our biggest customers in the coming months, in a segment in which we have no presence today. Plus, we are in the process of developing a transmission for wheel loaders – again a new segment. We are enlarging our scope of business."

Looking to the future

Negri has a close eye on the development of automated systems. "The future is in the simplification of machinery," he says. "Today a construction machine is very complicated. You need to be very skilled to make the right maneuvers. One of the keys is to reduce the level of skill required from the driver. You need an easier interface with the machine so that the machine is clever enough to work by itself without complicated handling."

And paving the way for this automated, or at least semi-automated, future is the continued electrification of machinery. "If you look at machines from 20 years ago, they were very straightforward: an engine, a transmission, a few gears, and that's it," says Negri. "Today there are a lot of sensors in a vehicle that understand what you're doing. Technology from the automotive industry is becoming part of construction and agricultural equipment. Connectivity and sensors and smart, clever software to simplify activity – this is the key."

But whatever future technologies Carraro ends up specializing in, Negri is clear about one thing: this is a global marketplace in which companies cannot afford to be provincial. "We serve 163 customers around the globe and are a truly international company," he says. "We are present here in Italy, but we serve Europe and the rest of the world. We have a presence in South America, India and China. We have local R&D activities, local manufacturing and service activity. We have a global footing." **iVT**

Saul Wordsworth is a freelance journalist who writes for various magazines, newspapers and websites

BOBBY M ROBINSON JR

Seal the deal

Ace Pump Corporation
Hall 30
Stand B2

SEAL FAILURES CAN LEAD TO COSTLY DOWNTIME AND INCONVENIENCE FOR OPERATORS. BUT A NEW KIND OF WET SEAL PUMP IS HELPING TO MAKE SUCH WORRIES A THING OF THE PAST

Even with the variety of centrifugal pumps and sealing options available for pumping applications in the industrial vehicle market, mechanical seal failures still account for over half the repair cost and critical downtime of pumps. Most mechanical seals rely on a thin layer of process fluid to cool and lubricate seal faces. This becomes a problem when the process tank is empty or the fluid causes bonding between the seal faces. In response to these issues, some pump manufacturers offer wet seal pumps for improved seal life. These wet seal pumps use a separate fluid for a dual mechanical seal to run in, but not all wet seal pumps offer the same level of protection for the mechanical seal.

The three most important aspects of a wet seal pump are a greater pressure in the seal chamber than pump cavity; the fluid selection in the seal chamber; and visibility, enabling inspection of the seal chamber's fluid level and condition.

Ace Pump's line of Oasis wet seal pumps, including the newest FMC-755FS-HYD, provide all of these important elements.

ABOVE: **Oasis wet seal pumps have a continuously pressurized chamber to minimize seal failures**

Avoiding seal breakage

Other pump manufacturers offer a non-pressurized or even a self-regulating seal chamber. In both these designs there is opportunity for the film of seal fluid to break down or, even worse, allow the process fluid to contaminate the seal faces, causing premature failure. One self-regulating design even states in its instruction manual not to run the pump dry for more than 15 minutes. The reason for this is that while running dry there is no pressure in the seal chamber to maintain the seal fluid film across the seal faces. All of Ace's wet seal pumps have a continuously pressurized seal chamber to promote a thin layer of barrier fluid across seal faces and completely isolate the mechanical seal. Ace Pump's pressurized seal chamber designs are tested to last 3,000 hours while running dry.

In combination with keeping the barrier fluid on the seal faces with a positive pressure, barrier fluid selection is also critical. The majority of wet seal pumps currently use automotive antifreeze as their seal chamber fluid, which can dry up and crystallize between the seal faces and cause a failure. Ace only uses Royal Purple Barrier Fluid GT 22 in its seal chambers. This premium oil was developed specifically for mechanical seals and is cleaned to a typical ISO 4406 14/13/11 Cleanliness Code, making it 250 times cleaner than other new oils. Keeping this premium barrier fluid between the seal faces prevents the seals from running dry, even when the pump is dry. This also forms a barrier to prevent the possibility of process fluids from contaminating the seal faces.

Maintenance time built-in

Ace pumps include a seal chamber pressure and sight gauge to allow planned maintenance instead of critical downtime. Some other maintenance free wet seal pumps do not even offer a sight gauge to check the cleanliness or level of the seal chamber fluid. All mechanical seals currently available are still considered a wear item, and even if you keep a pressurized chamber full of clean fluid there will be a seal failure at some point.

As the seal nears the end of its life, operators will notice that the seal chamber begins to require air and barrier fluid more frequently. If the seal chamber pressure drops too low while the pump is running, operators may notice the fluid in the sight gauge change color. These are signs that maintenance should be planned during the next available service opportunity to prevent downtime during a future critical operation. Ace is so confident in its Oasis wet seal pumps that they are all covered by an industry-first two-year warranty on all components, including the seal. **iVT**

Bobby M Robinson Jr is senior product engineer at Ace Pump Corporation

LUCIAN BADESCU

Next-generation ECU

EVOLUTION IN DESIGNING SAFETY-RELATED CONTROL APPLICATIONS FOR MOBILE MACHINERY

ABOVE: **TTControl's HY-TTC 500 ECU family features SafeRTOS integration**

Today, the developers of safety-related control applications for mobile machinery need more and more processing power from the CPU, memory and available onboard peripherals to scale with the exponential complexity that needs to be handled inside safety-related control applications.

However, the classical way of designing and implementing a control application (running as a main processing loop) proves to become a bottle neck when trying to reach the desired responsiveness, performance and quality of the control applications in the mobile machinery fields.

Adopting a real-time operating system (RTOS) as a backbone in the design of a safety application is the natural evolutionary step from running it as a main processing loop. SafeRTOS offers the support required for today's control application implementation.

TTControl's HY-TTC 500 engine control unit (ECU) family featuring SafeRTOS integration substantially improves the traditional approach of designing and writing an ECU application by allowing the main loop user application to split into multiple working tasks.

TTControl's HY-TTC 500 ECU family (safety certified to SIL 2/IEC 61508 and PL d/ISO 13849), allows the safety application to respond to real-time events and to handle other tasks in the background while waiting for the next event to happen.

Application software for modern mobile machinery requires periodic changes to satisfy customization needs and updates/improvements. Therefore a lot of resources need to be invested for testing activities affecting the whole machine. The SafeRTOS-based design helps by:

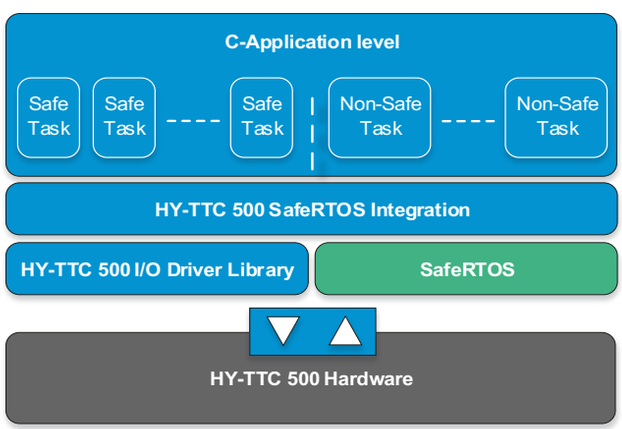
- making application easier to test and to maintain, hence cutting costs due to lower development and maintenance efforts.
- offering more flexibility in application implementation (due to the use of different task priorities and execution cycles), leading to less and more modular application code.
- allowing customers to reach faster time to market due to easy portability of existing application code when moving to more advanced and powerful microcontrollers supported by SafeRTOS.

Derived from the widely known FreeRTOS functional model, SafeRTOS was redesigned for safety-critical implementation and it is safety pre-certified.

TTControl has integrated SafeRTOS into the HY-TTC 500 ECU family and extended the real-time operating system (OS) functionality with control application specific features, such as run-time separation into safe- and non-safe tasks; monitoring concept for ensuring timely execution of all tasks; and application task ownership of any HY-TTC 500 I/O port used.

The main loop application is split into multiple working tasks that run until they are interrupted by a task with higher priority, blocked (waiting for an external event) or a time limit has expired. While waiting for the external event or their next turn to run, other tasks can be executed, which enables faster control loops and increases the efficiency of CPU use.

RIGHT: **The ECU can perform safety functions while handling other tasks in the background**



Tasks at hand

The safe and non-safe task isolation and separation feature, using the processor's memory protection unit (MPU), removes the risk of unwanted interleaving of application tasks with tasks performing other functions, such as low-level accesses to peripheral controls.

All I/O channel input and status data are available for all tasks. Each application task can have the ownership of any HY-TTC 500 I/O port used (but only one application task at the time for any output port). To fulfill the safety implementation requirements, the input and outputs with safety configuration cannot be owned by unsafe tasks. An implemented control mechanism ensures the consistency of output data.

The inter-task communication and synchronization mechanism using queue implementation permits safe data transfers between tasks.

All tasks are monitored from their time execution perspective. Out-of-time responses are reported to the application level using call-back functions. The decision regarding actions to be taken is up to the user application, for example, ignore, enter safe state or stop a software task.

With SafeRTOS integration, TTControl's HY-TTC 500 ECUs are now able to provide higher levels of robustness and responsiveness to the customer application and faster response to safety events due to SafeRTOS run-time performance. **iVT**

Lucian Badescu is a product manager at TTControl

TTControl
Hall 18
Stand C24

RYAN WAINWRIGHT-FISHER

Tractor engines of the future

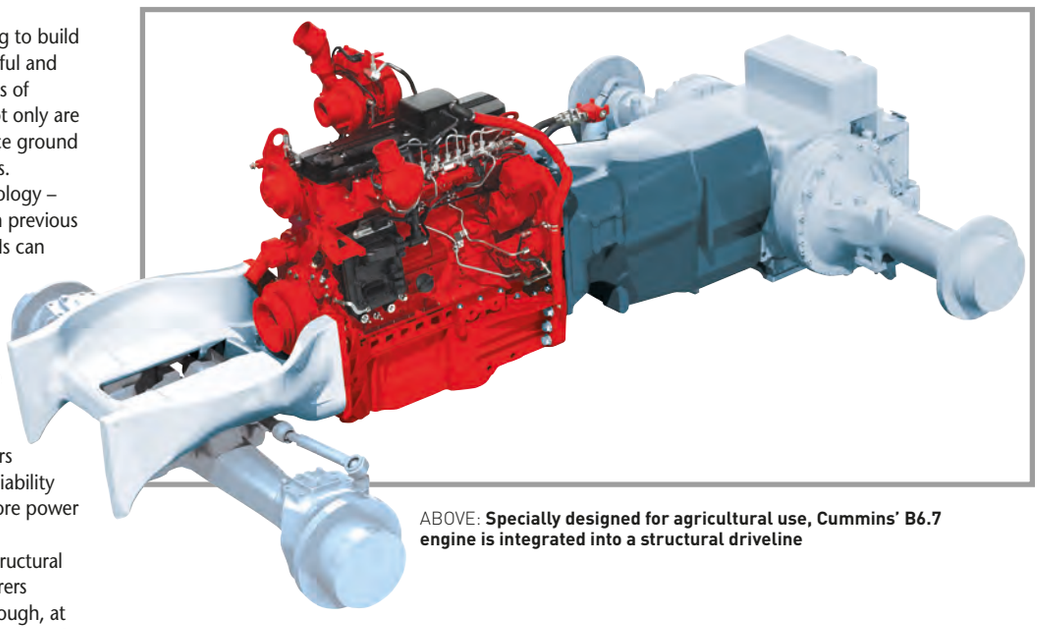
OFF-HIGHWAY VEHICLES ARE ON THE CUSP OF RAPID CHANGE DUE TO ADVANCES IN POWER, AUTOMATION AND CONNECTIVITY. WHAT DOES THE FUTURE HAVE IN STORE FOR THE NEXT GENERATION OF ENGINE DESIGN?

Cummins
Hall 15
Stand A5

Across the industry, OEMs are striving to build tractors that are lighter, more powerful and deliver a high level of reliability. The benefits of smaller, lighter machines are numerous. Not only are they more fuel efficient, but they also reduce ground compaction and are easier to drive on roads.

Thanks to next-generation engine technology – where new engines are more powerful than previous models, but with fewer components – OEMs can deliver these. Cummins' new Stage V B6.7 structural tractor engine epitomizes this trend. The first structural tractor engine produced by Cummins for over 20 years, it features a structural oil pan, rather than the more common structural block. In addition to its simple Single Module aftertreatment system, the compact, EGR-free design lowers installation costs for OEMs and increases reliability for end users, while delivering up to 5% more power and 31% more torque.

In terms of tractor design, the trend for structural engines is likely to continue until manufacturers develop tractors with chassis rails narrow enough, at a cost and performance level that negates the use of structural products. Similarly, tractors are likely to continue featuring a mix of tracks and wheels, depending on ground conditions and farm size.



ABOVE: **Specially designed for agricultural use, Cummins' B6.7 engine is integrated into a structural driveline**

Power solutions

For the foreseeable future, diesel power is the go-to power solution, particularly for smaller farms. With the advent of Stage V emissions legislation, which comes into force in 2019 and 2020, the latest generation of diesel engines, such as Cummins' Stage V range, are designed to produce almost no emissions, as well as being lighter and fuel efficient.

Electrified power has been championed by the automotive industry, governments worldwide and the media. For agriculture, it's fair to say that there is work to be done around battery capacity and size relative to tractor size and duty cycle. Diesel engine-powered tractors can run for between 10 and 20 hours between refueling, which, at least for now, outweighs the performance of currently available electric power systems in tractor applications. The expectation is that battery capability will increase and price will decrease over time, with Cummins already positioned for this with the purchase of electric power solutions providers Johnson Matthey Battery Systems, Brammo and Efficient Drivetrains.

By replacing hydraulics with electrified power such as a 48V system, nozzles, fans, seeders and drills can be made more accurate and efficient.

Some OEMs are testing methane-powered tractors, which are believed to produce fewer emissions, without reduced performance. However, fueling infrastructure is a key consideration. Methane is difficult to store on a tractor and it does not have diesel's high-power density.

Automation and connectivity

Driven by labor challenges in the farming industry, automation is becoming an increasing reality. Canadian firm SeedMaster recently announced that it has developed the Dot, a radically different design to that of standard tractors, but still powered by a Cummins Tier 4 4.5-liter diesel engine.

In the future, automated tractors may be smaller than manned ones. Aside from being cab-less, duty cycles are likely to differ, working longer periods and allowing for more passes with smaller implements. Although connectivity is not a new technology in agriculture, diagnostics and telematics systems will develop to become all-encompassing and fully integrated between the engine and driveline.

Conclusion

OEMs will continue to produce new state-of-the-art machines, but the cost-effective standard tractor will remain in demand – after all, this is business.

Manufacturers will continue to explore and invest in a suite of agricultural power solutions. As Cummins approaches 100 years of operation, it continues to push for more efficient, clean and capable powertrains, adapting its business model and capabilities to deliver these future technologies. Even so, development in clean diesel technology will carry on, alongside greater focus on complete drivetrain efficiency and the use of connectivity to increase customer productivity. **iVT**

Ryan Wainwright-Fisher is a technical specialist for off-highway customer engineering at Cummins

PATRICK THIL

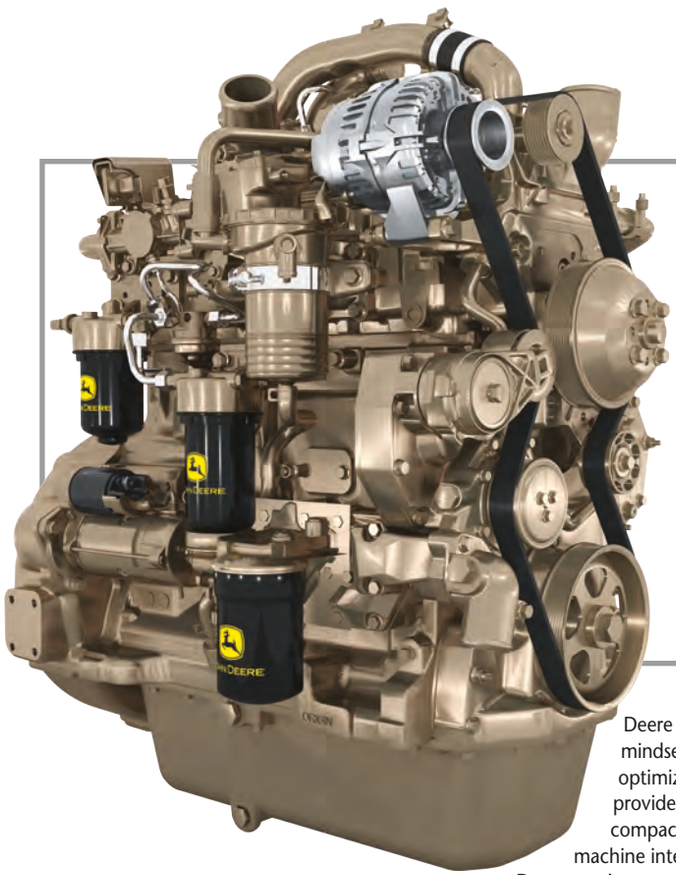
A complete Stage V-ready engine line-up

STAGE V SOLUTIONS ARE BEING TAILORED AND CERTIFIED AHEAD OF REGULATION DATES

John Deere Power Systems
Hall 36
Stand B7

John Deere Power Systems is leading its OEM customers seamlessly through the upcoming Stage V transition, thanks to its global field-tested experience.

"These trusted technologies provide OEMs and end users with the confidence that John Deere is offering a smooth transition to Stage V," says Sandrine Couasnon, manager, marketing services and sales engineering for Europe, Africa and the Middle East at John Deere Power Systems. "As John Deere is both an engine and vehicle manufacturer, we can leverage the remarkable global experience we have gained since 2011 to develop proven emissions solutions for our customers."



The Stage V-compliant 4.5-liter EWS (left) and 13.6-liter engines (below) will be certified prior to being manufactured en masse

Addressing industrial customers' needs

Ready to meet the current emissions needs within the European Union, the industrial Stage V line-up from John Deere will offer ratings from 36kW to more than 500kW (48hp to more than 670hp) with displacements of 2.9 liters through the upcoming 13.6 liters.

"Through each stage of consecutive emissions regulations, John Deere provided solutions that addressed key customer needs," says Couasnon. "These included increased uptime, low operating costs and flexible integration. The same applies to Stage V. For this stage, manufacturers will use diesel particulate filter (DPF) – a technology John Deere already has more than 900 million hours of experience using in the field."

This valuable experience on hundreds of internal and external OEM applications has resulted in a tested DPF solution, increasing uptime and offering the day-to-day reliability and durability users have come to expect from John Deere.

Stage V aftertreatment technologies from John Deere are optimized for flexible integration and offer reduced packaging and weight from previous Stage IV solutions. And because the technologies are built on the same engine platform as current Stage IV DPF solutions, the need for OEMs to re-engineer due to hardware or mounting changes is reduced.

The new 13.6-liter engine from John Deere, which will also be Stage V compliant, is an example of the company's leadership in providing innovative emissions solutions. When developing this engine, Deere adopted a 'clean-sheet design' mindset and utilized proven technologies optimize the final product. This engine provides installation flexibility and compact packaging, allowing for easy machine integration. With this design, John Deere continues to deliver increased performance, reliability, durability and overall value to its OEM customers and end users.

A global, strategic partner

The 2.9 liter through to the 13.5-liter engines will receive the Stage V certifications prior to the regulation date, while the 4.5-liter EWS and 13.6-liter engines will be certified prior to production.

"Our goal is to continue to be a strategic partner to our global OEM customers as we move into the next emissions stage, just as we've done with prior regulation changes," Couasnon said. "And with our worldwide service network of more than 4,000 locations – 1,500 of which are in Europe – customers can find expert support wherever its needed." **iVT**

Patrick Thil is manager for OEM Engine Sales EAME, Asia and Australia at John Deere Power Systems

NICOLA BATTISTI

New sensor success

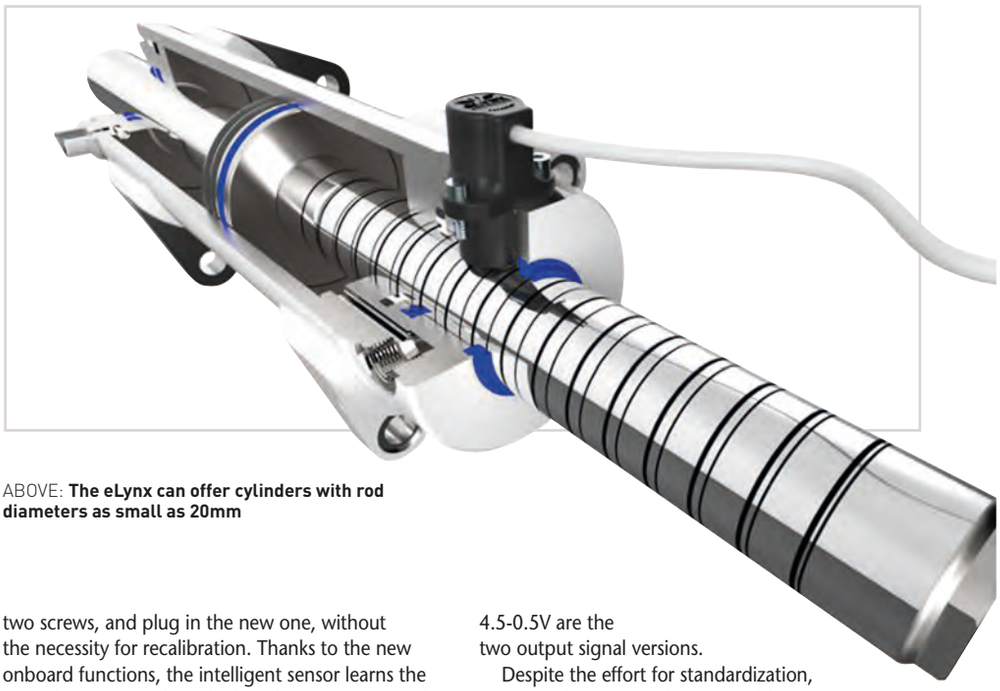
THE VERY LATEST IN ABSOLUTE SENSING TECHNOLOGY BENEFITS FROM STANDARDIZATION AND PLUG-AND-PLAY CAPABILITIES, HELPING TO IMPROVE RELIABILITY AND REDUCE MAINTENANCE COSTS

Optoi Microelectronics
Hall 20
Stand D46

The eLynx ELS22 absolute sensing technology, a trademark of Optoi Microelectronics and Giuliani Cylinders, is proving itself with success in the field. The first vehicles with new eLynx absolute systems have been in use since the beginning of this year, and they are showing excellent results with regard to precision, repeatability, reliability and robustness.

The core technology is based around the reflection of light emitted by a sensor and reflected by a rod, which has been imprinted with an optical code, using a state-of-the-art laser-marking process. In comparison with previous optical codes, the new codification, patented in 2017, offers better performances in terms of measuring range and production costs.

The marking of the code is continuously improving, thanks to state-of-the-art marking machines. Indeed, the new devices allow for better precision, better repeatability and reliability of the imprinted code on the mark. In this sense it is a reliability-focused innovation.



ABOVE: **The eLynx can offer cylinders with rod diameters as small as 20mm**

Applications

The steering application (using double effect cylinders) is still the most requested on the market, as no other competitors can offer similar benefits.

eLynx can also offer measuring solutions for small cylinders, where the rod diameter is as low as 20mm (0.8in) – something that isn't possible using other technologies.

Furthermore, several other applications have been built all around the world; eLynx is winning against other measuring systems on the benefits side – no rod drilling is necessary, plus it is simple to install and easy to integrate. The maximum measuring range has been extended from 300mm up to 1,500mm (12-60in).

Plug-and-play

The market demands more benefits at reduced costs. For this reason, Optoi and Giuliani are working together focusing on two main aspects: plug-and-play solutions, and standardization.

Plug-and-play means that if replacement sensors are needed, the user can quickly order the new part, unplug the old sensor from the cylinder by loosening two screws, and plug in the new one, without the necessity for recalibration. Thanks to the new onboard functions, the intelligent sensor learns the optical pattern on the cylinder where it is mounted, and over time it adapts its parameters, based on its real environment. This means that you decrease error probability due to the wrong calibration, maintaining precision and reliability.

Standardization

Up until now, the sensors were calibrated on each cylinder, and this 'wedding' created a unique custom mechatronic system fitted into the cylinder's excursion range – perfect, from a technical point of view, in terms of accuracy and resolution. But, if for any reason the sensor had to be changed, the complete cylinder had to be disassembled in order match its characteristics with another new sensor.

eLynx sensors are standard, helping to increase simplicity and lower maintenance costs. The standard versions are mainly based on measuring range and output signal: 250mm, 500mm, 1,000mm and 1,500mm (10in, 20in, 40in, 60in) are the four available ranges, while 0.5-4.5V and 4.5-0.5V are the two output signal versions.

Despite the effort for standardization, custom solutions are always possible, in every situation and configuration, starting with simple customizations (cable, connector, colors) up to more complicated customizations (output signal, protections, special diagnostics, measuring range, accuracy, redundancy).

Safer future industry

Harnessing the onboard intelligence capability and applying plug-and-play principles, Optoi and Giuliani aim to add more and more diagnostic functions to the future products, via advanced data collection. Information about the state of the system, the wear, the possible failures, the environmental conditions, etc, can be easily transmitted to the central unit of the vehicle to enable maintenance prompts and prevent failures. This will help to contribute to an overall safer system. **iVT**

Nicola Battisti is head of technical at Optoi Microelectronics

MATTEO ALLEVI

Joined-up thinking

IN THE VAST AND VARIED FIELD OF HYDRAULIC FLUID POWER, THERE IS A GROWING NEED FOR QUICK-RELEASE COUPLINGS. BUT WHICH REPRESENT THE BEST CHOICE FOR VEHICLE DESIGNERS?

Stucchi
Hall 20
Stand D30bis

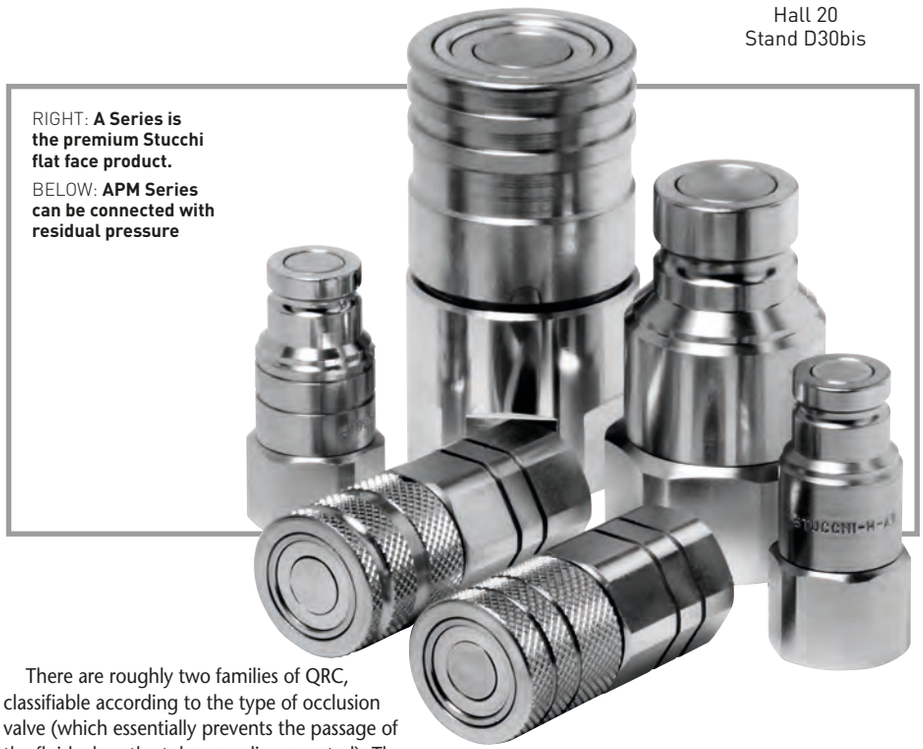
Off-highway vehicles of all types are hugely reliant on hydraulic technologies. Many such vehicles need to allow for the repeated connection and disconnection of hydraulic lines, to enable tool changes and maintenance.

On a farm, a tractor might need to be connected first to a mower, then a plow and the next day to a trailer. In construction there are a multitude of tools that can be attached to an excavator, all hydraulically driven by fluid power – for example, hydraulic hammers, asphalt cutters and buckets.

Flexibility and productivity gains

The ability to quickly and easily change tools makes work more efficient, increasing the flexibility and productivity of the machine. In the past, the connection and disconnection of the hydraulic lines was performed by screwing and unscrewing the fittings of the flexible pipes, which, filled with oil, released a large quantity of pollutants into the environment and enabled dirt, water and dust to accumulate in the hydraulic plant.

Today this procedure is almost supplanted by the use of quick-release couplings (QRC). These enable easy connection and disconnection of the hoses, with the advantage of reducing the release of oil into the environment and preventing the accumulation of dirt in the system, thanks to a shut-off valve that closes the lines during the disconnection.



RIGHT: **A Series is the premium Stucchi flat face product.**
BELOW: **APM Series can be connected with residual pressure**

There are roughly two families of QRC, classifiable according to the type of occlusion valve (which essentially prevents the passage of the fluid when the tubes are disconnected). The first type are quick release couplings with a poppet or ball, which due to their particular construction have the characteristic of still releasing some oil into the environment when disconnected. Second, there are QRCs with flat-face valves, which reduce the release of hydraulic oil to practically zero. The flat-face design of these valves means there are no recesses or inlets that can accumulate dirt, water, condensation or other impurities that could enter the hydraulic circuit at the next coupling.

Fewer components, less cost

The poppet or ball valve type of QRC has the advantage of using fewer components and therefore generally being cheaper. Flat-face products, on the other hand, are more complex because they are composed of a greater number of components and so cost more. However, this is compensated by the considerable technical advantages that make them advantageous both in long-term economic costs and in operation.

The most obvious advantage of flat-face valves is that no fluid is lost during disconnection of the junction with fluid in the pipes. The recesses in the poppet or the ball type valves create ample space for oil to escape, which not only causes environmental damage but can also be dangerous, as it creates a slip hazard. Furthermore, the loss of hydraulic fluid has economic implications. All these drawbacks can be negated with the use of flat-face couplings.

Popularity of flat-face valves on the rise

While products with ball and poppet valves are still very widespread in the market, there is a gradual flow of customers toward the flat face, which is now gaining rapidly in popularity. Vehicle designers would do well to always consider quick couplings with flat faces for new applications or they risk being left behind by the competition. **iVT**

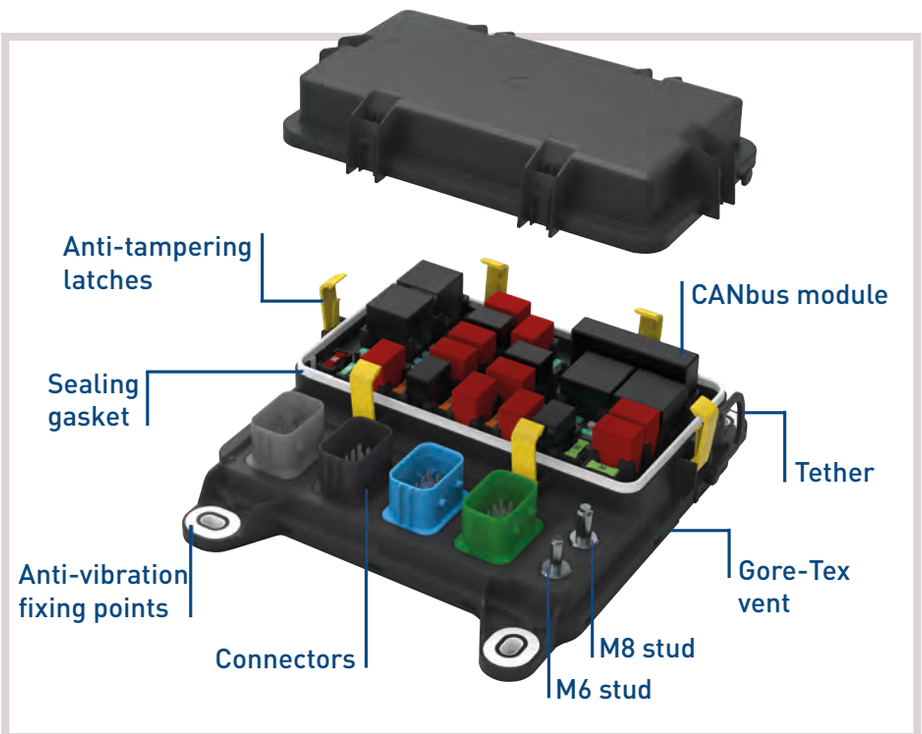
Matteo Allevi is a product specialist at Stucchi

DAVIDE BONELLI

The benefits of electromechanical power

MODULAR ELECTRICAL CENTERS CAN HELP TO SAFELY DISTRIBUTE POWER IN MACHINERY AND VEHICLES USED IN OFF-ROAD APPLICATIONS

MTA
Hall 18
Stand C13



ABOVE: **The MEC 97 is suited for use in engine compartments, as it can be positioned horizontally, vertically or inclined**

High-performing, compact, lightweight and cost-effective… these are some of the stringent demands that OEMs ask of suppliers when new solutions are being developed.

As a result of expertise acquired while developing and manufacturing electromechanical solutions for cars, MTA has recently developed the MEC 97, a modular electrical center for the distribution of power and the protection of major electrical utilities in agriculture, construction, heavy-duty and off-road applications.

The MEC 97 is a plug-and-play product produced with printed circuit board (PCB) logic and press-fit assembly – an innovative solderless connection technology that keeps contact between the press-fit pin and the wall of the hole gas-tight, ensuring optimal electrical contacts even in the presence of strong vibrations.

The MEC 97 enables functions to be integrated into one piece, thereby eliminating the need for different modules and associated wirings. It reduces the need for costly, heavy modules and cables, and thus helps to keep vehicles lighter.

Wiring in the MEC 97 is laid out simply, which helps to streamline and speed up assembly.

Customizable is better

MTA aims to offer off-the-shelf products that can be customized by the OEM for the specific application they are intended for – and the MEC 97 is an example of this. It comes with a basic configuration that enables customers to assemble a wide range of relays and fuses, depending on the electrical layout that they require.

The relays and fuses are all plug-in components and they are not welded, so they can be easily replaced if they get damaged.

Upon request, the MEC 97 can be customized for mass production. When customized, the case and cover of the unit remain standardized for all configurations, while the fuses/relays frame – which is a separate component from the MEC 97, together with the PCB – can be configured. This makes the unit a versatile solution, appropriate for a variety of diverse applications.

The external case of MEC 97 can also be tailored: it comes with two customizable studs for coupling with ring or fast connection terminals, and four connectors. The number of studs and connectors can vary, depending on customers' needs.

Mechanical highlights

MEC 97 comes equipped with an anti-vibration system integrated inside fixing points, to ensure high mechanical and electrical performances when operating in severe applications and to eliminate the need for silent mount blocks.

The unit also has: a Gore-Tex vent, which provides a barrier against water and dust while allowing free circulation of air in the unit; an over-molded sealing gasket; and six latches that close the MEC 97 and keep the cover against the seal.

These features ensure an IP69k protection during operation in highly demanding environments where targeted machines operate. Furthermore, the cover is tethered to the body to ensure it doesn't get displaced during assembly or maintenance.

The MEC 97 can be fitted in any compartment of a vehicle including the engine, where it can be positioned horizontally, vertically or inclined, thereby making best use of the space available.

The MEC 97 is compatible both with 12V and 24V electrical architectures and, upon request, can host a module to convert CANbus messages into digital outputs. **iVT**

Davide Bonelli is regional sales director at MTA

HAKAN LOVSTROM

A joystick for heavy duty

JOYSTICKS IN INDUSTRIAL MACHINERY NEED TO BE ROBUST, AND THIS REQUIREMENT IS PARTICULARLY IMPORTANT IN THE MINING INDUSTRY

How do you make sure a piece of mechanical equipment is tough enough for the hardest use? One way is to use decades of engineering experience. Another way is to put it through extreme durability tests. A third way is to test the joystick in the field for a long time in one of the harshest environments on Earth: mines.

The engineers at Caldaro have executed all of these methods to ensure that the new C16 joystick is ready for operation in challenging conditions.

The new single-axis joystick, C16, is part of a project with a leading company in the mining industry. Caldaro has extensive experience of developing new products with market-leading companies in different market segments.

"Working with big companies brings high expectations to deliver top-quality innovations in every respect," says Claudio Talamo, CEO of Caldaro. "These companies have their own experts in design and ergonomics, and they provide valuable inputs into our work. Developing products with these market leaders gives Caldaro the advantage of always putting out quality-assured products.

"These companies know that we are good at developing new products – especially for operation in the mining field."

The C16 is highly durable, while delivering precise control

A strong purpose

The mining company wanted Caldaro to develop joystick controls for its new operator cabins.

"A project team was put together and industrial designers started working on different proposals," says Talamo. "We then had a design to follow when working on the technical aspects of the joystick. We were given dimensions for the joystick's size and our mission was to make it as robust as possible."

With more than 20 years of experience in creating technical solutions for the mining industry, Caldaro knows that durability is the key.

"We know what materials and technical solutions work best in harsh mining conditions and how they will cope throughout the joystick's heavy usage, as well as what kinds of chemicals the joystick will be exposed to during operation. The solutions made for this joystick are the result of our findings from our experience with our products that operate in mines."

The heart of the joystick – the electronics – are potted in a special compartment that is completely sealed. To make the joystick even more durable, a rubber gaiter protects the joystick, as well as sealing it to the panel to which it is affixed.

Proving the capability

"We have both braces and belt for keeping the electronics absolutely safe. This joystick is tough enough for the hardest use," says Talamo.

The team put the joystick through extreme durability testing, but at no point did it break.

"We pulled and pushed the knob in all directions, with very high force," explains Talamo. "The only thing that happened was that the knob snapped out of gear. After a simple push back into the panel, the joystick was fully functioning again. We carry out the same testing for all of our products," he adds. "We put it into a test bench where the same movement is repeated continuously for millions of cycles. We also let official institutes test the joystick to their high standards."

The Caldaro C16 joystick has been a great success since it hit the market and it is already used by leading companies from different fields.

"We have been developing products for mining purposes for more than 20 years and we have been continuing to learn as we've done so," says Talamo. "Through this, we have become experts in avoiding pitfalls in developing our products." **iVT**

Hakan Lovstrom is a technical writer and editor

High-level connections

AS ELECTRICAL SYSTEMS IN OFF-HIGHWAY AND COMMERCIAL VEHICLES BECOME MORE COMPLEX, IT IS MORE IMPORTANT THAN EVER TO SELECT THE RIGHT CONNECTORS

Heavy-duty truck, forklift and emergency vehicle manufacturers are working to lower emissions and improve the efficiency and reliability of standard vehicles, while also incorporating electric or hybrid electric technologies. Such technologies have many advantages, but they also introduce high-current performance requirements and add yet more signal- and power-integrity issues.

The advancement in efficiencies of electronics for the tracking and real-time monitoring of heavy-duty trucks and long-haul vehicles has been particularly aggressive. Forklifts are becoming more automated, adding increased safety and reliability concerns, even as they operate over extended periods in evermore demanding environments. For emergency vehicles, patient safety is paramount, so connectors need to meet isolation requirements, while the vehicle itself must be capable of operating reliably at high speeds and in extreme conditions.

Designing the next generation of heavy-duty vehicles is a massive challenge. The good news for designers is that they don't have to go it alone. In fact, they shouldn't.

Move fast, design well

Throughout the industrial and commercial transportation market, manufacturers are working on innovative solutions to enable vehicles to achieve goals related to improved energy efficiency, which in turn reduces pollution and waste.

Printed circuit boards and connectors are more sensitive than mechanical systems to vibration, shock, mechanical stresses, moisture, temperature extremes and electromagnetic interference (EMI). In medical emergency vehicles, requirements are even more demanding, as there is a need to ensure that the patients are completely isolated from any electronic or electrical systems.

Developing the right connector and cabling for a specific application requires an understanding of metals and metal combinations for the pins, sealant strategies, plastics, usage models, environmental demands and regulatory requirements.

Given the high stakes, designers would be wise to consider off-the-shelf connectors and harnesses from TE Connectivity to ensure a reliable and electrically robust connection. There are many to pick from.

ABOVE LEFT: **The Detector connector provides a visual confirmation of power – its distinct glow helps with troubleshooting, especially in areas with difficult connector visibility and accessibility**

ABOVE RIGHT: **Among the mounting options for the AMP MCP 9.5 two-position connectors are flange, sealed flange, in-line and PCB mount**

For example, the AMP MCP 9.5 two-position connectors for harsh environments are made from heavy-duty thermoplastic and can withstand severe vibration and mechanical shock. They are IP 67- and IP 69K-rated (with backshell) to protect from dust, dirt and moisture, and come with several mounting options. They also have a slide lock for easy mating. The series operates over a wide temperature range of -30°C to 100°C (-22° to 212°F) and can handle up to 70A in 10mm² off a 28V DC supply.

In some cases, a visual confirmation of power is required. The Deutsch DT Detector combines ruggedness with a distinct glow in a transparent housing, as well as a wedgelock with an integrated 12 or 24V LED option.

Interesting design twists

As the Deutsch DT connector shows, design requirements can take interesting twists. While a good connector provider can offer an off-the-shelf solution 95% of the time, picking the right connector not only requires knowledge of system requirements, but also relevant industry and regulatory changes.

As a result, it's important to consult early with a connector provider, for a high-level system view that will ensure a well-integrated solution, in addition to insight into related trends.

Things to look for in such a partner include a strong engineering and support team. Also look for a history of solid solutions and innovation in a variety of applications, up-to-date regulatory knowledge and a willingness to visit on-site and discuss design particulars. It is also important that they have established connections up and down the transportation design and manufacturing food chain.

Furthermore, there must be a holistic approach to designing electrical architecture. An experienced connector manufacturer can leverage its experience to ensure the customer considers all options and mitigates the risk of problems in the field.

TE Connectivity offers a wide range of off-the-shelf solutions, and will exhibit its comprehensive portfolio at the IAA Commercial Vehicles event in Hall 11, Booth F08. **iVT**

Chuck Cant is sales manager at TE Connectivity Industrial & Commercial Transportation North America

MARTIN RIEDL

Customizable controls

GRAPHICAL USER INTERFACES ARE INCREASINGLY POPULAR IN ALL KINDS OF VEHICLE, BUT WHEN FUNCTIONS ARE COMPLEX YOU NEED SOFTWARE WITH THE FLEXIBILITY TO PERSONALIZE ALL THE CONTROLS

Human-machine interfaces (HMIs) in an industrial vehicle are critical to its operation and functioning. Such displays offer users intuitive and context-specific, environment-sensitive information. They need to be simple, easy to learn and use, while being customized for the environment they are going to be used in.

A multimodal and versatile toolkit

Elektrobit's EB GUIDE (graphical user interface development environment) is the technology behind some of the best industrial user interfaces. EB GUIDE is a reliable, customizable and easy-to-use toolchain for the development of multimodal HMIs with a graphical and voice user interface, as well as touch and gesture operation. It supports various development phases – executable specification, modeling, rapid prototyping, simulation and target deployment.

EB GUIDE enables developers to create and simulate a multimodal UI model on a desktop environment and later deploy this model with identical look-and-feel to final deployment. Using EB GUIDE makes it easy to manage versions (functionalities) and variants (brands, languages, skinning) by sharing common HMI components. Its model-based development approach saves time and money during the whole HMI development process, including the maintenance phase. EB GUIDE was used recently to develop an all-new control system.

The challenge

Today, with access to state-of-the-art graphics and 3D content, user interfaces can be incredibly complex. In some cases, subject to environmental conditions and ease of use, buttons and levers are being replaced by touchscreens with sophisticated multiple functions. Nevertheless, the user still needs to be able to interact with or control the machine using various modalities such as buttons, levers and speech (multimodality). This means the user has the freedom to choose the way that he/she prefers to operate the machine, which may be governed by what's possible in the actual situation (e.g. both hands on joysticks while employing speech control to issue commands and directions or even using a combination of speech and gesture to navigate the terrain). Ideally there should be no constraints – the user is free to select the mode that's best for the current situation. This results in intuitive interaction between the user and the vehicle.

ABOVE: **EB GUIDE enables developers to tailor their HMI system to personal requirements**

Kässbohrer Geländefahrzeug AG produces and sells snow-grooming vehicles under the brand name PistenBully. With PistenBully, the increasing number of complex features meant that operating the vehicles involved a great many switches and knobs. When operating in a tough snowbound mountain environment, fault tolerance was high, which meant the operator could switch on two functions that should not have been switched on at the same time.

PistenBully therefore decided to switch to an HMI touchscreen solution for a user-centric design that shows only the features the user wants and prevents the accidental activation of functions. Visualization of the function in action enables ease of use and reduces errors. A new user interface concept was required to improve usability, increase flexibility and reduce production costs.

RAFI develops and produces systems and components for human-machine communication, such as electromechanical components, operating panels, touchscreens, keyboards and ECUs.

With RAFI as hardware manufacturer and Elektrobit (EB) as software supplier, PistenBully found the perfect development team to set up the new HMI solution. RAFI prepared the touchscreen hardware and EB provided the development environment and HMI architecture. PistenBully could then smoothly take over the HMI development, finalize it in a short time with EB GUIDE as the HMI tool and tailor it to customers' needs. The ready solution can be first found in the PistenBully 600 F, with other vehicles to follow soon.

The benefit

PistenBully now offers a state-of-the art HMI with great usability and high flexibility to its strong and loyal customer base. By using EB GUIDE and taking over development work by itself, PistenBully found a fast and cost-effective way to achieve this benefit. **iVT**

Martin Riedl is product manager for EB GUIDE, Elektrobit Automotive

NILS HABICHT

Future vision

AS MOBILE MACHINERY GETS MORE COMPLEX, IT'S IMPORTANT TO HAVE A CONSOLE THAT EMPOWERS THE OPERATOR TO SAFELY AND EFFORTLESSLY TAKE CONTROL OF ALL FUNCTIONS

Versatility and ease of use make the Opus A6 2nd Generation the ideal console for the mobile machinery market. It is compatible with any vehicle with a CAN interface and can be configured in just a few clicks. High-quality standards and customer-centric product development are just two reasons why Topcon is a market leader.

As machinery becomes complex, one might be concerned that users in the future will become overloaded. But Topcon aims to address this challenge by creating the perfect interface between man and machine.

This philosophy is apparent in Opus A6 2nd Generation operator panels, distinguished by a high level of operating convenience and extreme ease of programming. This rugged, field-tested product is designed to be used in harsh working environments. It is run through four rigorous tests for functionality, durability and extreme temperatures to ensure the best quality for every customer.

The Opus A6 2nd Generation is ideal for complex HMI (human-machine interface), which relies on processing of a wide range of information.

LEFT: **The A6S can be used as a standalone or dashboard solution**

ABOVE: **The A6E features a bright, high-resolution display with 800x480 pixel resolution**

High spec

The unit features a bright, high-resolution display with a clear picture, offering complete functionality under all operating conditions. With an optimized size of 7in (17.8cm) and an 800x480 pixel resolution, everything the operator needs is perfectly readable. The large 512MB of RAM, combined with the 32bit, i.MX 6 processor with 800MHz and 2GB, or optionally 4GB, of flash memory is ideally suited to demanding applications. An aluminum housing provides maximum stability and optimal heat dissipation.

The device can be oriented either horizontally or vertically and can be integrated in either standalone or dashboard mounting. Up to three built-in camera inputs allow the user to easily connect analog cameras. Additionally, a digital Ethernet camera can be connected.

With two CANbus ports and four configurable analog/digital inputs, the Opus A6 2nd Generation is suitable for a wide range of mobile machines. It can read and display any enclosed CAN message. All of these features help to make it a hugely popular product, and Topcon has sold more than 88,000 units to date.

On the Standard version, the full-speed USB 2.0 input on the front is best suited to high-speed data exchange and is positioned in the casing of the unit for maximum protection against the elements. The unit offers 12 soft keys and four hard keys.

The Opus A6 2nd Generation Eco and Standard versions feature multicolored LEDs that provide an immediate visual indication if any faults are detected. An onboard speaker enables the playback of WAV and MP3 files for auditory alerts. Additionally, HD video files can be played to instruct the user visually.

The device can be programmed with C++, CODESYS, ISO-VT or the Topcon software, Opus Projektor. The Projektor Tool allows the user to easily display any CAN message. The user can also integrate images and objects easily by dragging and dropping. This means the user does not require programming skills to customize the display interface.

Upon the acquisition of Wachendorff Elektronik in 2015, Topcon became the world's only manufacturer specializing in display units that are developed and assembled entirely in Germany. The displays manufactured in Geisenheim, Germany, complement the full portfolio of Topcon Positioning Group, a leader in precision solutions for mobile work machines. **iVT**

Nils Habicht is a marketing specialist at Topcon

ANNAMARIA CHIERICI

Custom hydraulic connectors

AN EXCITING NEW DEVELOPMENT IN THE WORLD OF HYDRAULIC CONNECTORS MEANS THAT DESIGNERS WILL SOON BE ABLE TO GET INSTANT 3D MODELS OF COMPONENTS, CUSTOMIZED TO THEIR OWN SPECIFICATIONS, AHEAD OF MANUFACTURING

Faster, an Italian company, is one of the leaders in the production of hydraulic components. Its product portfolio comprises three main product areas: quick-release hydraulic couplings, tailor-made casting solutions and MultiFaster.

The brand name MultiFaster was patented in 1994 and has become well known throughout the industry for providing simultaneous connection of multiple hydraulic lines. The system is composed of two plates, a lever, several hydraulic couplings and electrical connectors.

In the past 25 years, Faster has developed and enlarged the MultiFaster standard offering, and the series now encompasses more than 50 different products. MultiFaster is used in various fields, including agricultural and construction equipment, special vehicles and industrial applications.

Launching in the virtual world

Faster is to relaunch the MultiFaster in an unconventional way, through a software-based product configurator embedded in its website (fastercouplings.com), which enables customers to build their own MultiFaster to meet their specific needs.

The configuration starts with selection of some key technical parameters: maximum flow rate, number of hydraulic/electrical lines, plate half (fixed or mobile). Afterward, the customer can select among different plates configurations, different shapes of the lever, different coupling sizes, different types of threads and, eventually, different kinds of electrical connectors. For example, there are 32 different types of lever to choose from, with parameters such as having the lever on the right or on the left side of the plate, short or long, S- or U-shaped, with a flat or round handle, or with improved grip technology.

There are some compatibility rules: by selecting a certain flow, you can only select a certain number of housings, meaning also a certain number of couplings or electrical connectors. Depending on the number of couplings, you will then be redirected to the most suitable plates. According to the maximum flow rate selected, the software will also define the maximum size of coupling, and so on.

There are 32 lever configurations on the MultiFaster

At the end of the configuration, customers will see a 3D model and can save their configured MultiFaster. They can also download a detailed technical datasheet, where they can find the configuration recap, a picture of the configured MultiFaster, technical specifications, details about each housings, and a list of spare parts suitable for that specific product. It is also possible to download the 3D model in .stp format and purchase the product.

MultiFaster configurator is based on a software that is able to manage variable elements, that interact with both the Faster website and the company's ERP software.

Once the configuration is over, the system is able to recognize whether the customer configured a brand new product, a product that exists among Faster standard offer, or a product that has been configured before by somebody else.

Download or delivery

If the user simply saves the configured MultiFaster, the system will generate a price and a new part number, and related downloadable materials, such as technical datasheet and the 3D model in .stp format.

If the customer adds the configured product to their cart, the systems interact with the company ERP, generating an order, a bill of materials, an assembly cycle, and a technical drawing for the assembly operators. The product is then assembled and shipped to the customer.

The MultiFaster configurator allows for an advanced product customization, while at the same time aiding design: by downloading the 3D file, any designer can easily insert the MultiFaster on the machine being designed.

The MultiFaster configurator also facilitates design by allowing the generation of multiple test-configurations, until the customer finds the one that best suits his or her requirements, thus reducing to a bare minimum the interactions between the technical departments.

Usually, when a customer needs a tailor-made MultiFaster, it takes about two weeks to get a 3D model; that is the time required for the various interactions between customers and Faster R&D, where both designers are also working on other projects. With the help of the MultiFaster configurator, the customer can get the 3D model independently in five minutes.

The MultiFaster configurator will be officially presented at EIMA 2018, with a corner dedicated to live configuration section. It will be available for public view from 2019 and full working processes will start soon after that. **iVT**

Annamaria Chierici is marketing manager at Faster SpA

LINDA VAN DIJK

Smart camera solutions

DIGITAL CAMERAS ARE IMPROVING SAFETY AND EFFICIENCY IN APPLICATIONS INVOLVING TRUCKS, CRANES, HEAVY EQUIPMENT, MINING EQUIPMENT AND SEMI-AUTOMATIC OR REMOTE-CONTROLLED VEHICLES

Thanks to its Ethernet-based technology, Stoneridge-Orlaco's EMOS camera line is highly versatile in camera imaging applications. The product range features an EMOS two-wire Ethernet camera (BroadR-Reach) and Stoneridge-Orlaco will be soon adding a router for reliable wireless video transfer. "With this addition, the EMOS camera is the ideal camera for product managers on the lookout for smart camera solutions to integrate into the industrial vehicles of the future," says Paul de Jong, product marketing manager at Stoneridge-Orlaco.

Use with intelligent machines

The digital image quality and high resolution of 1280x960p means that the EMOS is ideally suited for advanced image processing. Applications include image recognition, stitching for surround view and stereo vision for measuring depth, volumes and distances. The EMOS camera can also be combined with other Ethernet sensors for optimal results – an approach known as sensor fusion. This transforms the camera into an intelligent sensor, making it ideal for applications in the mobile equipment sector, thanks in part to its robustness and potential for human-machine interface (HMI) integration.

HMI integration

At Agritechnica, Stoneridge-Orlaco will show that the EMOS can be integrated into HMIs from Parker, CrossControl, Topcon, TTControl, Anedo and STW.

HMIs and onboard ruggedized industrial computers are used frequently in the agricultural and construction sectors. "We are expecting the popularity of analog cameras to decrease rapidly in the near future, giving way to their digital counterparts," says de Jong. "The market is still developing, but the major players have already made it clear that Ethernet is the future, and we are responding to this with our robust cameras. Part of this involves adding two-wire Ethernet cameras and robust wireless solutions to the range."

Compact cameras for large-scale work

Thanks to its robustness, the EMOS can be used in demanding environments such as agriculture, mining and construction. At 55 x 60 x 24mm (2.1 x 2.4 x 0.9in) and weighing 150g (5.3oz), the camera's compact size means that it can be positioned discreetly on any work vehicle and within an existing Ethernet network. The camera can operate at temperatures from -40°C to 85°C (-40°F to 185°F), and is shock and vibration resistant (50*g* and 15*g* rms at a frequency of 24-2,000 Hz). It also has IP68/IP69K protection against dust and water.

ABOVE: **Stoneridge-Orlaco's EMOS is a low latency Ethernet camera intended for onboard computer systems**

Ultra-fast operation

The camera is quick and easy to set up. With a maximum delay of 48ms at 30fps, it has a system latency of less than 100ms thanks to the use of RTP (Real-time Transport Protocol) protocol over UDP (User Datagram Protocol) This means that the system is not slowed down by an internal browser, unlike conventional IP cameras. As communication with the camera uses this independent protocol, developers have a choice of what peripheral equipment to use with it. **iVT**

Linda van Dijk is project manager, communications, at Stoneridge-Orlaco

MATTHIAS SEUFFERT

Leveraging custom fan drive solutions

AS NOISE REGULATIONS IN INDUSTRIAL APPLICATIONS BECOME MORE STRINGENT, MANUFACTURERS MUST IDENTIFY WAYS TO REDUCE ENGINE SOUND LEVELS WITHOUT SACRIFICING PERFORMANCE

RIGHT: **Horton's lightweight LS11 fan optimizes airflow and efficiency in a wide range of on- and off-highway applications, such as in excavators** (below)

Increasing the reliability and fuel efficiency of off-highway vehicles is both a competitive operating strategy and a reaction to legal mandates. Ultimately, OEMs have a vested interest in the performance and fuel consumption of the various vehicles and equipment they offer as it has a collective effect on their customers' profitability.

In the off-highway industry, viscous (variable-speed) fan drives have become a proven solution for OEMs to maximize fuel efficiency, increase reliability and reduce noise in a variety of industrial applications including agricultural vehicles, mining equipment, excavators, generators and industrial compressors. Using viscous – or fluid – couplings, variable-speed fan drives operate according to the cooling demands required to keep the engine at optimum operating temperature. When less cooling is needed, it operates at a low RPM off speed, allowing faster warm-ups, increased cab heat, noise reduction, increased available horsepower and less fuel consumption. When more cooling is required, it ramps up to a higher speed quickly, smoothly and with reduced stress on the drive, engine and components. Furthermore, variable-speed fan drives are maintenance free (no liner is needed) and help OEMs meet Tier 4 requirements.

When identifying the best fan drive manufacturer for both fuel efficiency and noise reduction, it's crucial to choose a company that has a keen understanding of a variety of cooling needs and can develop a customized solution regardless of production volume. By partnering with a firm such as Horton – which has more than 65 years of engine cooling experience – OEMs can identify variable-speed fan drives that are tailored to fit any engine perfectly. Most importantly, by working with a company like Horton, OEMs will experience all the capabilities of a global manufacturer with the customer support of a local partner, ensuring a personalized solution that gets the most out of any engine.

Solutions in action

SMS Equipment, headquartered in Edmonton, Alberta, is a supplier of heavy machinery and equipment to a variety of industries. As several of the company's excavator units operate in harsh conditions, including extremely cold temperatures during the winter season, some of its customers were experiencing a number of cold-weather performance issues that affected cab heat and hydraulic fluid temperatures. After analyzing the technical issues, the company brought the problem to the attention of Horton and requested a customized solution that would resolve existing issues in the field, as well as preventing similar issues on future units.

Within two weeks of their initial discussion, Horton shipped a prototype solution, consisting of an LCV80 variable-speed fan drive and an MS9 fan. Once the prototype solution was received, a Horton technical team flew to Edmonton to inspect the excavator and address any challenges associated with retrofitting the solution. After analyzing the drive in person, the Horton team returned to the R&D lab to further refine the solution and develop a custom retrofit kit that would be easy for SMS Equipment to install.

Once implemented, the modification enabled the engine to retain more heat, providing warmer cab and hydraulic fluid temperatures. Most importantly, as a result of the SMS Equipment/Horton collaboration, all new excavators are equipped with the cold weather package.

When choosing a variable-speed fan drive manufacturer, it's vital to choose a partner that designs products that have a record of proven performance and durability. By working with a company like Horton, OEMs – both large and small – can be assured that they will receive a solution that addresses any need. **iVT**

Matthias Seuffert is sales manager for off-road Europe at Horton

CHRISTIAN HOWE

Agricultural autonomy

THE AGRICULTURAL INDUSTRY HAS MOVED FROM LABOR-INTENSIVE MANUAL WORK TO A HIGHLY AUTOMATED PRODUCTION PROCESS REQUIRING EVERMORE COMPETENT SENSOR TECHNOLOGY

ABOVE: **Curtiss-Wright's sensors and traction inverters are suitable for a variety of agricultural vehicle applications**

Curtiss-Wright Industrial has relationships with many industry-leading OEMs and is highly experienced in working with agricultural machinery designers to provide safety-critical components and subsystems that can withstand environmental challenges – for example, water, dust, shock, vibration and temperature extremes – and that are ergonomically optimized for efficient operator control that reduces fatigue and increases productivity.

For many agricultural applications, Curtiss-Wright is developing vehicle controls designed to incorporate multiple functions that can be operated with the use of just one hand, finger or thumb. These controls typically incorporate push-button switches, rotary thumbwheels and joystick paddles and levers, which variously offer switched and proportional control of the vehicle's numerous features.

Improving precision with sensors

The company's contact and non-contact linear, rotary position and tilt sensors are suitable for numerous agricultural vehicle applications; and the robust, mechanical design of its WM-H10 shaft-operated rotary position sensor offers exceptional levels of performance.

The full range electrical output of the WM-H10 can be set to correspond to maximum rotations from 15° to 360°, providing a dual linear output voltage proportional to the absolute position of the 6mm, D-profiled shaft in either direction from a reference angle. To avoid errors associated with air-gap fluctuations, an integral magnet arrangement ensures a consistent sensor-magnet separation.

The two independent measuring circuits, each with its own 5V DC power supply connection, enable the use of algorithms that compare the signals for error checking. By using the first output signal as the source of rotational motion detection, and the second signal for diagnostic purposes, comparing the positional data from both outputs, signal veracity can be determined, meaning high-performing, safety-critical applications can easily be addressed. Further integrity is also provided as the outputs enter predefined states in the event of connection errors to the sensor.

Advanced inverters

For vehicle control applications, Curtiss-Wright's WTI-Traction Inverter series offers state-of-the-art technology and innovative design for use in hybrid and pure-electric applications.

WTI-Traction Inverters operate with multiple motor technologies – including AC induction, permanent-magnet synchronous (PMS) and interior permanent-magnet (IPM) types – and offer a high level of self-protection with both current and transistor temperature measuring locally to the IGBTs, rather than through remote components. This technique delivers fast and accurate temperature measurements, offering effective protection against adverse high-current conditions including short-circuit or thermal overload.

Operation efficiency increased

Advanced motor control algorithms using field-oriented control with space-vector modulation, combined with a 2-10kHz variable switching frequency, means high operating efficiency and increased operation time.

A fundamental frequency of up to 1,000Hz enables WTI-Traction Inverters to drive high pole-pair, high-speed motors. A torque motor-control mode is available for hybrid applications, speed mode for pure-electric applications, or DC bus voltage mode. In DC bus mode, the inverter can moderate adverse and damaging voltages resulting from situations including regenerative braking.

WTI-Traction Inverters offer a versatile connection to master control systems by either J1939 or CANbus protocols. A customizable, discreet interface also supports digital, analog and solenoid-drive control options.

So whether Curtiss-Wright is customizing an existing product to better suit an application, or creating completely new concepts to address an OEM specification, its global team of engineers is ready for the challenge and will partner with design teams to ensure the most reliable and cost-effective equipment is developed. This intelligent engineering, from initial concept to finished product, demonstrates Curtiss-Wright's commitment to providing the advanced control and power management systems demanded by today's agricultural vehicle manufacturers. **iVT**

Christian Howe is group marketing manager at Curtiss-Wright Industrial Group

BULLETIN BOARD

A new breakthrough in gear-pump noise reduction

Our perception of noise is influenced by sound frequency. A gear pump in an industrial vehicle emitting noise at a lower frequency improves sound quality, enhancing operator comfort in the cabin and meeting the most demanding legal requirements for noise emission. This is exactly what Shhark achieves, thanks to its innovative, **Turolla**-patented design.

The flow ripple of Shhark (19-tooth gears) compared with that of a dual-contact flank pump (11- to 13-tooth gears) has a lower frequency at the same peak-to-peak amplitude. The noise emitted by a gear pump is directly proportional to the ripple; consequently Shhark emits noise at lower frequency than the dual-contact flank technology. This makes Shhark an excellent choice in terms of noise emission.

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Workshop testing – no tractor required

Hydrokit, a specialist in electrohydraulic solutions for plant and mobile machinery, has designed a power unit that enables the testing of hydraulic attachments in the workshop without the need for a tractor to drive them.

The unit comes fully equipped with pressure gauges, direction control valves, a reservoir, a cooler and an emergency stop. It is powered by an electric motor.

The wheel-mounted unit can be easily moved by hand and helps reduce costs by reducing energy consumption, and by requiring less maintenance than a tractor. It is also eco- and user-friendly because there are no exhaust gases in the workshop and noise levels are reduced to a minimum.

The power unit can be made to measure according to a customer's specific needs. The adjustable variables on the system include motor power, flow rate, pressure, PTO, flowmeter, proportional valves and the control unit, which is available in either manual or radio remote-control versions.

To see a video of the unit in action visit ivtinternational.com/hydrokit

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Quote Ref: **528**

Essential displays

Bauser specializes in standard and customized hardware and software solutions based on CAN, CANopen and SAEJ1939 – including battery and time controllers, panel instrumentation, and hour meters. One such solution (other variations in all sizes possible) is the Type 909, a 3.5in (8.9cm) thin film transistor liquid crystal display (LCD) in color with four pushbuttons and up to five colored warning lamps. It offers digital and analog inputs, as well as a CAN interface with CANopen or SAE J1939 protocols, and it can operate in temperatures ranging from -30°C to 85°C (-22°F to 185°F).

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Quote Ref: **529**

High heat resistant housings for lithium-ion batteries

Renewable energies are gaining ground worldwide. In the development of alternative drives and energy sources, lithium-ion batteries take center stage. They offer impressive benefits such as emission-free drives, high efficiency and low self-discharge. But they are susceptible to thermal risk and this places new demands on fire protection in the engine compartment. **Thermamax** considered these demands and developed a solution: Tmax-Battery Housing.

In the event of a failure, lithium-ion batteries can reach temperatures of 1,000°C (1,832°F). This overheating can lead to fire. Secure casing of these high-performance batteries helps to keep the temperature under control and to ensure safety for both people and machines.

As well as being resistant to high temperatures, the Tmax-Battery Housing's is modular and scalable, easy to maintain, pressure-balanced, offers protection against water spray and dust, and is highly resistant to stone impacts. It also has an extended lifetime thanks to its temperature-control components.

The housing ensures maximum safety in case of accident, extended battery range, longer battery life and greater operational safety.

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Quote Ref: **530**

Pumps with PR control for fan drives

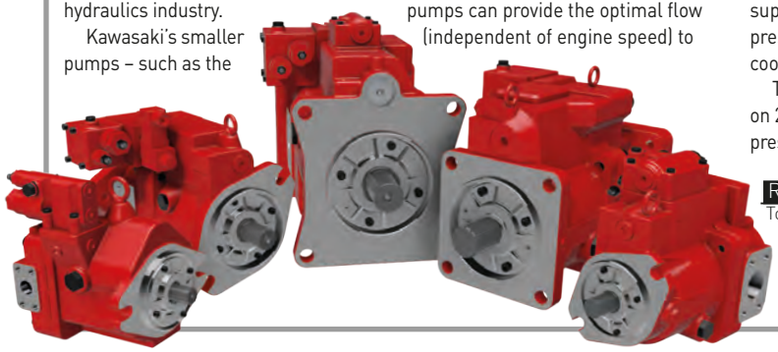
Kawasaki has been making hydraulic components generally for more than 100 years, and for agricultural machinery for over 50 years. It works closely with machinery OEMs to develop customized products, to help them conquer their markets. Its advanced technology and great attention to detail has made it a market leader in the hydraulics industry.

Kawasaki's smaller pumps – such as the K3VL and K3VLS – have become highly successful key components in fan drive systems, where their compact design and low noise are particularly valuable attributes.

In addition, the pumps, with a range of 28-150cc/rev, offer world-class reliability and exceptional service life. Together with the inversely proportional electronic pressure control, these pumps can provide the optimal flow (independent of engine speed) to precisely control fan speed. In this way, just enough fan speed is provided to keep the engine at an optimum temperature, while also minimizing noise and not wasting precious energy to drive the fan unnecessarily. This is a critically important requirement in today's demanding noise and emissions regulatory environment.

If there is an electrical power supply problem, the compensation pressure will go to maximum, thus cooling and protecting the engine.

These pumps are available for use on 24V DC supply voltage and working pressures are up to 320 bar.



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Quote Ref: **531**

Safe FPU calculations

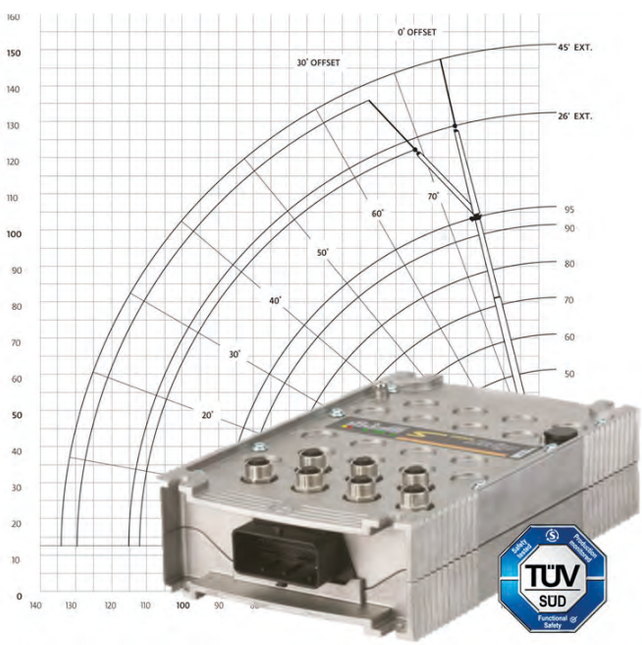
Lifting operations for cranes, elevated working platforms or aerials require a high safety level. This includes the safe calculation of the load limit and of working-range limits to protect endangered areas within the operating range. In addition, autonomous vehicles may require safe floating point calculations for driveway calculations, to precisely and safely maneuver around detected obstacles.

Inter Control's Digsy Fusion S significantly reduces the effort necessary to achieve these safety goals.

Until now, trigonometric calculations for safety functions have typically been realized by approximation tables. To achieve the required safety level, extensive measures had to be implemented.

The redundant and powerful floating-point unit (FPU) of the safety-controller Digsy Fusion S allows for direct implementation of arithmetic and trigonometric functions without complex conversions. This, coupled with the intensive testing, is a thing of the past.

The TÜV-certified floating-point operations of the MathLib library (variable type REAL) can be used for the safe basic operations: addition, subtraction; multiplication; division; and modulo-division. It also performs the safe arithmetic functions: exponential with two; exponential with x; logarithm to the base 10; natural logarithm; square root; absolute value. Also, its safe trigonometric functions are: sine; cosine; tangent and related arcus functions.



The Digsy Fusion S is then perfectly suited for telescoping machines such as cranes, elevated working platforms, aerials and concrete pumps, as well as for automated guided vehicles.

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Quote Ref: **532**

Achieve 200A DC charging with combo vehicle inlets

Amphenol's ExcelMate CC (Charging Coupler) product line – available in Europe through TTI Europe – includes both charging cable plugs and vehicle inlets.

Compliant with IEC-62193, the high-performance IEC Combo Plug connectors meet all the necessary standards and are available in 65A, 125A and 200A DC versions. These mechanically robust connectors have been designed to withstand over 10,000 mating cycles and insertion forces over 100N. They are available in any requested cable length.

The IEC Combo vehicle inlets are designed to be used for 32A or 63A AC Charging and 60A, 125A or 200A DC charging. The two power contacts DC+ and DC- are monitored by temperature sensors to avoid the risk of overheating during charging. The inlet can be supplied with two different electronic locking actuators for 12V or 24V to prevent the plug connector being accidentally removed during the charging process. All inlets are equipped with protection caps to prevent water ingress up to a protection level of IP44.

These high-current IEC Combo vehicle inlets will be particularly interesting for manufacturers of agricultural and construction equipment, but they may also be relevant for manufacturers of other vehicles where fast DC charging is required.

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Quote Ref: **533**

Universal contour grip

Otto's new contour grip with universal orientation has been added to its family of ergonomically designed, customizable contour grips. The ability to customize the switches on the front, back and side of the grip enables a vehicle designer to create a switch configuration that meets their unique requirements.

The Universal Contour Grip (G3-C) accommodates virtually any Otto electromechanical or Hall effect switch, including: P and HP series pushbuttons, HTW series thumbwheels, K series rockers, T series toggles and TC modules. Additionally, the Universal Contour Grip is compatible with Otto JH and JHM series Hall effect joysticks.

The Universal Contour Grip's ergonomic design was created with feedback from experts in the field, including machine operators who tested it in a virtual reality environment and real-world applications. This new grip was designed to accommodate both left- and right-hand use and the shape was created to minimize fatigue, allowing for extended use.

The grip is made to withstand harsh environments and can be used in construction, agriculture, forestry, industrial, and other demanding applications. Soft-touch options are available.

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Quote Ref: **534**

Magnetic incremental encoder for direct shaft mounting

Rotational position needs to be detected in many mobile machine and industrial vehicle applications. But many encoders aren't suited to dirt, humidity and extreme temperatures, which can lead to premature sensor failures. **ASM** presents Posirot PMIS4/PMIR7, a non-contact, wear-free magnetic incremental encoder solution designed to withstand harsh environmental conditions and offer a unique, simple slide-on shaft assembly.

The Posirot PMIS4/PMIR7 measuring system consists of a sensor head PMIS4 and a magnetic ring PMIR7 with magnetic index mark. The sensor head is made of a robust metal and is closed on all sides. The magnetic ring is available in four different diameters (20, 27, 35 or 50mm) to fit various shaft sizes. The magnetic ring is mounted directly onto a machine or motor shaft without coupling, utilizing a patented slide-on mounting solution. The sensor provides a linearity of ±0.1° and a resolution of 184,320 pulses per revolution. The distance between the sensor head and the magnetic ring can be up to 1mm. The sensor has protection class IP67 and operates reliably at temperatures of -40°C to +85°C (-40°F to 185°F). Furthermore it is shielded against electromagnetic interference. Available output types are HTL, TTL and TTL24V.

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Quote Ref: **535**

Connectivity without compromise

Elobau's 351CM007 CAN module easily connects operator controls and sensors with digital or analog outputs to CANbus systems. Initially designed for the firm's J4F joystick with safety electronics, it is now available as a standalone solution to offer safety electronics on any joystick.

Designed for extreme operating conditions, the module has an IP67 protection class, operating on CANopen or SAE J1939 CANbus protocols. Wiring the machine is simple as all components and controls are connected, and communicate on one bus system. If operating on SAE J1939 with safety functions, components connected to the module can fulfill safety functions in accordance with SIL2 (EN 61505:2010), PLd (13849-1:2008).

Although compactly designed for easy installation in confined spaces, the 351CM007 doesn't compromise on functionality, with 17 inputs for analog and digital signals, three LED outputs, and an additional 5V supply available for external components.

Constructed from fiberglass-reinforced plastic, it is lightweight yet reliably robust. The molded design contains openings for fixing cables to avoid unintentional damage, and mounting sleeves for simple and accurate mounting.

The CAN modules are configured by Elobau for each application, giving complete system connectivity.

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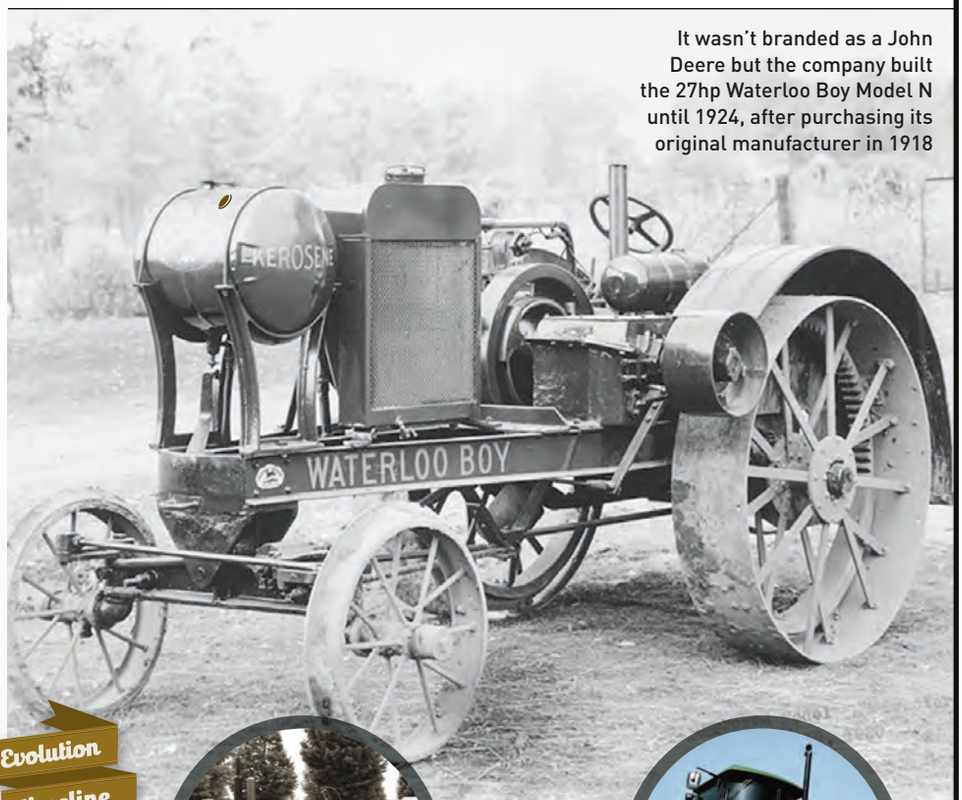
Quote Ref: **536**

A CENTURY OF TRACTORS

John Deere is celebrating 100 years since it started building tractors



It wasn't branded as a John Deere but the company built the 27hp Waterloo Boy Model N until 1924, after purchasing its original manufacturer in 1918

In March 1918 Deere & Company, an agricultural machinery manufacturer, entered the tractor business with the US$2.25m acquisition of the Waterloo Gasoline Engine Company in Iowa. At the time the investment excited some controversy as many critics did not believe that tractors had much of a future and thought that farming would continue to rely on the use of traditional horse power for many years to come. Even among supporters of the technology, very few expected that the machines would become so key to Deere's growth.

The first John Deere branded, green and yellow tractor was the Model D, in production from 1923 to 1953, the longest run of any farm tractor. John Deere's all-time bestseller was the Model B, with 300,000 sold from 1935 to 1953, while the 4020 became the most widely sold single model tractor, with a total of 175,000 produced from 1963 to 1971. John Deere became the tractor sales leader worldwide in 1963.

Technological innovation has always been at the heart of the Deere tractor business. In 1954 it became the first company to offer power steering on tractors and in 1966 introduced ROPS (roll-over protective structure) as a safety feature, setting the standard for the entire industry.

In 1992 John Deere introduced a fundamentally new concept in the industry: the 6000 series, built at its European headquarters in Mannheim, Germany. The machine's modular frame made it lighter and more stable, enabling an almost unlimited number of configuration options.

In 1997 an innovative track concept was introduced in the 8000T series, which meant less compression on soil. It was very successful and in later years was introduced on higher performance vehicles, such as the 9400T, at the request of customers.

In its most recent tractors, such as 2017's 6250R, Deere introduced its new CommandPRO joystick, which enhances operator comfort and makes the vehicle easier to control.

To celebrate its anniversary, the John Deere Forum in Mannheim displaying vintage tractors that have strongly influenced the company's history, including an original Waterloo Boy. **iVT**

Read our interview with John Deere's Mark Von Pentz on **page 14**; find out about the company's work in ISObus from **page 48**; and watch a video charting the company's tractor history at **ivtinternational.com/jd100**

Evolution timeline

Model D (1923)

Model B (1935)

4020 (1963)

2850 (1986)

6400 (1992)

9400T (2000)

650R (2017)

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