iVT Industrial Vehicle Technology International

JUNE 2018 VOL. 26 No. 2

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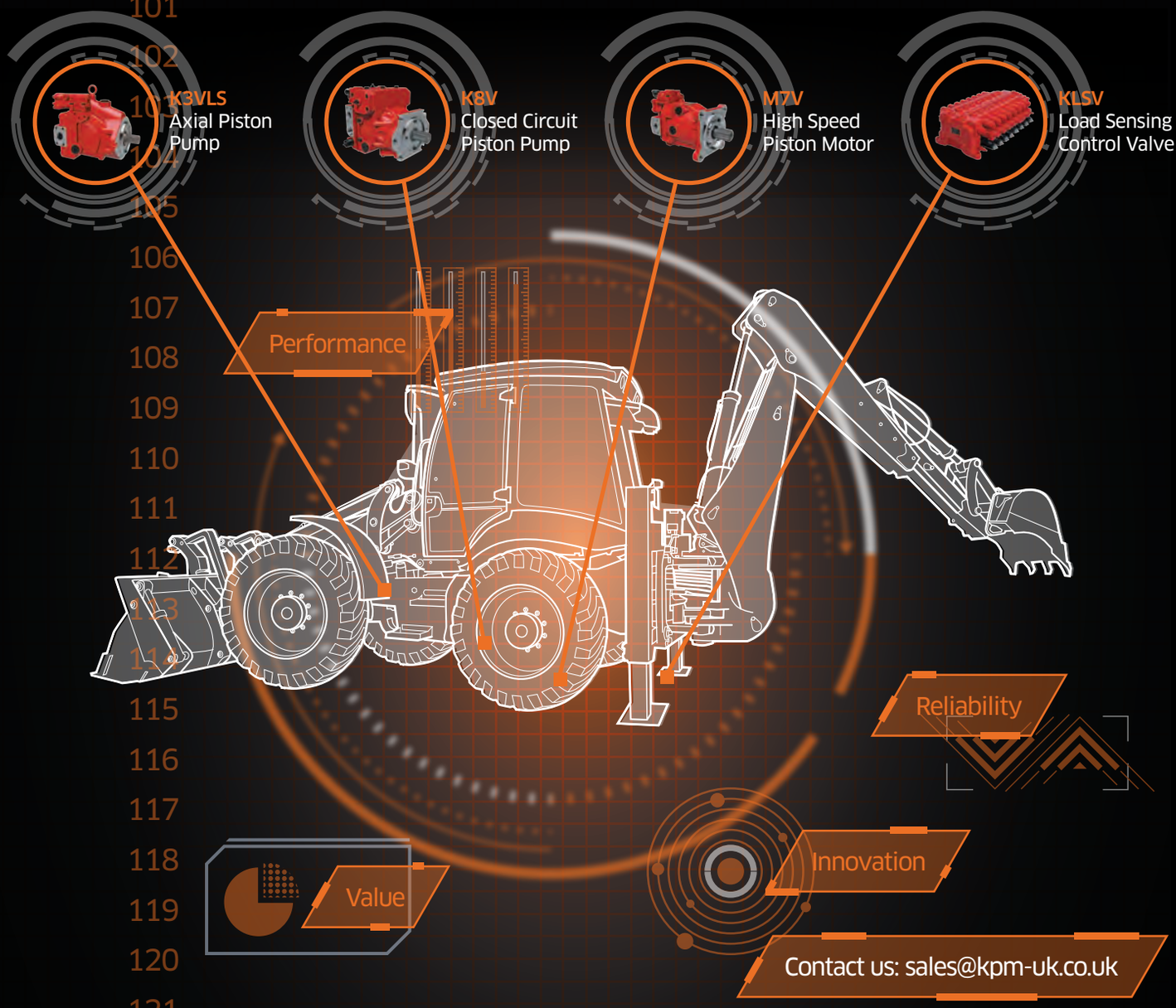

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100th ANNIVERSARY

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25 YEARS

Vol. 26 No. 2

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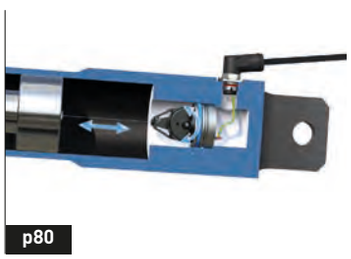
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FOREWORD

Getting to meet some of the most dynamic business leaders in the world is one of the great pleasures of editing *iVT* magazine. Last year I was invited to Rocester, in central England, to interview JCB's chairman Lord Bamford, an iconic figure who has lived the JCB brand since birth. This year I traveled a little further, to Eskilstuna, Sweden, to meet Volvo CE's president, and member of the Volvo Group Executive Board, new kid on the block Melker Jernberg, who has been in the job only since the beginning of the year. But though from that briefest of descriptions you might think that Jernberg was less immersed in the world of off-highway machinery than Bamford, you'd be wrong. He too has a lifelong passion that dates back to childhood, when his parents ran a construction company. And, like Bamford, he also has an interest in innovation that is leading him to focus on the future and push his firm to maintain its place as a technology leader.

Tom Stone takes control – under the watchful eye of Volvo CE's Mikael Andersson

Both men take huge pride in their new vehicles. Jernberg has traveled the world in the past few months visiting as many of Volvo's sites as he can, jumping behind the controls of machines at every opportunity. In Eskilstuna he even got me to have a go – you can find out what happened from page 24. Meanwhile Bamford was personally on hand at the recent JCB launch event, the star of which was the brand-new 220X excavator. Find out more about the machine, along with some insight from 'Lord B' himself, from page 48.

As *iVT* celebrates its 25th anniversary we have, of course, used the opportunity to take stock of how far the industry has come since 1993 (p4). But, as ever in *iVT*, we're far more interested in the future than the past. And not just what industrial vehicles will be like in 25 years' time, but also what they will be like in 10 years, five years… next month. OEM R&D centers are focused daily on this same challenge, but are often secretive about their true workings. We manage to shed a little light on the mysteries of such departments from page 34. And elsewhere we get expert opinions on where the fields of hydraulics (p72), CANbus (p66) and automation (p14) will be in the near and far futures. As for the future of *iVT* itself, keep a close eye on our website in June as we are about to relaunch with a fresh new design and features.

The more I get to know about industrial vehicles and the people who create them, the more I begin to understand the passion of leaders such as Bamford and Jernberg. And while I cannot claim my early memories are filled with off-highway machines in quite the same way as theirs, I can say that meeting them has been truly inspirational – even if I might never actually fully master the controls of a 90-ton excavator.

Tom Stone, editor

Coming up in the September 2018 issue of *iVT*

SPECIAL PREVIEW of EIMA agricultural machinery expo, Bologna, November 7-11 • The latest vehicle designs • Interviews with agricultural OEM leaders • And much, much more…

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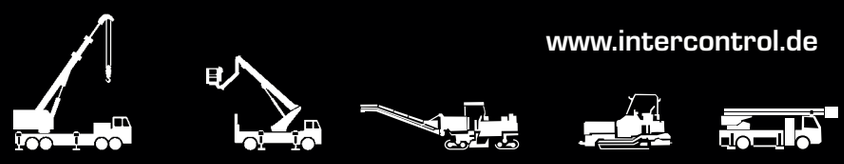


JAMES ALLEN, IVT INTERNATIONAL

25 years in the making

THIS MONTH WE CELEBRATE *iVT*'S 25TH ANNIVERSARY. HERE WE TAKE A LOOK BACK AT SOME OF THE MEMORABLE MOMENTS RECORDED IN THIS MAGAZINE'S PAGES SINCE 1993

25 YEARS

1993 1994

Automated guided vehicle tech was already being developed in 1994

"The technology employed has already been in use for five years. Vehicles are fitted with a fiber optic gyro, such as the type employed in aircraft navigation for determination of direction"

A quarter century of publishing is a milestone. Much has changed in the industrial vehicle industry in that time. And yet, remarkably, some themes are constant.

A look back at one of the earliest issues (1994's Materials Handling & Lift-Truck annual) reminds us that driverless vehicles are not a new topic by any stretch of the imagination. They were source of fascination for the industry then, although the only real-world examples were in the form of automated guided vehicles (AGVs). Like now, many engineers were excited about the emerging technology, expectant that a breakthrough into the mainstream was imminent. The 1994 article describes how driverless systems were the "great hope in the field of in-plant transport" as far back as the 1970s and 1980s, and that forklift manufacturers in particular were determined to solve the remaining problems.

Technology has come a long way since then. Obstacles are being overcome, and today the consensus is that fully automated vehicles will be a common sight in many off-highway applications before *iVT* celebrates its half-century.

Fast forward

Five years after the launch of the magazine, in 1998, we documented a new land speed world record. Admittedly, the 35.1km/h (21.8mph) achieved by the Merlo telehandler wasn't quite as impressive as the supersonic 1,228km/h (763mph) of

A gravity-defying demonstration in 2006 impressed *iVT*

"Previously it seemed unlikely to have an electric forklift that could come close to a diesel in terms of performance"

Harald Wozniak, head of international marketing, Linde Material Handling

2006

2007

In 2007 Volvo Penta already saw the potential for HVO, which it now approves for use in all its engines

"Our general view is that the best way to use biodiesel is blending it into all available fossil diesel, instead of running captive fleets on higher blends. We have a much more favorable view on second-generation biofuels, such as hydrotreated vegetable oils (HVO)"

Rolf Westland, advanced engineering manager, Volvo Penta

1998

The fastest telehandler in the world was showcased in 1998

"The engine was moved to be opposite the very heavy cab, providing a neat counterbalance. To transfer power to the wheels Merlo opted for hydrostatic driver, doing without complex propeller shafts or gearboxes. Hydrostatic drive gave many other advantages in terms of controllability, instant braking and the ability to customize torque output"

the ThrustSSC recorded at the same Black Rock Desert location in Nevada, USA. But as was reported at the time, by the latter vehicle's creator Richard Noble, its feat "couldn't have been achieved without the Merlo" – by which he was referring to the invaluable support role the telehandler had provided to the team.

Only a relatively recent addition to the industrial vehicle plant scene at the time, sales of telescopic handlers were expected by some to outstrip those of backhoe loaders. That both industrial vehicles are popular to this day is emblematic of how competitor pressure can be a force for good in spurring engineers on to develop their own products to ensure they remain relevant

Electric dreams come true

We move into the 2000s. In 2006, the excitement around the capabilities of Linde's electric forklift was palpable, with its newly launched E12 to E20 range defying gravity in an eye-catching demo witnessed by *iVT*'s contributing editor at the time, Gerald Scheffels. Lift trucks have long been ahead of the rest of the industry for electrification, but 2006 represented an important tipping point when the performance of such vehicles became directly comparable to their diesel counterparts.

A year after that article, when the industry was still four years away from Tier 4/Stage IIIB's arrival, consternation over the requirements of the impending emissions legislation was genuine. Some believed that switching to biodiesel would be the best way to meet the requirements, but Fiat Powertrain Technologies engineer Giovanni Bodritti voiced industry

Many emissions-reducing technologies suggested in 2008 are still being improved on today

2007

"The injection system is a key technology in a process that combines the use of EGR (to reduce NO_x emissions) with high injection-pressure (to cut PM), while making maximum use of the fuel"

2014

In 2014 JCB organized a competition inviting predictions for vehicle design in 2073

"These winning designers have managed to combine elements of futuristic science fiction with a practical understanding of the way in which flexible, versatile JCB equipment could be powered and operated in 60 years' time"

Tim Burnhope, chief innovation and growth officer, JCB

concerns, saying, "If [biodiesel is] used under the wrong conditions, there can be severe consequences for the engine."

Now, of course, stringent emissions guidelines have only tightened further. Again, it is testament to the industry that no matter how tough the regulations become, innovations in engine design continue to be developed to ensure compliance is possible. A 2008 feature titled *20 ways to reduce emissions* illustrates this point nicely with the technologies mentioned – such as selective catalytic reduction and anti-idling functions – still being tweaked and improved today.

Far future predictions

Vehicle design has been refined over the past 25 years, but one 2014 article could be an indication of where we are heading. A future-focused competition, overseen by JCB, asked contestants to imagine how industrial vehicles might look in 2073. Four years on and it is still far too soon to be able to say, with any certainty, which of the winning designs, if any, will look like a production vehicle of the future.

The industry is transformed from what it was 25 years ago; it is exciting to consider what lies in store over the coming 25 years. Can alternative fuels surpass diesel as the dominant power source? Will autonomous technology finally make the long-awaited breakthrough in to the mainstream? What effects will 3D printing have on the industry? Will other technologies emerge that aren't currently on our radar?

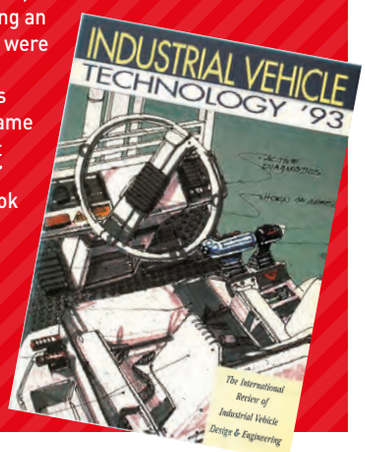
On page 34 of this anniversary issue, *iVT* gets an insight in to how OEMs' R&D departments, tasked with answering such questions, are predicting the future and developing technology accordingly. **iVT**

WHEN *iVT* WAS BORN...

On its launch in 1993, *iVT* was an instant hit, bringing something totally new to the industry. Magazines did exist that would run only product announcements from advertisers. But here, for the first time, was a publication offering an independent view of the market.

Phil Pope, now an OEM consultant and contributor to *iVT*, was working for New Holland power components at the time and remembers the impact it made. "It was interesting because instead of just giving the perception of the component suppliers, there was also editorial, so you were getting an independent view on what the OEMs were saying," he says. "Now it's the most recognized magazine in the business worldwide. The fact that someone came along and was doing something a bit different was very welcome, I think."

Last issue (*iVT* March 2018) we took a look back at that very first edition. You can still read the article via our online magazine archive, at www.ivtinternational.com



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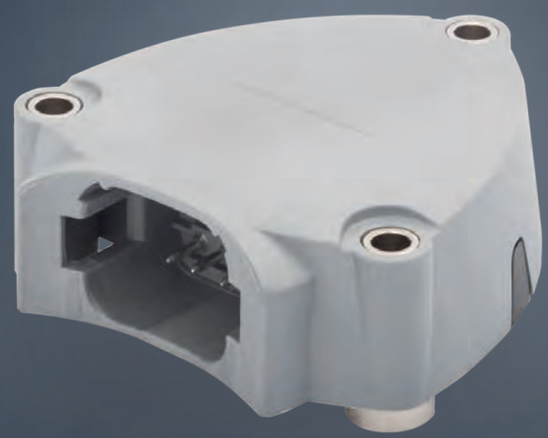

CONSTRUCTION FOCUS

Recycling giant

HYUNDAI LAUNCHES WASTE-HANDLING LOADER

Hyundai has launched a new heavy-duty wheel loader, equipped with an eclectic mix of smart technologies.

Designed with the waste handling and recycling industries in mind, the new HL960 HD includes an electronically controlled 222hp engine, high-performing axles for increased load capacity, and clever clutch technology to improve fuel efficiency.

It has particular features that make it well suited to the harsh operating environments found in the waste industry: optional solid, puncture-resistent tires; extra guarding for increased protection for both the machine and its operator; and a dual-axle oil cooler to prevent overheating.

The vehicle is being launched in both the European and North American markets.

7in

Size of touchscreen monitor. The audio system integrates Bluetooth connectivity and a microphone

CONTROLS

Joystick controls for the boom, bucket and third hydraulic line are standard. Joystick-controlled steering is an option

222hp

Net power output (at 2,200rpm) of the Stage IV Cummins QSB6.7 electronically controlled diesel engine

19,300kg

Operating weight (21 tons)

±1%

Accuracy of onboard weighing system

3.3m³

Bucket capacity (4.3yd³)

10%

The increase in the size of the cab compared with the previous HL960 model. Includes rollover and falling-object protection for the operator

SMART CLUTCH

Intelligent clutch cut-off technology improves fuel efficiency by minimizing the loss of power on the torque converter

44,000kg

The load capacity of the front axle (48.5 tons). The rear axle has a 35,000kg (38.5-ton) load capacity

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JAMES ALLEN, IVT INTERNATIONAL

25 YEARS

Great expectations

IN THE FUTURE, OFF-HIGHWAY VEHICLES AND THEIR CONNECTED INDUSTRIES WILL LOOK VERY DIFFERENT – HERE'S HOW

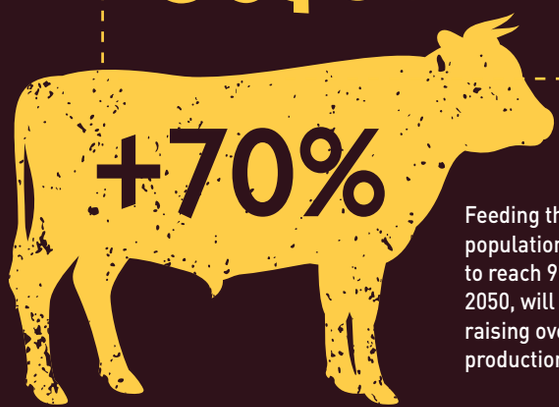
AGRICULTURE

Food production in developing countries will need to almost double by 2050, in order to keep pace with population growth.

Source: Food and Agriculture Organization of the United Nations

Total average annual net investment in agriculture in developing countries required to deliver necessary production increases by 2050 is

US$83BN



Feeding the world population, projected to reach 9.1 billion by 2050, will require raising overall food production by 70%

MINING

Value of electric mining vehicle market by 2028 is predicted to be...

US$9bn

Automated mining vehicles market will be worth US$5bn by 2028

Source: IDTechEx

Machine sales

In 2021, about 197,000 construction machines are expected to be sold in North America. Total sales were 175,690 in 2017

Source: Statista

Growth of drones market by 2022

30% Mining

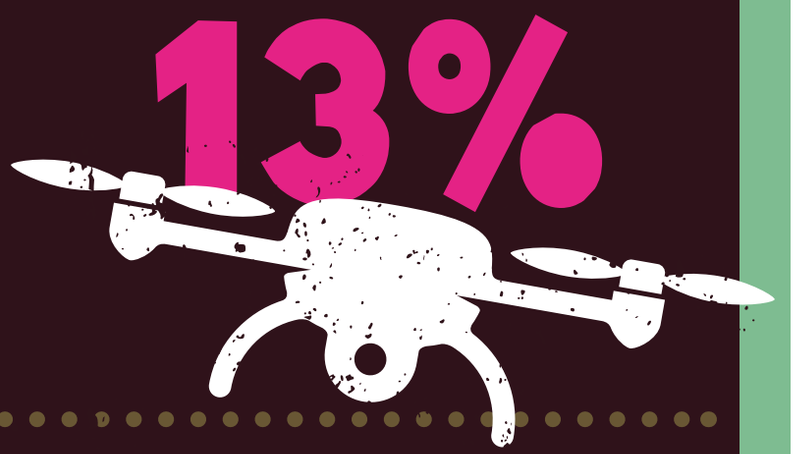
59% Construction

36% Agriculture

Source: Interact Analysis (from 2016 baseline)

Global shipments of drones are set to experience a 13% CAGR from 2017 to 2024

Source: Global Market Insights



OCEAN THERMAL ELECTRIC POWER

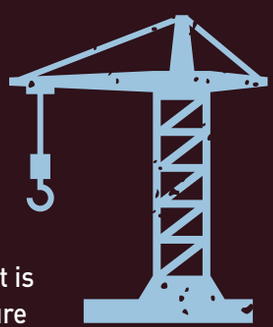
As electric vehicles increase in popularity, the demand placed on national grids will rise, some say to breaking point. Thermal energy generated from the world's oceans is a potential answer. The process exploits the temperature differences between cold, deep seawater and warm water at the surface. A demo plant off Hawaii can generate up to 105kW of power – enough for more than 100 homes – but ocean thermal energy is expected to outstrip fossil-fuel-based power supplies by 2050. A 1MW plant is currently being planned in Japan.

CONSTRUCTION

By 2030, over

20%

of all new buildings will use 3D printing technology



The Grand Paris Project is the largest infrastructure construction project in Europe. When it is completed in 2030, it will provide 124 miles (200km) of roads and 75 metro stations at a cost of €32.5bn (US$38.2bn)

Source: JLL

Construction firm Balfour Beatty expects human-free building sites by 2050

Source: Balfour Beatty

The global off-highway engine market is anticipated to grow at a CAGR of 10-15% from 2018 to 2023

Source: QY Research

Telematics

The global off-highway vehicle telematics market is projected to deliver a 8.9% CAGR from 2016-2026

The Latin American off-highway telematics market is expected to register the highest CAGR (2016-2026) followed by Japan

Source: Future Market Insights

Demand from road construction projects, mining and government defense spending is expected to drive up crawler dozer sales in India by more than 25% over the next five years to 2023

Source: Off-Highway Research

AGRICULTURAL OUTLOOK

The latest crop

An autonomous prototype harvester has been designed to pick tomatoes inside greenhouses – and with less damage to the produce than with human harvesting

50%
The estimated saving on harvest costs when using an autonomous picker

METOMOTION'S GREENHOUSE HARVESTER

Vehicles across the entire industrial sector are becoming increasingly automated. In agriculture, autonomous technologies will be seen not only in fields and on farms, but in greenhouses as well.

MetoMotion, a startup greenhouse robotics organization based in Israel, has developed a multipurpose robotic system called GRoW (Greenhouse Robotic Worker) that can carry out labor-intensive tasks inside greenhouses.

The company's first application-specific robot is an autonomous harvester for greenhouse-grown tomatoes. Designed by Amos Boaz in collaboration with MetoMotion, the machine was specifically created for integration into existing greenhouse practices.

The harvester is made up of an autonomous guided vehicle (AGV), multiple robotic arms, an advanced vision system and a proprietary harvesting component tailored to the fruit or vegetable that it is harvesting.

The robotic harvester is expected to minimize damage to produce during picking, as well as increase efficiency. Currently 30-50% of total costs in greenhouse farming are labor-related, but with one human operator required to monitor up to five robotic harvesters, MetoMotion estimates that greenhouse farmers could save up to 50% in harvest-related costs.

For more information about MetoMotion's GRoW system, visit MetoMotion.com

MAIN IMAGE: **A working prototype of the robotic harvester**

ABOVE: **Boaz's designs for the vehicle**

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ALBERTO SECO

The new Olympian

Construction projects for Olympic Games are some of the biggest in the world. They invariably involve the creation of brand-new arenas and stadiums, and even entire urban districts. Occasionally a building project somewhere else in the world can lay claim to being larger, but one characteristic distinguishes Olympic projects from many others: the immoveable deadline. As the end date approaches, the atmosphere on the construction site becomes increasingly stressful. And, with a large number of machines and workers excavating, building and moving material, the rate of accidents tends to be higher than on other construction sites. In the lead-up to the last summer Olympics, in Brazil in 2016, 11 construction workers died. Two years earlier, more than 60 workers died during construction for the Sochi Winter Olympics in Russia, with some reports putting the true figure in the hundreds. These are shocking statistics that the organizers of the Paris Olympic Games in 2024 will be anxious not to repeat. Hence the creation of this CMC concept wheel loader, developed to enhance safety through design and reduce accidents on the construction sites of Paris 2024.

Arms

- Lower arms curved to maximize visibility in lower front area, even when arms are raised
- There is an open view between the middle sections of the arms, even when the bucket is raised
- Center of gravity for arms is lower than conventional loaders, for outstanding front stability
- Inverted Z-linkage prevents loading/unloading mechanism and cylinder from obscuring the operator's view

REVIVING A BRAND

Alberto Seco's concept revives the distinctive red and white livery of CMC (Constructions Mécaniques de Carvin) vehicles – icons of French industrial vehicle history, produced in the manufacturing facilities of the Poclain vehicle division.

The first wheel loader models were launched in 1971, followed by tracked models. Production of dozers was planned and some prototypes were built, but the mid-1970s recession forced the sale of the Poclain construction vehicle arm to Case and led to the disappearance of the CMC brand.

25 YEARS

IN THE NEXT FEW YEARS, CONSTRUCTION WILL BEGIN FOR FRANCE'S LATEST HIGH-PROFILE MEGA PROJECT – THE PARIS 2024 SUMMER OLYMPICS. WITH SIMILAR EVENTS MARRED BY POOR SAFETY RECORDS, *iVT* LOOKS TO THE DESIGN TWEAKS THAT COULD MAKE ITS OFF-HIGHWAY VEHICLES SAFER

Cab

- Two conventional posts plus two double posts
- Windshield is tilted back to improve upward visibility
- Backward sloped glass rear area improves visibility toward lower points
- Gently sloped steps on both sides
- Step structure can be tilted to access mechanisms during maintenance and cleaning
- Bright rails run all around the loader – in distinctive bright blue and easy to spot
- A platform extends out from under each of the two sliding doors, for safer access

Hood and mechanisms

- DOC and DPF units placed longitudinally to avoid increasing the height of the hood, maintaining maximum side visibility
- Rear fender structure has been cut in the corners to improve lower rear visibility
- Fuel, AdBlue or hydraulic oil tanks are accessible from the steps structure and the cab platform
- Engine parts and batteries are easily and safely accessible from the counterweight and rear frame thanks to an electrohydraulic engine hood tilt

Counterweights

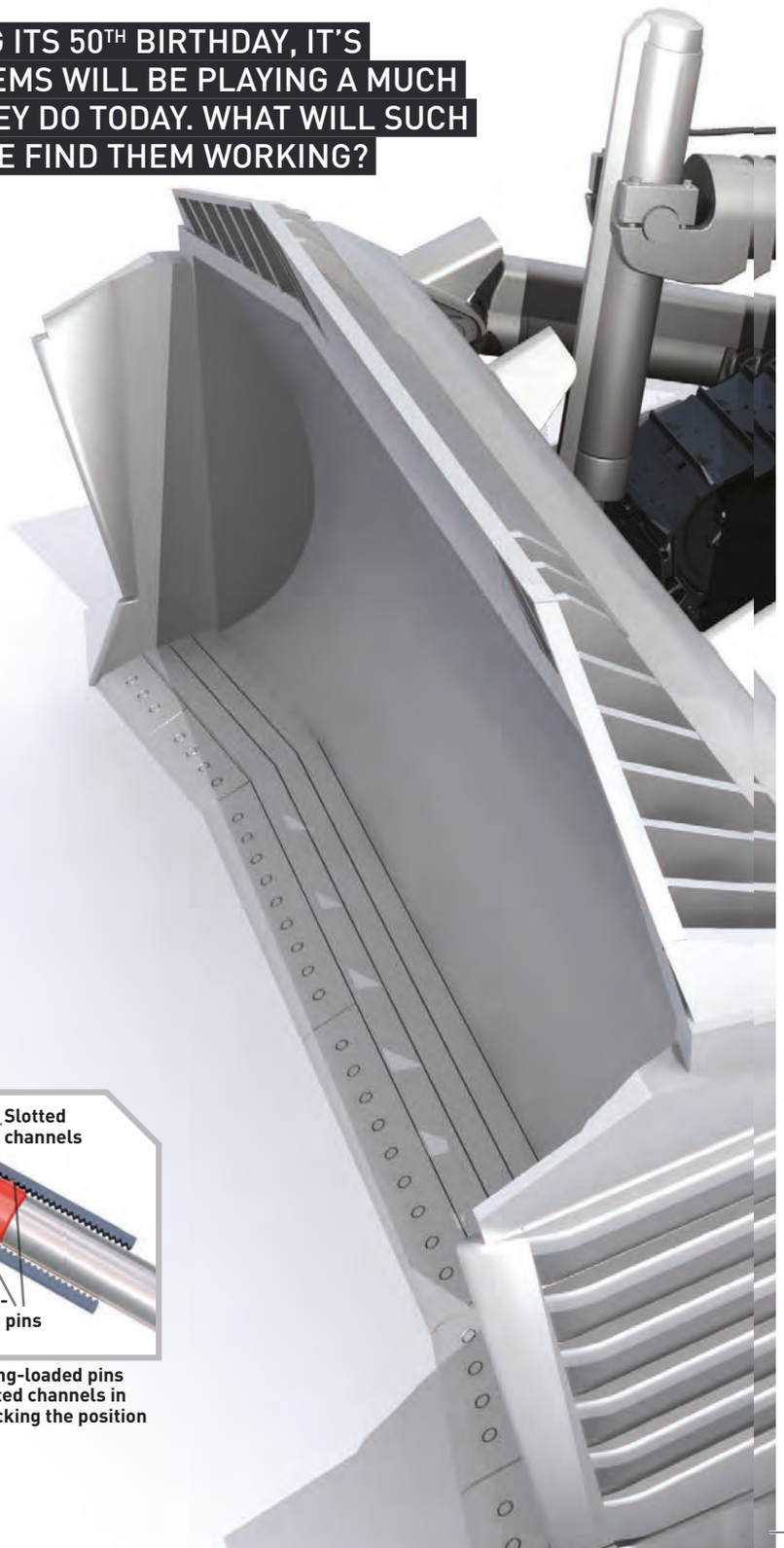
- Shape of the side ballast minimized to offer better lower rear visibility
- Counterweight concentrated in central lower area of the frame

UK Intellectual Property Office, Design Application Number 6035849

JON POPE

The Autonominer

BY THE TIME *iVT* MAGAZINE IS CELEBRATING ITS 50TH BIRTHDAY, IT'S SAFE TO ASSUME THAT AUTONOMOUS SYSTEMS WILL BE PLAYING A MUCH LARGER ROLE IN VEHICLE DESIGN THAN THEY DO TODAY. WHAT WILL SUCH MACHINES LOOK LIKE? AND WHERE WILL WE FIND THEM WORKING?



This large, bug-like machine is industrial designer Jon Pope's imagining of what a large mining dozer from the year 2043 might look like. It's fully autonomous and powered by batteries. It features regenerative charging technology, innovative hydraulics and a new kind of cooling system, described in more detail opposite.

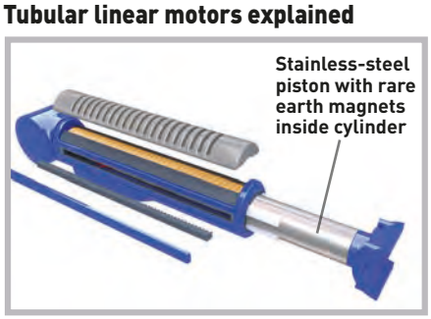
"If I had a time machine and set it to 25 years from now, I predict I'd be more surprised by what has not changed than what has changed," Pope tells *iVT*. "All new equipment will most likely be powered by batteries or fuel cells. But diesel power will probably still be in use by small contractors using older equipment. So hydraulics will still also be part of the aging diesel fleet. They might still even be used on some new machines.

"I also predict vehicle operators will still be required. Autonomous machines will most likely be a big part of the industry, but maybe not all of it. It depends if the cost comes down enough for low-production-volume machines like off-highway heavy equipment. Another stumbling block to full autonomy could be heavy litigation burdens on OEMs, when property damage or personal injury occurs due to systems failures."

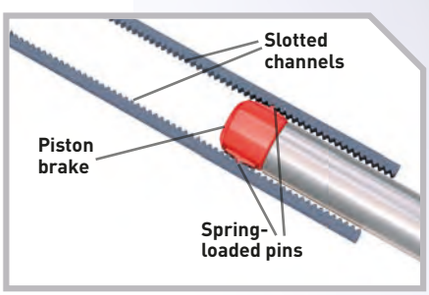
One industry Pope predicts *is* likely to be fully autonomous in 25 years' time, at least in North America, is mining, hence his design for this dozer.

"Most sites are remote and closed off to the general public," says Pope. "So when (not if) a piece of autonomous equipment gets loose, there is less chance of serious injuries or damage to property occurring."

Tubular linear motors explained

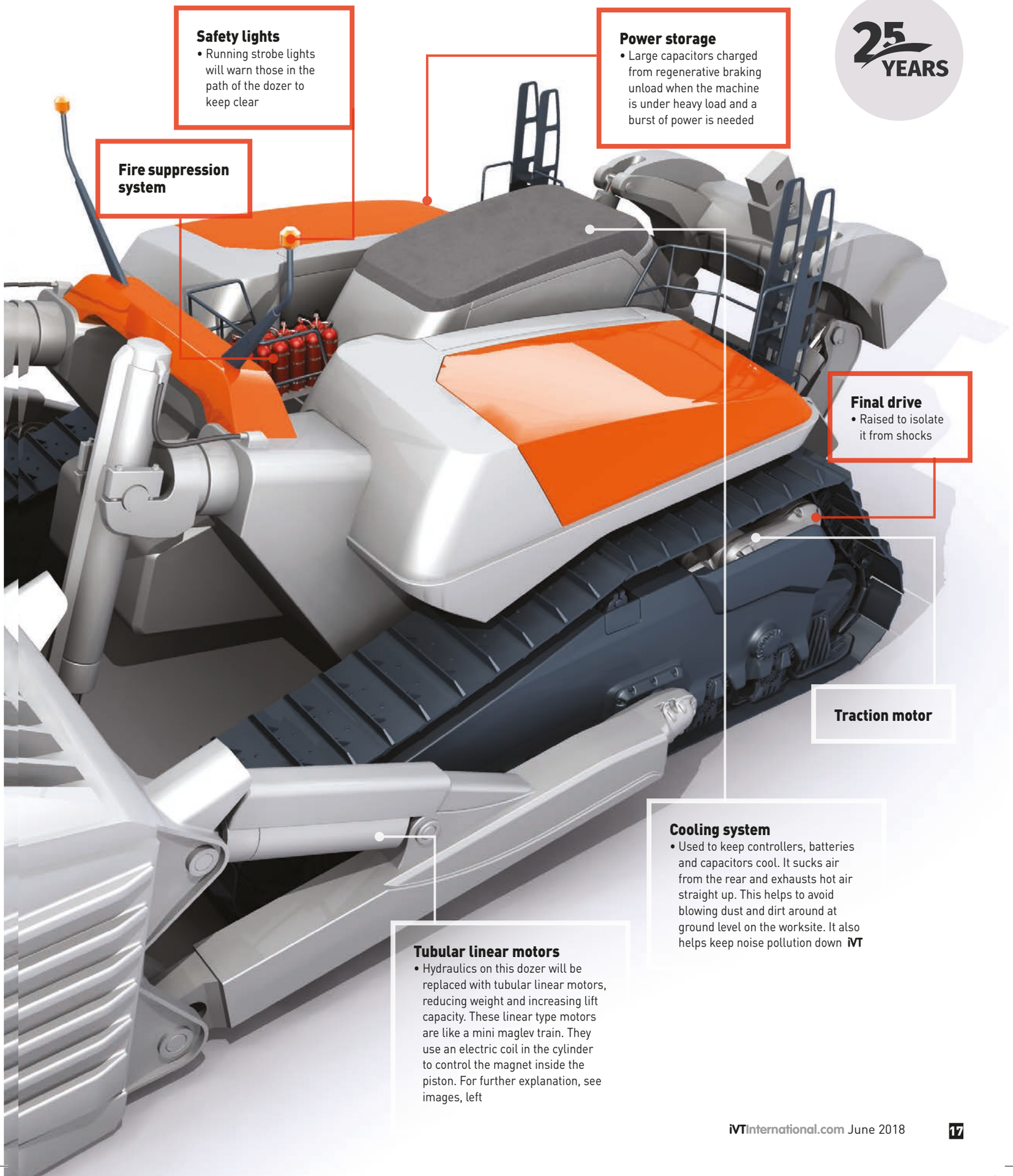


Magnets hold back spring-loaded pins on the piston brake when a coil in the cylinder is on. This allows the piston to move in and out



When the coil is off, the spring-loaded pins push out and fit into the slotted channels in the inside of the cylinder, locking the position

25 YEARS



Safety lights
- Running strobe lights will warn those in the path of the dozer to keep clear

Power storage
- Large capacitors charged from regenerative braking unload when the machine is under heavy load and a burst of power is needed

Fire suppression system

Final drive
- Raised to isolate it from shocks

Traction motor

Cooling system
- Used to keep controllers, batteries and capacitors cool. It sucks air from the rear and exhausts hot air straight up. This helps to avoid blowing dust and dirt around at ground level on the worksite. It also helps keep noise pollution down **iVT**

Tubular linear motors
- Hydraulics on this dozer will be replaced with tubular linear motors, reducing weight and increasing lift capacity. These linear type motors are like a mini maglev train. They use an electric coil in the cylinder to control the magnet inside the piston. For further explanation, see images, left

SHOW PREVIEW

All aboard!

The STZ-L4 is among the new construction vehicle transport solutions from regular IAA exhibitor Goldhofer

IAA IS INCREASINGLY ATTRACTIVE TO THE OFF-HIGHWAY SECTOR

Preparations are underway for the 67th IAA Commercial Vehicles expo, which takes place at the Hannover Exhibition Grounds, September 20-27, 2018. Many component manufacturers from the off-highway sector will be in attendance alongside OEMs, including Goldhofer, which often exhibits at leading construction vehicle expos such as Intermat.

"The slogan 'Driving Tomorrow' represents both a claim and a promise," says Bernhard Mattes, president of the German Association of the Automotive Industry (VDA), which is organizing the event. "In September the IAA Commercial Vehicles will be the driver of dialog and innovation surrounding the global forward-looking questions for the commercial vehicle industry."

The IAA will reflect topical issues in the industry, including digitization, the future of diesel engines, and the movement toward electric and hybrid-powered vehicles.

The event will also feature the New Mobility World conference, where experts will share their knowledge and insights into the future of mobility.

For more information and to register your interest in the event, visit: www.iaa.de/en

COMMERCIAL VEHICLES IN NUMBERS

50%
OF HEAVY TRUCKS BUILT IN THE USA COME FROM EUROPEAN-OWNED FACTORIES

71%
OF FREIGHT TRANSPORTED OVER LAND IS CARRIED BY TRUCKS

>150KM (93 MILES)
DISTANCE THAT 85% FREIGHT TONNAGE TRAVELS

10.7 YEARS OLD
THE AVERAGE AGE OF THE 29 MILLION VANS ON EUROPE'S ROADS

11.7 YEARS OLD
THE AVERAGE AGE OF THE 6.5 MILLION TRUCKS ON EUROPE'S ROADS

Statistics source: The European Automobile Manufacturers' Association

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HANDLING FOCUS

Perfect lifts

DUTY CALLS

Hiab launches new truck-mounted forklift

Hiab exhibited its new Moffett M5 NX lift-truck at the UK's 2018 Commercial Vehicle Show, which took place in Birmingham in April.

The model was developed with an efficient power-to-weight ratio suitable for medium- and heavy-duty applications. Light enough to be carried by most trucks or trailers, the forklift can lift up to 2,500kg (5,510 lb) and is available with the firm's optional Lift Assist system that enables safe unloading from one side.

The M5 NX can be customized to suit differing needs, thanks to a wide range of options and attachments – among them, varied lift heights, four-way steering, a choice of forks and various tire options.

"The hood has been redesigned to give extra visibility, and together with the new LED lights and beacon, interlocking seatbelt, a larger enclosure and new pedal positions, these features give maximum safety and comfort to the operator," said Keith Quigley, senior vice president, truck mounted forklifts at Hiab. "And the redesigned hood and rear doors make access for daily maintenance checks incredibly easy and fast."

ABOVE: **The M5's low hood, to the driver's right, maximizes visibility**

LEFT: **The Connect software is compatible with non-Linde trucks**

DATA DISPLAY

A software solution for forklift operations

A fleet management system for forklift operators has been developed by Linde.

The Connect software keeps track of operating hours, jolts and downtimes, as well as indicating when maintenance work is required.

Available for all the company's industrial trucks, the system can also be fitted on vehicles from third-party manufacturers.

Modern electronics ensure that today's forklift and warehouse trucks can collect a large amount of data during operation. However, to make the most of this potential, users not only need to be able to read the information, but also evaluate it.

"With the availability of this solution, we are offering our customers full transparency with regard to their fleet," said Anke Hensel, senior director for business solutions at Linde Material Handling. "The Connect software is also ideally suited for mixed fleets."

Using the new system, a usage control network can be established in which the driver logs on to the truck either via RFID chip card or PIN before starting work.

BETTER SAFETY

Increased safety for forklift operators with Genie's Lift Guard

Genie is increasing safety for those working on and around scissor lifts.

The Lift Guard contact alarm prototype for slab scissor and vertical mast lifts alerts operators and ground personnel to potential hazards when working at height.

Available across the entire range of Genie scissor lifts and vertical masts, the new system was unveiled during OSHA National Safety Stand-Down week in May.

The electronic secondary guarding solution is designed to activate an alarm when an obstruction makes contact with an activation whisker mounted to the lift's platform guardrails.

"Safety and productivity are key to our design process," said Michael Flanagan, Genie product manager. "The system is designed to aid an operator's situational awareness and provide a secondary layer of guarding."

BIN HYDRAULICS!

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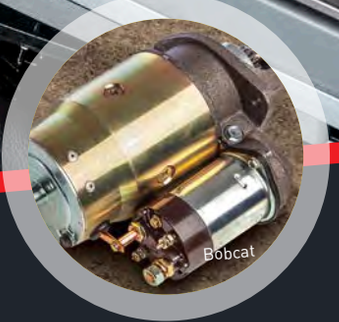

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TOM STONE, IVT INTERNATIONAL

Catch me if you can

MELKER JERNBERG BECAME PRESIDENT OF VOLVO CONSTRUCTION EQUIPMENT AT THE START OF 2018. TO SAY HE'S HIT THE GROUND RUNNING IS SOMETHING OF AN UNDERSTATEMENT – HIS HECTIC WORLDWIDE TRAVEL SCHEDULE HAS HAD EVEN HIS OWN TEAM STRUGGLING TO KEEP UP. NOW HE HAS HIS SIGHTS SET ON THE FUTURE – AND IS READY TO LEAVE THE COMPETITION IN THE DUST

Illustration: Mercedes deBellard - Folio Art

"I SAID TO MY MANAGEMENT TEAM, 'I THINK IT'S A GOOD IDEA FOR YOU TO MEET ME, BUT YOU'LL HAVE TO FIND OUT WHERE I AM FIRST…'"

95%
The target reduction in CO_2 emissions for Volvo's electric site project

When Melker Jernberg was growing up, his parents owned a construction company. Planning moments when work was over and he could jump into the off-duty vehicles for a quick turn at the controls was a rite of passage – and so the child is the father of the man.

Our interview was initially organized to take place at Volvo CE's HQ in Gothenburg, Sweden. But when we were first introduced, at Intermat Paris, the week before, Jernberg checked his diary… and his face fell: "We can't do this in Gothenburg, it's just an office there. I want us to drive some vehicles!"

These days there's no need for Jernberg to wait his turn. If Volvo CE's new president and member of the Volvo Group Executive Board wants to test some machines, a few phone calls are made, some travel arrangements are tweaked, *et voila*, just over a week later I find myself waiting for Jernberg in a room, not in Gothenburg, but at Volvo's Customer Center, in Eskilstuna, an hour-and-a-half's drive west of Stockholm.

At 49, Jernberg is relatively young to be heading a global company like Volvo CE, but his boyish energy and enthusiasm mean he could pass for even younger. As I'm preparing to sit down for a good chat he bounds into the room and informs me there's been another change of plan: we'll be heading out into the test area immediately and conducting the formal part of the interview a little later – he can't wait to drive some vehicles. A quick change into high-vis jackets and safety boots and we're outside waiting as Mikael Andersson, manager of Volvo CE's Customer Center demo ground, prepares an A45 articulated hauler.

ABOVE: **The three key vehicles that will run Volvo's electric site project in late 2018: (clockwise from left) The EX1 cable-electric 70-ton excavator; the HX2 autonomous hauler; and the LX1 hybrid wheel loader**

"I'M NOT A GOOD DRIVER! THERE ARE DIFFERENT LEVELS OF KNOWLEDGE THAT YOU NEED… YOU CAN TRY TO DRIVE, NO PROBLEM, BUT THEN TO BE REALLY SKILLED TAKES A LOT MORE TIME"

Melker Jernberg, president, Volvo CE

After the build-up, Jernberg's initial revelation is a surprise: "I'm not a good driver!" he confides. "There are different levels of knowledge you need… you can try to drive, no problem, but then to be really skilled takes a lot more time."

Nevertheless, Jernberg has been making up lost time since he started in his new role on January 1, 2018 – traveling the world to visit as many Volvo CE sites as he can, and taking the opportunity to be hands-on with the vehicles whenever possible. "Not only because it's fun," he says, "but also because it's part of the business. I think it's important to understand the products and how they are used."

The next 20 minutes or so are taken up with a couple of circuits of the test track in the fully loaded A45, with Jernberg and I taking turns at the wheel. A 35% incline looks like a challenge to me… but Andersson laughs and sure enough the hauler is up and over the huge mound of rubble and scree like it's a grassy mole hill. Next, it's a go in the huge EC950E excavator, with which I'm quickly lifting huge boulders with the lightest of touches. It's a brief but brilliant

TOP SECRET

Jernberg chats to Albin Nilsson, Volvo CE development engineer for electromobility systems, at the R&D center

INSIDE VOLVO'S RESEARCH CENTER

During our morning at the Volvo CE Customer Center in Eskilstuna, Jernberg also gives *iVT* an exclusive tour of the firm's nearby R&D center – its largest, employing around 700 people.

The building is normally off limits, but we were treated to a sneak preview of the HX2 – the new version of the HX1 autonomous, battery-electric load carrier that was first revealed to the public in late 2016.

The workshop we step into has an LX1 prototype hybrid wheel loader flanked by two brand-new HX2 machines, one of them still in plain green with no decal lettering. Both have their inner workings exposed, so we have to be careful where we point our cameras...

The pair are part of a fleet of eight HX2s that Volvo is building for its electric site project, due to go live for 10 weeks in the fourth quarter of 2018. The site – a collaboration with Volvo customer Skanska, the Swedish Energy Agency and two Swedish universities – will aim to demonstrate how a fully working quarry can be powered almost entirely by electricity, reducing on-site carbon emissions by 95%, compared with the same site using diesel machines.

"You tested an A45 hauler – and with those, it's the bigger the better," machine applications and concepts specialist Joakim Unnebäck tells *iVT* on a quick break from his work. "Here we do the opposite of that. We take the operator out and we go full electric – and for this it's the smaller the better. In this project, eight of these will do the work of three big rigids.

"They will need recharging, but that's part of the working cycle. They'll stop for one minute, fully charge, and then they're off. They won't run 24 hours a day in the project, but they could in theory. And then you can go smaller. These carry 15 tons. It's already very tiny for us."

Into the real world

While the HX1 was a proof of concept, the HX2 is a real workhorse, incorporating shared technologies and components from the Volvo Group. "It's the same electric motors, batteries and everything as we have on the buses," confirms Unnebäck. "It's a new axle design, purpose-built for this machine, but we reused the bus electric motor. As we have the electric motor in the axle, we don't need any prop shaft."

As the HX2 moves about the electric site, part of the route will be pre-programmed, with GPS guidance, but the final part of each cycle, where the HX2 interacts with the loader, will be calculated by the machine, as it will vary slightly each time. The addition of radar and lidar sensors on the front and back of the machine will enable autonomous object detection and avoidance.

"For the project we'll use windmill energy – Skanska owns a windfarm, which makes enough power for the project," says Unnebäck. "Added to the HX2s and the hybrid wheel loader, we will have a cable-connected excavator..."

70-ton electric excavator

The biggest of the new electric site contenders is the all new EX1 – a 70 metric ton excavator, based on Volvo's EC750, that can function on electric power only.

"Most of the time, this machine will be stationary," explains Uwe Müller, Volvo CE's chief project manager for the electric site. "Its job will be to load blasted rock into the mobile crusher before it's transported to the secondary crusher and then processed. The EX1 and the mobile crusher [also set to run on electric power] will work together, only moving a few meters once or twice a day as the excavator works its way through the blasted rock. Because the machine will be relatively static, it's ideally suited as a fully electric machine on a cable. This has allowed us to make it a zero emission excavator when it's plugged into the grid. However, we've designed it with flexibility in mind, so it's been built as a dual-powered machine. Therefore, we have the option of using the diesel engine when it's needed, for example, to reposition the machine or quickly move it prior to blasting.

"To fit the new components in the machine without increasing its size required a significant amount of repackaging work," continues Müller. "However, in terms of the operator interface and controls, nothing has changed – it's operated in exactly the same way as a conventional Volvo excavator. If the cable is connected, the machine will automatically start in electric mode. If it's not, it will start in diesel mode."

insight into the Volvo world. "Boys with their toys!" grins Jernberg as I jump down from the cab.

Down to business

As we return to the main building, Jernberg reflects on his first five months in the role. "I've been traveling most of the time," he reiterates. "We had a deal: I said to my management team, 'This will be a little bit strange because when I start, in my first week, of course you will think it is a good time to meet and discuss the future – but I won't have time for that, because I will be traveling! So, I think it's a good idea if you meet me, but you'll have to find out where I am first, and then come to these places.' So, of course, we have had management meetings, but so far not at the head office. Three weeks ago was the first time I visited it – and I couldn't find my room!"

As he's visited all corners of the business, Jernberg has quickly become known not only for his passion for construction machinery, but also for his charm and genuine interest in all employees and their contacts – something that has helped him to understand the business and plan to keep pace with the demands of customers.

"If we don't understand our customers and their businesses, we cannot be a product innovation leader in the long term. Volvo has a long heritage of innovation and safety, but it's important to see the difference between business and people. So, the innovation of the business and products is coming from two angles. Of course, we can sit in our offices and try to predict the future, but we also need to mix this with keeping pace with what's happening today. It is important to be in both worlds."

"IT'S NOT JUST ABOUT MAKING AN ELECTRIC EXCAVATOR. WITH JUST THAT YOU ARE NOT GOING TO CHANGE THE WORLD. IT'S ABOUT HOW PEOPLE USE IT AND ARE CONNECTED IN THAT USE"

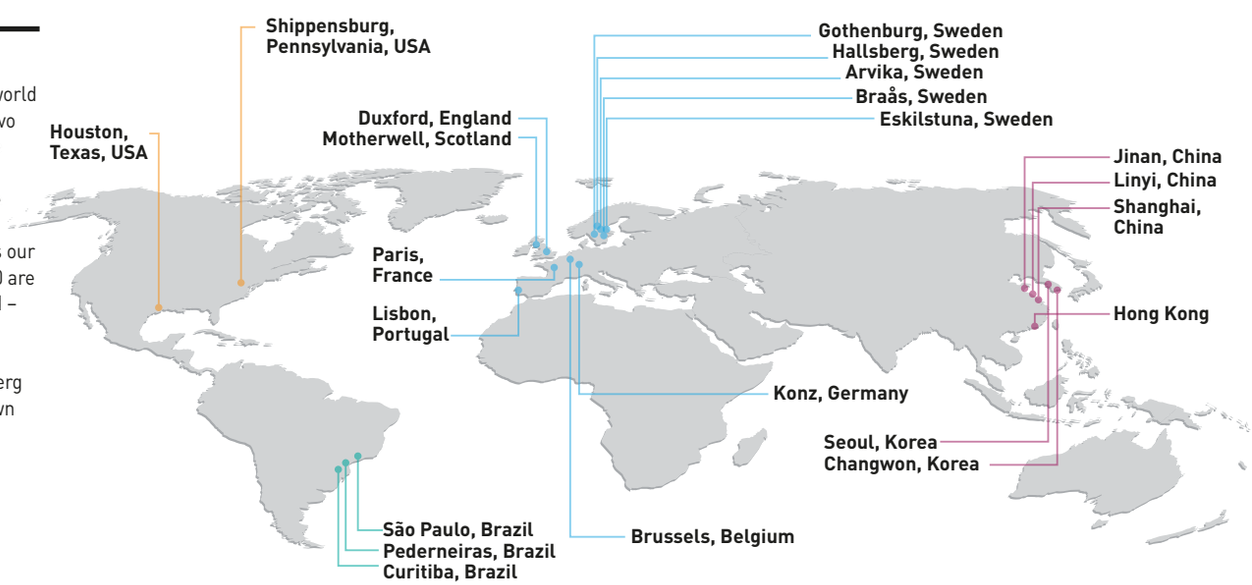
Market growth

Jernberg has joined Volvo CE at a time of worldwide growth in construction vehicle sales. Across the industry, increases of 8-10% are reported in Q1, compared with 2017, but Volvo has outperformed most, with sales up by 20% in this period. Jernberg is clear that this isn't simply down to the company riding the industry trends, but also thanks to smart working practices: "Market is one thing. But you can influence it from within the company. We've been on a great journey the last few years and now we can see the results. It's encouraging to see the spirit in the company. It's down to a lot of dedication and commitment to deliver to the customers, which is fantastic to see. But also, it's down to cooperation with Volvo Group.

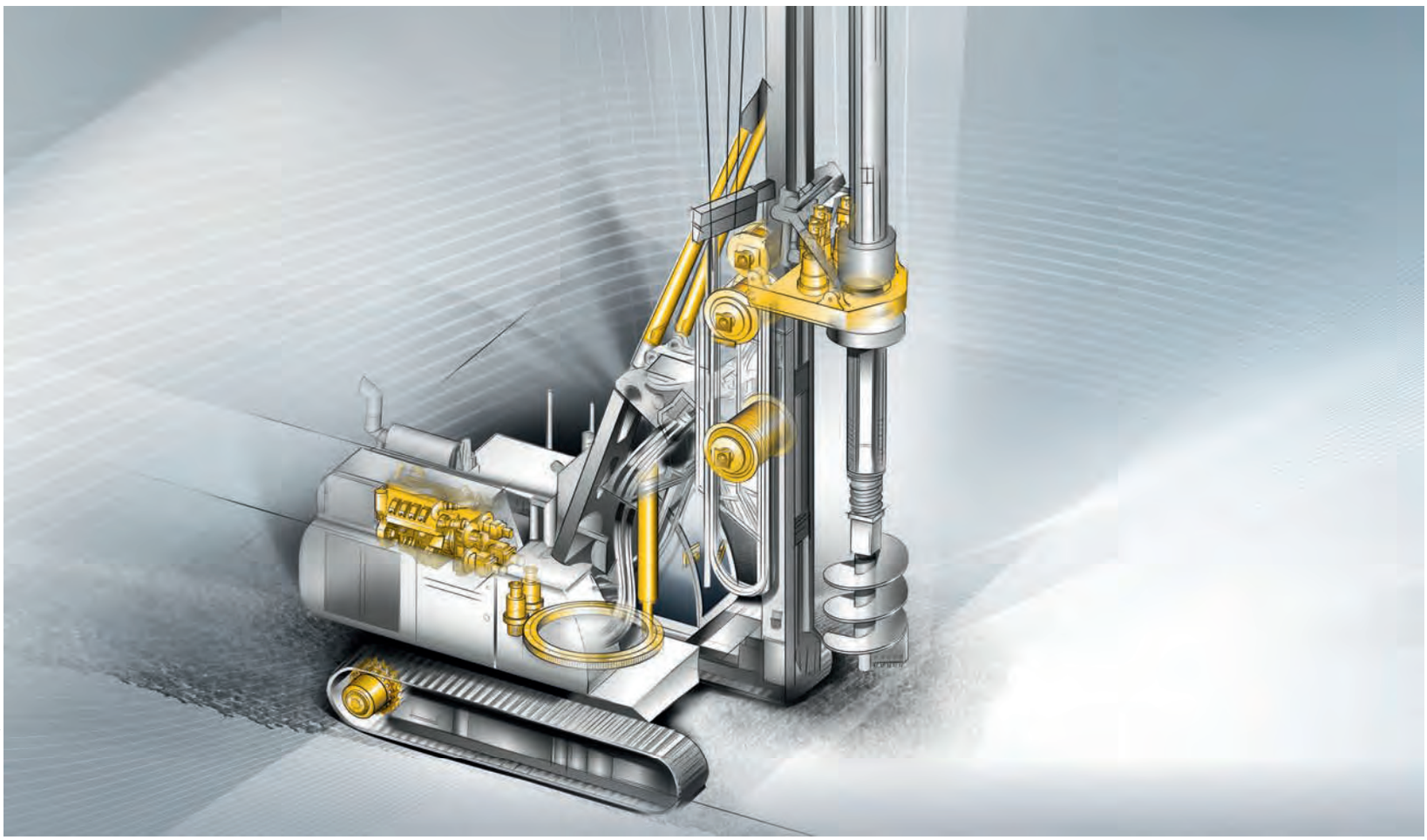
GLOBE TROTTER

In his first five months at Volvo CE, Melker Jernberg has traveled the world visiting his company's facilities, Volvo dealerships and international trade shows. "I've not seen 100% of our own sites, so I still have a few more to see," he says. "Also, a very important part of our distribution is our dealers. Out of our 212 dealers, 200 are independent and 12 are fully owned – so it's also very important to me to understand that perspective."

Some of the key locations Jernberg has visited so far this year are shown on this world map.



Components for Your Equipment.



A strong partner for the construction and mining industry

Components by Liebherr perform a wide range of different drive tasks in various applications in the fields of construction and mining. Examples include large diameter bearings and hydraulic cylinders in excavators, diesel engines and fuel injection systems in cranes and hydraulic piston pumps and motors in pipeline machines.

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This means we can serve big projects with machines and trucks and engines and a good service setup."

Looking at the global picture, Jernberg has plenty of reasons to be optimistic. "What is a little bit special at the moment is that most of the regions are strong at the same time," he says. But there is one market he is particularly focused on: "China is always an area you need to have a close eye on. The up and down swings have been a little bit bigger in China than in the rest of the world. But if you take the trend line, of course there's growing demand in China, as in the rest of the world. China is one focus for us."

But can Volvo CE's high-end, cutting-edge machines really be suited to the more basic needs of Chinese customers? Jernberg believes there is a misconception in what this relatively new market demands. "I think all markets have a wide spread in their specification for advanced and less-advanced machines. That's valid almost everywhere. China is coming from a less mature point from the machine perspective, but the need and the business case for more advanced machines is easy to find. At the moment, we are selling a lot of advanced Volvo machines in China. But we have a venture with SDLG, which we own 70% of. So, a big part of our offering at the moment is the SDLG products, but I don't say it necessarily always needs to be like this. It's a combination. It's a great asset for us to have the technology, operation and distribution, and so on, from two different angles in China."

"I'M IMPRESSED BY THE COMBINATION OF THE HUMAN BEING AND THE MACHINE AND WHAT YOU CAN DO WITH THAT"

ABOVE: **Jernberg's machine of choice – the EC480E – during testing with *iVT***

Fueling the future

So, what will the technologies of tomorrow look like? Jernberg says that while Volvo is famous for groundbreaking innovation, he's not going to take his eye off the ball in terms of investing in the likely sources of growth in the near term. "In our business, the current technology, the current products, are very important, and they will continue to live for a long time. I'm quite sure," he says. "There's a lot of debate about the diesel engine and there's a lot of development still to do on the diesel engine and it's extremely important for us to continue with that. In the diesel engine you can use different fuels – sustainable, or renewable fuels. HVO [hydrotreated vegetable oil] is a big part of our offering going forward."

ABOVE: **Jernberg chats to *iVT* editor Tom Stone as they walk between vehicles**

Indeed, since the beginning of 2016, Volvo Penta has approved HVO for use in all its diesel engines, without any need for modifications, which can lead to a reduction in CO_2 emissions of up to 90%.

Jernberg is clear about the need to reduce emissions in the future, but open as to the best ways to do this. "We need to find the best solution, or the best combination of solutions, moving forward. Of course, in the end, electrification will be a big part of our offering. The development of batteries and also the electric motor itself is going quite quickly at the moment, even if we haven't seen that big breakthrough yet.

"I think we are in a kind of shift – when we are in the future looking back, this will be thought of as a time of extreme change."

Joining the dots

For Jernberg, answers do not lie in single solutions – it's more important to look at how technologies can fit together to create a whole that is more powerful than the sum of its parts. "The combination of electromobility and autonomous machines can be quite interesting," he says, looking forward to Volvo's fully working electric site, due in the final quarter of 2018. The concept was first launched back in

2016, with the unveiling of Volvo's first prototype hybrid wheel loader, the LX1, alongside its fully electric and autonomous 'helper', the HX1 mini-hauler. But this autumn will be the first time the concept is proved in a real-world setting. Joining the LX1 will be an updated HX, the HX2, and the all-new cable-connected excavator, the EX1 (see sidebar, *Inside Volvo's research center*, page 23).

"Of course, you can look at how the machines are connected to each other. But also you have the next level of the system – how you run the site. So there start to be more challenges to overcome than simply having the most efficient machine with the most efficient operator.

"It's about how everything connects together. You don't want a vehicle to just be connected to other vehicles – it also needs to be connected to the site. It's about how you manage the whole site. It's not just about making an electric excavator. With just that, you are not going to change the world. It's about how people use it and are connected in that use."

"IT'S IMPORTANT TO UNDERSTAND HOW WE CAN INFLUENCE THE WORLD A LITTLE BIT. CAN WE BE A PART OF SOLVING SOME OF THE GLOBAL CHALLENGES WE HAVE? I THINK SO"

CAPTAIN OF INDUSTRY

Melker Jernberg became president of Volvo Construction Equipment and member of the Volvo Group Executive Board on January 1, 2018.

Born in Orsa, Sweden in 1968, Jernberg has worked in a number of roles in the automotive, steel and powder metallurgy industries.

A graduate of the KTH Royal Institute of Technology in Stockholm with an MSc in mechanical engineering, Jernberg joined Scania in 1989, where he remained for 22 years, ultimately becoming senior vice president with responsibility for Scania's Bus and Coach business area.

In 2011, Jernberg joined Swedish steel manufacturer SSAB where, as executive vice president, he was responsible for running the company's European, Middle Eastern and African businesses. His most recent position prior to joining Volvo was as CEO and president at Sweden-based metals powder manufacturer Höganäs, a position he assumed in 2014.

Race for the prize

Given Jernberg's relentless drive, you'd be forgiven for thinking he has no time for relaxation, but a few pastimes still interest him, even if some are on the wane: "I used to say that I like to play golf, but I don't anymore as I'm getting so bad! My kids beat me all the time! Maybe that's a good way of spending time with my family and kids, but I don't like it anymore!"

BELOW: **(from left) Melker Jernberg, customer center manager Mikael Andersson and *iVT* editor Tom Stone, during the vehicle test in Eskilstuna**

Jernberg's sons, 22, 20 and 12, are snapping at his heels professionally, with two studying engineering and the youngest fascinated by machines, cars and tools. Time, then, for a little artificial performance enhancement during leisure hours?

"I like cars," he says. "It was a part of me when I was growing up. But it's also the feeling of what you can do with a car when you are not in traffic and on a track... I think as normal human beings we understand that we won't ever be able to run as fast as Usain Bolt, but when it comes to cars, the belief is that if I have as fast a car as him, then I can be a good driver. I'm impressed by the combination of the human being and the machine and what you can do with that."

My mind returns to half an hour before when I felt almost as if I had bionic powers, lifting and smashing rocks in the EC950E... and I have to admit, I'm impressed, too.

But, for Jernberg, wielding such extraordinary power is not just about winning games, or even just about winning customers; it's about making the world a better place and meeting some of the environmental challenges of today and tomorrow.

"Of course we will be there for customers, to make good products, and so on," he says. "But I think it's even more important to understand how we can influence the world. Can we be a part of solving some of the global challenges we have? I think so. And we discuss that a lot. How do we combine designing, building and selling machines with a little bit of higher purpose? I think it's important for all employees of course, but also for the customers and owners to have a little bit of this higher purpose, because in the end you need to discuss what it's all about. And of course, the tool for us for doing that is really good machines. In the future, when we look back, I would like say that, yes, Volvo Construction Equipment really was a big part of making the world a better place." **iVT**

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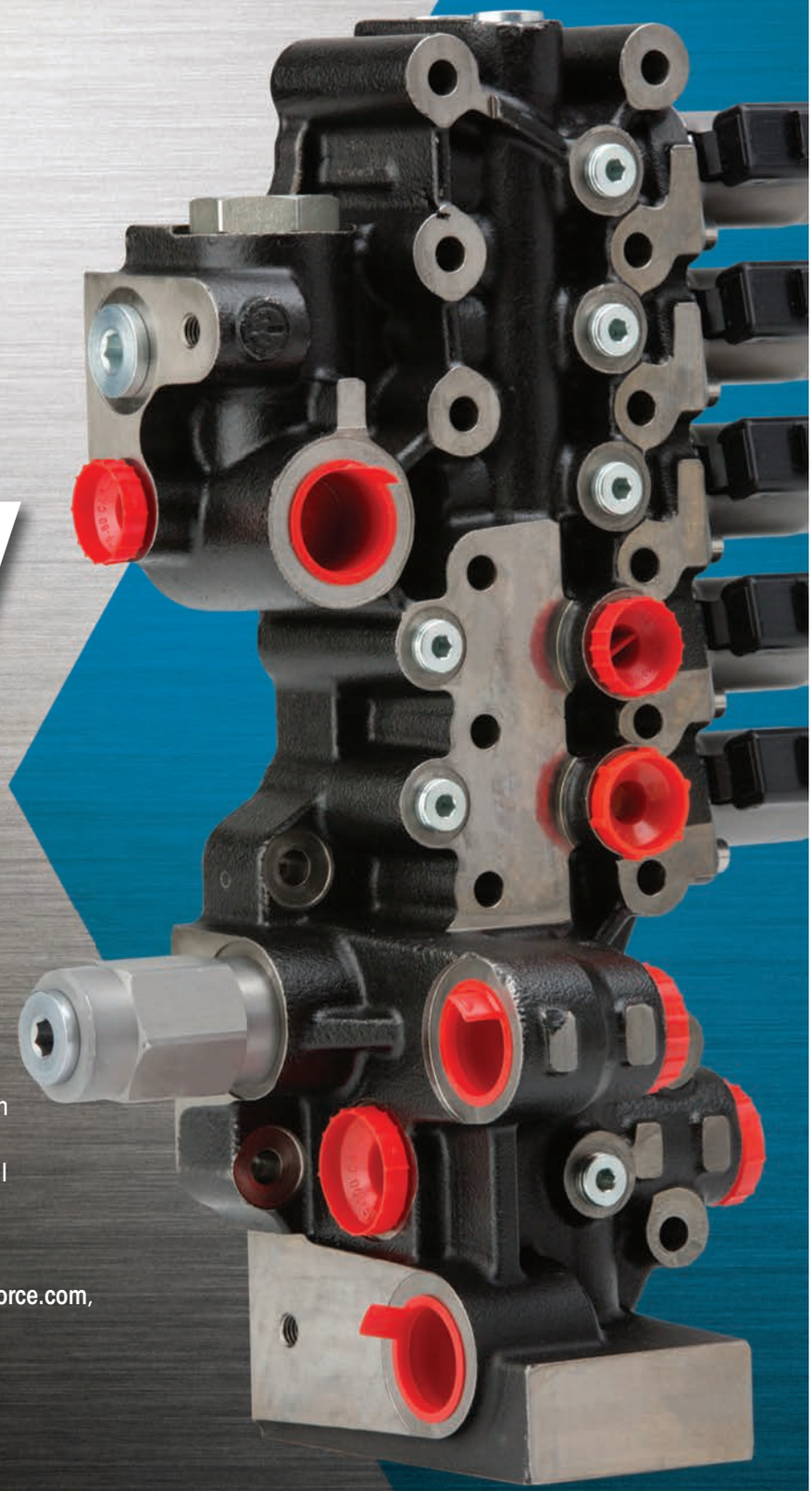

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JAMES ALLEN, IVT INTERNATIONAL

Future-

A LOOK INSIDE THE SECRETIVE RESEARCH AND DEVELOPMENT DEPARTMENTS OF INDUSTRIAL VEHICLE OEMs

Illustration: Sean Rodwell

proofing

The strangest designs are considered and tested behind closed doors

For an OEM to survive – and, indeed, thrive – in the competitive industrial vehicle market, it is paramount that it has employees working on future development projects. That OEMs are meeting today's stringent emissions legislation is largely down to the work carried out by R&D engineers over the past 25 years. It is in this space that emerging technologies can be explored, developed and tested to ensure they increase a vehicle's performance and reliability before it is launched to market. Due to the secretive nature of the projects, R&D is an area that many OEMs are understandably reluctant to talk about publicly. Here, however, senior R&D figures at several OEMs have given *iVT* a unique insight into the machinations of their departments.

JENNY ELFSBERG, DIRECTOR OF EMERGING TECHNOLOGIES, VOLVO CE

RIGHT: **The Case IH Autonomous Concept Vehicle has the potential to revolutionize farming**

BELOW: **Volvo's HX2 has similar bodywork to its predecessor the HX1, but inside, its autonomous and electrical systems have been fully updated (for more see page 27)**

R&D was once quite decentralized but became more top-down, with project managers conducting initial work and then estimating how many engineers were required.

Now we're going back to more self-organizing teams because the technologies are so complex and no one can predict exactly what's going to happen when you put different components together. It makes for a more collaborative experience. There is also a bigger demand now for data. In the past, although we used simulation models, user profiles and contextual data were not in great demand. Now, as much data or experiences from an operator that can be collected are retrieved.

The long view

The Triple Zero Vision is our prediction of what customers in the future will want – and that's zero accidents, zero emissions and zero unplanned stops. Added to this, technology will need to become much more efficient. It's a long-term direction to strive for.

Development process

We have tried asking our people to consider specific areas to research, but while it is productive, it also stops some technologies from being considered. So we try to be very open-minded and only when an idea matures and develops does work become more targeted.

Early on an idea should lead to some kind of early prototype within three months. But then of course the further you get into testing in harsh conditions, the higher the requirements on the prototype.

People power

We have about 2,000 people in R&D and this has increased a bit over the years. I don't think we need to grow; what matters is we work together in a better way. I only have about 20 people in my advanced engineering team, but they work with academia, startup companies and the other engineers in the company. If we become better at collaborating, R&D will get even better.

Digital future

Nothing will have a bigger impact on the construction industry than digitization – sharing and utilizing data from connected machines and infrastructure. That will be the biggest shift. It is more significant than automation.

Our industry is very diverse; there are the super muddy clay mines, open-pit mines, quarries and road works. This is something we should be grateful for, because that means there is room for tailored solutions. Common architecture helps us build more models based on the same parts, which leaves scope for interesting new machine types, optimized specific tasks.

"NOTHING WILL HAVE A GREATER IMPACT ON CONSTRUCTION THAN SHARING DATA... IT'S BIGGER THAN AUTOMATION"

Jenny Elfsberg, Volvo CE

2,000
The approximate number of employees working in R&D for Volvo CE, worldwide

US$1bn
The approximate annual R&D spend by Case IH

ROB ZEMENCHIK PRECISION SOLUTIONS AND TELEMATICS, CASE IH

Case IH's R&D function is grouped into three different areas, with timelines ranging from 5 to 20 years. Product development works on a five-year road map and is driven by customers' current requirements through the customer driven product development (CDPD) process.

The Advanced Engineering group works on concepts that anticipate customers' future needs and design concepts that could be brought to market 10 to 15 years from now.

The third group focuses on new technologies that are still more than 15 years away. Without the constraint of immediate timelines, it can push the limits of what is possible. This group works on advanced concepts: it was responsible for designing and testing the Autonomous Concept Vehicle that premiered in 2016.

Varied prototypes

We develop physical prototypes, virtual prototypes and proof of concepts. The amount of time required varies depending on which of the three prototypes is being considered. The time from a concept to the actual product launch depends on a variety of factors, including testing cycles, manufacturing and commercialization cycles, market acceptance and demand, and component development and availability, among others.

Future plans

We are investing heavily in automation and machine integration (ISObus) and optimizing agronomic conditions throughout the crop cycle to improve agricultural yields, and anticipate that the associated technologies will be important in the long term. Case IH has 6,000 individuals dedicated to innovation, based across 53 R&D centers, and we spend approximately US$1bn annually on the department. The company owns 9,629 active patents.

"THE ADVANCED ENGINEERING GROUP WORKS ON CONCEPTS THAT ANTICIPATE CUSTOMERS' FUTURE NEEDS AND DESIGN CONCEPTS THAT COULD BE BROUGHT TO MARKET 10 TO 15 YEARS FROM NOW"

Rob Zemenchik, Case IH

SATPAL SOKHI, HEAD OF ENGINEERING, MECALAC CONSTRUCTION EQUIPMENT UK

BELOW: **Mecalac's 6MDX cabbed dumper is one of the first vehicles to be produced by its new Coventry, UK, factory that it bought from Terex in 2017**

In the past we have been quite product-focused, with design and development teams operating on products independently; we now emphasize subject matter expertise. It means we can be more fluid and reactive to project demand, regardless of the products in the pipeline. The culture is a lot more proactive now and we have an ethos of delivery, which speeds the R&D process.

Development timescale

Up to 24 months ahead, the plans are generally firm, with design and development activity already in progress. Three- to five-year plans are fluid, although we do have a good understanding of what we want to achieve. Anything beyond five years is visionary and big picture.

Project timescales vary according to the product; however, a good example of responding to market demand is the new cabbed dumpers [the 6MDX and 9MDX] which were unveiled at Intermat in Paris [April 2018]. This innovative design has gone from concept to market-ready machine in just six months.

Across our compaction, dumper and backhoe loader lines, there have always been at least six R&D projects on the go.

Customer demands

Today's marketplace is demanding change much more quickly than ever; we have structured our design, engineering and test teams accordingly to respond to this need for speed. Our goal is to remain at the forefront of design technology and deploy the latest tools available to us.

We place a strong emphasis on securing investment for R&D, aiming to bring groundbreaking products to market in the shortest possible timeframe. As such, budgets have been realigned to make this possible. The R&D team has grown by 15% over the past 12 months.

With the new cabbed site dumper, we have also brought a focus on unique styling and accessibility into the mix. The idea is for all Mecalac product to stand out visually through next-generation design, and focus on small but important touches like being able to easily climb onto the machines rather than having to scale steep steps.

Site managers are looking to have more control over their fleets, and so we are working on the area of connected vehicles and the technology to provide operators and managers with more insight. This isn't just about driver and equipment behavior, but also safety, efficiency and productivity management.

"TODAY'S MARKETPLACE IS DEMANDING CHANGE MUCH MORE QUICKLY; WE HAVE STRUCTURED OUR DESIGN, ENGINEERING AND TEST TEAMS ACCORDINGLY, TO RESPOND TO THIS NEED FOR SPEED"

Satpal Sokhi, Mecalac

Low emissions

Emissions continue to remain a key priority, particularly ahead of the roll-out of the European Stage V diesel engine regulations in 2019/2020. We are continuing to work on mobile machinery powertrains to meet current and future emissions requirements.

One prime example of this is the fully electric Mecalac e12 excavator. Designed and manufactured at the Group Mecalac headquarters in Annecy, France, the game-changing model boasts a compact size, high performance and environmentally friendly credentials. Adopting $LiFePO_4$ battery technology, the e12 offers an impressive range, long service intervals and, most importantly, no risk of fires or battery fluid leaks.

6
The number of months it took to take the new Mecalac 6MDX from a concept to a market-ready machine

1.3%
The proportion of Manitou's budget spend that goes on R&D

DON VOLLMAR, VICE PRESIDENT OF ENGINEERING, MANITOU

Manitou's R&D department takes on challenges we have to overcome, like meeting emissions regulations, as well as working on innovations. Sometimes we will concentrate on cutting emissions and sometimes the focus is on adding benefits for the customer.

We set out a five-year product plan with projects. Beyond five years it's more directional and more trend-based. In five years you might have multiple generations of a product.

Prototype development

We could produce a prototype in a month or it could take several, depending on the project. If you want to turn an internal combustion vehicle into an electrified vehicle, that's a six-month prototype. But if we're changing hydraulic components and keeping the same base power system, then changing out and putting in new hydraulic technology can be done swiftly.

We can also turn prototypes around fairly quickly because in our R&D center we have the ability to generate a computer-aided design [CAD] model. It means we don't have to rely on the operations team to build something. The building of a prototype depends on the lead times of component suppliers to get purchased components in time.

In the past, the challenge was linking the CAD models from various departments. Linking CAD between different functions is now seamless.

Changes since 1993

In the past 25 years, we've made big jumps in efficiency and effectiveness, although recently, improvements have been more incremental.

The proportion of budget spend on R&D is about 1.3%. That will probably grow in the coming years as the markets improve.

The five stages of autonomy apply whether it's automotive, agriculture or construction. Moving along those stages, you spin off other innovations.

We're on board with all the megatrends affecting the industry. I don't think it's a matter of not pursuing them – we have no choice, as they are coming.

I'm not saying we're going to come up with new electric, fully autonomous products next year by any means, but we've outlined our 5- to 10-year road maps and that's the path we're heading toward.

"THE BUILDING OF A PROTOTYPE IS OFTEN DEFINED BY THE LEAD TIMES OF THE COMPONENT SUPPLIERS"

Don Vollmar, Manitou

ABOVE: **Prototypes are largely hand-built, requiring skilled workers**

STEFAN PROKOSCH, SENIOR VICE PRESIDENT PRODUCT MANAGEMENT INDUSTRIAL TRUCKS COUNTERBALANCE, LINDE MATERIAL HANDLING

BELOW: **Linde puts particular emphasis on the early stages of the development process**

In the past Linde's R&D focus was on what was technically possible, but customers' needs are now being considered, too. Particular emphasis is being placed on the early phases of the development process.

Today, development involves several departments. In addition to pre-development, testing and design, product management and sales are closely involved, along with production and purchasing. We are also focusing on product platforms to increase customer benefits, leveraging new solutions faster and raising synergies regarding flexibility in our factories, which results in better lead times.

13,000
Linde Material Handling's approximate global workforce

Shortening development times

In general, development times are falling. Our aim is to implement ideas faster than ever, helped by methods such as agile product development. Linde has 10-year development plans, but technological progress, digitization and networking require continuous adaptation to new circumstances.

The trends that are important for the materials handling industry include automation and robotics, digitization, cross-process networking, new energy solutions (like lithium-ion battery technology or electric forklifts and warehouse trucks with fuel cells) and various systems that make the use of forklifts, and indeed the whole working environment, safer. Driving forces include the developing e-commerce sector, an increase in the international trade of goods, and growing individualization.

"IN GENERAL, DEVELOPMENT TIMES HAVE BECOME SHORTER. THE AIM IS TO IMPLEMENT IDEAS MUCH FASTER"

Stefan Prokosch, Linde Material Handling

PETER DIBBERN, VICE PRESIDENT OF CORPORATE PRODUCT DEVELOPMENT, JUNGHEINRICH

Jungheinrich centralizes R&D for advanced technologies, but has R&D at production locations, too. This successful approach has remained unchanged for years.

A 10-year development plan is updated annually to include projects already scheduled but whose prioritization is subject to yearly review, leading to shifts in the sequence of product development. In developing the overarching technology, we create road maps stretching 15 or even 20 years into the future.

"WE HAVE CONCENTRATED ON IN-HOUSE DEVELOPMENT AND PRODUCTION OF INTELLIGENT BATTERY MANAGEMENT SYSTEMS"

Peter Dibbern, Jungheinrich

The time from an initial idea to the finished prototype varies. In some cases, a functional sample can be produced within weeks, often the case when the idea can be realized by reprogramming a control. There are times, however, when the process can take years, particularly when it comes to the development of a truck, like the ETV 216i reach truck introduced at LogiMAT and CeMAT.

Growth Industry

Last year, Jungheinrich expanded its R&D activities, with an emphasis on developing partial and fully automated trucks, expanding product variety and continuing to optimize lithium-ion technology for use in material handling equipment.

In 2017 R&D spend rose to €77m (US$91m) from €62m (US$73m) the previous year. This equates to 5.3% of the net sales generated by new trucks relevant to R&D. The number of personnel in R&D increased again in 2017: across the Group, 538 employees are now involved.

In 2011 we launched the first truck with lithium-ion technology. We have since focused on in-house development and the production of intelligent battery management. In 2017 we expanded our lithium-ion portfolio to cover all voltage and power classes. Li-ion batteries and corresponding charging technologies are available on almost all trucks. Jungheinrich underscores the durability of this technology with a five-year or 10,000 hour guarantee for lithium-ion batteries. **iVT**

RACHELLE HARRY, IVT INTERNATIONAL

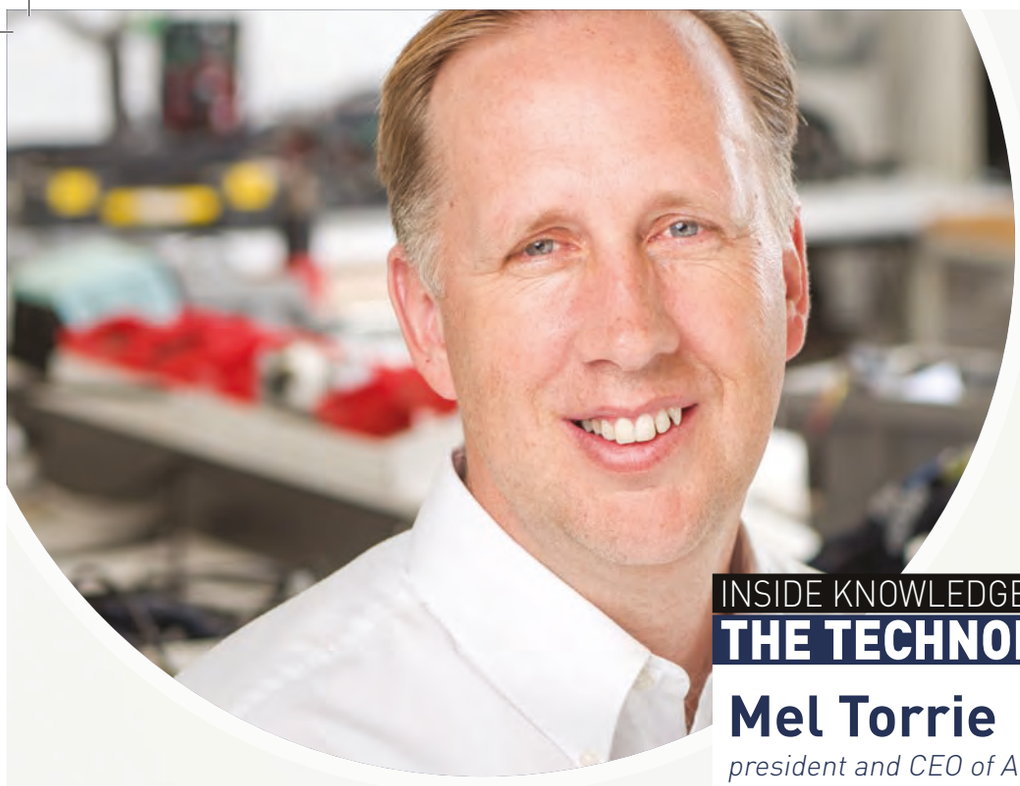
Ready for

25 YEARS

TWO INDUSTRY EXPERTS REVEAL HOW LONG THEY BELIEVE IT WILL TAKE FOR FULL AUTONOMY TO BE ACHIEVED IN INDUSTRIAL VEHICLES – AND WHY

Autonomous vehicles (AVs) are rapidly changing the face of the construction, agriculture and mining sectors. Here, Mel Torrie from Autonomous Solutions and Gunwant Dhadyalla from the UK's University of Warwick share their views on the timeframe to full autonomy across all types of industrial vehicles and the challenges and opportunities the technology creates for those in the industry.

autonomy?



INSIDE KNOWLEDGE:

THE TECHNOLOGY PROVIDER

Mel Torrie

president and CEO of Autonomous Solutions, USA

There's definitely a need to change the architecture of industrial vehicles to drive-by-wire systems that can be easily automated, and I think manufacturers are feeling the push toward that need, as well as toward electronification.

The industrial sector that has taken the biggest leap toward autonomy is mining. It's the sector that is most desperate for affordable labor in remote locations, as well as reducing the need to get workers out of the area if something goes wrong. The mining sector is changing the way we think about working without humans on site. Other industries are following, although they are moving more slowly. In agriculture the appeal of using autonomous technologies is that labor costs can be saved, especially as minimum wages gradually increase. I've seen cases where farmers have made their own automated vehicles! The desperation is there and the need is there.

Why aren't manufacturers doing more to provide fully autonomous vehicles, and what's slowing deployment? First, the liability risks. Second, the biggest profit sector for manufacturers is service and support – expired warranties, parts, etc. With autonomy, vehicles will be driven correctly and consistently all the time, because that's what they've been programmed to do. This will impact service and support, because with autonomy it will take much longer for vehicles and parts to wear out, and that will take money out of manufacturers' pockets. Third, the size of vehicles is set to decrease. Humans will not be required to sit inside fully autonomous industrial vehicles, so the math changes.

The potential advantages of autonomous technologies are much greater for end users than for manufacturers. End users stand to make huge wins based on labor costs, productivity gains and machine durability, and that's why some manufacturers are saying there isn't a demand for this technology. I've heard one of the biggest manufacturers in the world say that there's no demand, which is silly.

Will we reach full autonomy in the industrial vehicle sector? I think it will happen in the next five years. It's coming fast! There are already remotely controlled vehicles and machines that do the not-so-difficult jobs on industrial sites, such as driving back and forth. The key to successful deployment of fully autonomous industrial vehicles is to use them in areas where you can restrict public access. People will be afraid to use these technologies in construction sites, for example, if kids can just wander in or if there are tons of service guys walking around. If technologies are put in place that can detect when humans are entering the workzone, then deployment will be pretty quick.

The use of fully autonomous vehicles will change working as we know it. Humans will still be in the loop, but they will be sat at a desk working remotely during the daytime. Night shifts will become a thing of the past because remote operation can be carried out from different time zones. We'll no longer have tired people working at night, slowing performance.

5 years

until we see AVs being commonly used in industrial applications

"I'VE SEEN CASES WHERE FARMERS HAVE MADE THEIR OWN AUTONOMOUS SYSTEMS! THE DESPERATION IS THERE"

INSIDE KNOWLEDGE:
THE ACADEMIC

Gunwant 'Gunny' Dhadyalla

principal engineer of the energy and electrical systems group, University of Warwick, UK

The movement of industrial vehicles must be fully understood before fully autonomous versions are deployed. For example, many on-road autonomous vehicles' visual systems are camera based and they rely on landmarks or cues to position themselves. If an autonomous industrial vehicle is working in a large quarry or field, what points of reference could it use to ensure it moves to the correct destinations?

Wheels may not move as planned. If an autonomous vehicle is working in sand, for example, its wheels could spin and affect the vehicle's functionality, as well as the precision movement of other parts.

There are a few key industrial areas where we're already seeing ground being made toward full autonomy. In mining, autonomous vehicles have been successfully deployed because they can be used to carry out tasks remotely to improve safety for workers. In construction, autonomous technologies are making repetitive tasks such as bricklaying more controllable. In agriculture, autonomous technologies are being used to carry out simple tasks like seeding.

The obvious advantage of using autonomous technologies in the industrial sector is the increase in productivity that can be achieved. People are sometimes concerned that this could come at the expense of jobs, but as history shows, jobs often evolve and their structures change. We'll see a migration of skills, with fewer people driving and controlling vehicles because the vehicles will be driving and controlling themselves. But humans will still be required to supervise these fleets of autonomous machines.

How will autonomous industrial vehicles increase productivity? One large machine – be it a tractor, crane or digger – could be replaced by a number of smaller machines. And if one breaks down, another could step in right away to carry out the same task, to keep productivity maximized.

Safety will be hugely improved by autonomous vehicles. On one hand, humans are being taken out of the loop, so their exposure to harm is lessened and their safety is increased. On the other, the entire meaning of safety will change when humans are no longer controlling vehicles. And what happens if something goes wrong?

The impact that autonomous technologies will have on the meaning of safety will also affect other industries. For example, in the automotive sector the promise of there being no accidents will hugely change the insurance industry. As autonomous vehicles continue to be used in the industrial sector, similar effects will be felt in the peripheral world around the technology itself.

So will we reach full autonomy across the industrial vehicle sector? I think we'll see lots of cases of fully autonomous industrial vehicles being used in the next decade. However, controlled environments are key. This is why for on-road vehicles, short-distance pod trips and transportation buses have been so successful. **iVT**

10 years

until we see AVs being commonly used in industrial applications

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JACK ROPER, IVT INTERNATIONAL

The X factor

THE 220X IS THE VERY FIRST MACHINE IN A NEW SERIES FROM JCB THAT IS SET TO SHAPE THE NEXT TWO DECADES OF INDUSTRIAL VEHICLES. *IVT* GETS A FIRST LOOK AT THIS FRONT-RUNNER, TO FIND OUT EXACTLY WHAT GOES INTO BUILDING A CONSTRUCTION SUPERSTAR

As the first in JCB's much-anticipated new generation of X Series machines, the new 220X 20-ton excavator took center stage at a March 2018 launch event at the company's HQ in Rocester, UK, which was bristling with new products. The previous day's rain had abated and it certainly felt like a watershed when, after a fanfare of marquee neon and dry ice, guests were shepherded out into Wredon Quarry's titanic cauldron to watch these muscular leviathans rollick and cavort over gravel hills beneath a turbulent press of sky.

The 220X purports to achieve 10% better productivity and 15% better fuel efficiency than its predecessor, the JS220 excavator. It represents the fruit of a £110m (US$150m) investment and the culmination of four years of subsequent research and development. It is a statement of intent – and its timing could not be better.

"We're bringing these new machines to market at a time of exceptional global growth," says JCB's CEO Graeme Macdonald. "Last year, the world market hit 897,000 units – up more than 21% versus 2016. The global tracked excavator market rose by 43% – that's more than 186,000 units. It's my firm belief that the momentum behind that growth will last for at least the next three years." It was against this backdrop that Macdonald introduced the new X Series machine. "This is a game-changing excavator," he continued, "ready to seize the opportunity offered by a period of global growth. It underlines just how serious we are about building our presence in this sector."

The 220X runs on a JCB EcoMAX Tier 4 Final/IV engine providing 129kW of rated power and maximum torque of 690Nm at 1,500rpm. The global boom and arm design proved on previous machines is retained, fashioned in high-tensile steel and reinforced with three-piece wrapper plates and cast ends, but subtle expansion of the new machine's upper-structure has allowed its central architecture to be deftly centralized.

"At 2.7m [9ft] wide, it is 200mm [8in] broader," explains chief innovation and growth officer Tim Burnhope, "allowing us to mount the main boom with minimal offset, reducing stress on the slew bearing for incredible smoothness and pinpoint accuracy when digging a trench. It has a 38% larger slew motor, coupled with a 16% increase in slew braking torque."

For Burnhope, the real story is not so much the machine's huge power as the thousand little things that combine to help make the 220X special – and the perfectionism of JCB engineers fixated on getting all of them right. "We've obsessed over every little detail," he says. "Every inch of these excavators has been examined to provide maximum durability and reliability. But more than that, we've made it easier for the operator and service technician, reducing downtime and boosting productivity. Our customers are demanding more of machines than ever before. We've listened – and delivered on their demands."

Advanced control

This philosophy is manifest in the 220X's stand-out CommandPlus cab, which reflects increasingly high expectations of comfort from canvassed customers. Flat-glazed all round with an integral ROPS frame, it is a full meter (3.3ft) wide and 100mm [4in] longer than previous cabs, making the operator environment a luxuriant 15% more capacious. Home comforts abound, including a cooler, full roof-blinds and a luggage tray with three 12V sockets. All three industry-leading Grammer seat options feature adjustable armrests and a 145° reclining facility, while the top-spec seat is fully heated and ventilated to keep operators agreeably chilled or toasty, as applicable.

"The newly designed track pedals have T-bars featuring a non-slip coating," Burnhope chuckles, "so you can even drive it in your socks!" Fully sealed and pressurized to minimize dust ingress, the cab rests on four dual-reservoir viscous

67dB(A)
The low in-cab noise level in the 220X

LORD BAMFORD ON THE HISTORY OF JCB EXCAVATORS

As *iVT* looks back over the last 25 years, we caught up with JCB chairman Lord Bamford, at the 220X launch event, and asked him to tell us a bit about the history of his company's excavators

Born on the day his father founded the company, JCB chairman Lord Bamford's childhood memories must be crowded with fantastic shapes of half-forgotten vehicles.

"I can remember excavators before they were hydraulic," Lord Bamford tells *iVT*. "They were cable operated. Even further back, I remember steam-powered excavators, many with face-shovels, which worked in quarries. The biggest brand in England at that time was Ruston-Bucyrus.

"We first started making excavators in the 1960s," he continues. "We had a license agreement with an American company, Warner & Swasey. That first got us into it."

A first tracked excavator – the **JCB7** (1) – was launched in October 1964, combining Warner & Swasey's super-structure and hydraulics with JCB undercarriage and main excavator assembly. Further models appeared in the 1960s, including the 5C (2).

"The **6D** [3] was the most popular," Bamford recalls, fondly. "It had a Ford engine originally, which produced about 60hp and was around 15 metric tons."

LEFT AND BELOW: **The 220X CommandPlus cab represents a leap forward in ergonomics**

BELOW LEFT: **Maintenance access is easier than ever**

mounts, delivering low in-cab noise of 67dB(A). With 11 vents and molded ducting, an impressive 43% gain in cab ventilation is also achieved. "At the touch of a dial, airflow position can be adjusted to suit the operator," Burnhope explains, "just like in your car." Indeed, it is an automotive standard of comfort to which the CommandPlus cab aspires.

Best-in-class ease-of-use is provided by ergonomic, operator-focused design. Servo levers mounted to pods suspended from the seat move with the operator, providing optimum control and reduced fatigue. Intuitive menus are accessible via a 7in (18cm) tilt-adjustable monitor with automotive-style rotary controller. At the operator's right hand, an all-new command pod combines key switches and controls into a single, seat-mounted unit – enabling regular operations to be executed faster.

Easy quick-hitch facilitates simplified changeover of large breakers or fork attachments, while pipework shut-off taps come as standard, speeding the connection of hydraulic attachments. Innovations, including a stop/start button, reduce the steps required to start the machine, saving time on-site.

"The operator is up and running within two seconds of turning the

25 YEARS

4

The *iVT* years

In December 1992, as planning began for the first ever edition of *iVT* (published in 1993) JCB's **JS200** tracked excavator (4) rolled off the production line. It was the first fruit of JCB's decade-long partnership with

5

Japan's Sumitomo Construction Machinery, which produced several more JS tracked models and JCB's first wheeled excavators, the **JS130W** and **JS150W** (5).

In 2008, JCB opened its £40m (US$55m), 41,800m² (450,000ft²) Heavy Products plant in Uttoxeter, where X Series machines are being built today. The millionth JCB machine produced – a **JS220** tracked excavator (6) finished in shimmering silver, rolled off the line in 2013.

6

And now the 220X is poised to write a new chapter in the firm's history. But what have been the main advances in JCB excavators since 1964? "I think more efficiency," reflects Lord Bamford. "Hydraulics have got a lot better, engines are more efficient and the digging outputs have improved. They're also quieter and cleaner – and more reliable. The early ones weren't so reliable, truth be told. Now, you get people doing thousands of hours with nothing going wrong except for wear and tear."

key," says Burnhope. "We've also timed the 30 most common 'day-in-the-life' tasks an operator performs," he continues, "from changing the quick-hitch to selecting the lift mode. By obsessing about detail, we have cut in half the time it takes to do these jobs, through intuitive display and switch gear layout."

Key components

The latest generation of Japanese components already proven in JCB machines furnish the 220X with a rugged longevity while providing precise and efficient control. A state-of-the-art Kawasaki hydraulic pump is combined with a Kayaba valve block, 14% larger main service spools, and a hydraulic regeneration system that recycles oil, reducing fuel consumption. "High-flow hydraulic lines have increased from 19mm to 25mm [0.8in to 1in] in diameter," explains Burnhope, "reducing backpressure while maintaining flow to improve hose life. SAE4 bolt-flanged connections have replaced threaded fittings and formed metal pipe has replaced flexible hoses at critical locations, bringing new levels of robustness."

No stone, it seems, has been left unturned in seeking efficiency gains. Track gearbox moving parts have been reduced, delivering 8% better tractive effort and 20% better tracking fuel efficiency, while auto-stop and auto-idle EcoMAX engine features promise fuel savings up to 5%.

Testing times

The 220X has endured thousands of hours of punishing tests to ensure its toughness and reliability. Whole 20 metric ton excavators have been put on an automotive-style machine shaker rig (designed to replicate a dry river-bed) and subjected to 15,000 hours of tracking and vibration. The dig-end has undergone 1.1 million test cycles, with each door subjected to more than 10,000 slam-tests and an electronic test rig used to try connections and components.

Vehicles have been tested in the wilds of Finland, in ambient temperatures ranging from 55°C down to -30°C (131°F to -22°F) . Meanwhile, new techniques have been introduced at JCB's Heavy Products plant in Uttoxeter, such as electrophoretic deposition (EPD) coating to ensure full, corrosion-resistant coverage of metal components, and robot-welding of the dig-end and undercarriage for consistent quality. An unprecedented 42% of the machine will be constructed in sub-assemblies, simplifying the main line and allowing additional quality checks to be built in.

Looking good

Aware that cosmetic knocks and scrapes can quickly dent an

"A NEW ZERO-EMISSION SECTOR IS EMERGING QUICKLY – AND WE KNOW THE INDUSTRY NOW EXPECTS AND NEEDS CHOICE"

Tim Burnhope, chief innovation and growth officer, JCB

JCB'S FIRST ELECTRIC EXCAVATOR

On the same day JCB unveiled its new 220X machine, company history was made when it revealed its first-ever electric mini-excavator – the 19C-1 E-TEC – a zero-emission machine and also JCB's quietest excavator, with external noise five times lower than the 19C-1 that provides its template.

Three lithium-ion battery packs and an efficient 48V driveline provide autonomy over a full day in typical duty cycles, or four hours in extreme operations, with Bosch Rexroth load-sensing hydraulics instrumental to energy-efficient performance. Full recharge takes six hours via the onboard charger or just 2.5 hours with an optional off-board fast-charge unit.

"With urbanization comes the challenge of machines operating more closely with people as well as underground and indoors," says Tim Burnhope, JCB's chief innovation and growth officer. "A new zero-emission sector is emerging quickly – we believe the 19C Electric Mini meets and exceeds industry expectations."

15%

Increase in fuel efficiency of the 220X over its predecessor, the JS220

excavator's resale value, JCB has labored to keep the 220X looking new for longer. Hence two purpose-built impact points protrude from the counterweight, a pronounced skirt circles the upper-structure, and all contact surfaces are zinc-plated to prevent corrosion.

Because the first thing a prospective second-hand buyer often does is to open the service access doors, these are pressed and hemmed in double-skin steel with sturdy handles and a welded framework. Servicing itself is easier than ever, with 5,000-hour hydraulic oil service intervals and 2,000-hour filter-change intervals. The 220X boasts an SAE rating up over 30% on prior models, an easily accessible IP69-rated single-point fuse box, a 23% larger toolbox and clustered grease-points for quicker servicing. JCB LiveLink telematics come as standard.

One of the family

This beast debuted as belle of the ball at an event that saw JCB maintain a seemingly relentless pace of innovation, announcing the launch of some 40 new machines in 2018.

For Tim Burnhope, the 220X fits into a jigsaw of landmark vehicles released over a three-year period, including the 3CX Compact and Hydradig for rental markets and confined urban jobsites; new Loadalls, some featuring revolutionary DualTech VT transmission, for a changing agricultural industry; and a new range of mini-excavators, including JCB's first-ever electric 19C E-TEC excavator, for the housing sector. This last big piece – the first 'X Series' machine – is intended for infrastructure.

Markets are buoyant and, with JCB expecting the global population to reach 10 billion by 2050 and the percentage dwelling in cities to swell from 54% to 70%, the 220X looks sure to prove a powerhouse of global construction projects for years to come. **iVT**

STAGE V: CLEAN DIESEL

Despite entering the electric vehicle market with its 19C-1 E-TEC (see previous page), JCB anticipates diesel being the fuel of choice for larger machines for many years to come, albeit in a much cleaner form than ever before. It is therefore justifiably proud of its new Clean Diesel Stage V solution, incorporating diesel oxidation catalysts (DOC), integrated DPF and selective catalytic reduction (SCR) to meet European Stage V regulations that take force from January 2019.

"JCB engines have low-emission, high-efficiency combustion systems developed for Stage IIIB and Tier 4," says group director of engines Alan Tolley. "This means we started development for Stage V from a good position. JCB's particulate control technology features low particulate combustion, oxidation catalyst, filter and integrated engine, and regeneration control system. It is designed as a completely integrated system that's highly reliable, highly effective and invisible to the customer."

The company notes that manufacturing one lithium-ion electric battery generates 6 metric tons of CO_2; moreover, given the US$220,000 cost of a lithium-ion battery large enough to power a 20-ton excavator for eight hours, clean diesel has a bright future.

"We're proud to be developing innovative, near-zero-emission engines," says Tim Burnhope, JCB's chief innovation and growth officer. "Make no mistake, diesel is crucial in generating the high power needed to shape and construct the future of the world we live in."

Auto industry scandals may have tarnished diesel's reputation, but CO_2 emissions across JCB products are down 43% since 2010

A JCB excavator for 2043. This concept was designed for the computer game *JCB Pioneer: Mars*, in which players must mine precious materials and construct large-scale buildings on the Red Planet, using specially designed JCB machines

On the Web

Watch the launch video for the 220X at **www.iVTinternational.com/220x**

MARTIN RICKATSON, IVT INTERNATIONAL

ITS HISTORY CAN BE TRACED BACK 25 YEARS, BUT FORWARD-THINKING INNOVATION REMAINS CENTRAL TO THE CASE IH QUADTRAC PHILOSOPHY – THE LATEST RANGE NOW INCLUDES THE WORLD'S FIRST HIGH-HORSEPOWER ARTICULATED TRACTORS AVAILABLE WITH CONTINUOUSLY VARIABLE TRANSMISSION

On track

The new, top-of-the-range Quadtrac 620 (right of photo) has twice the power output of the launch model (left)

There is an iconic agricultural vehicle that is almost exactly the same age as *iVT*. A quarter of a century ago, in 1993, only prototypes existed for Case IH's groundbreaking Quadtrac. It took until September 1996 for a production version to be launched, and until recently it remained the only machine of its type. For farmers requiring maximum output and maximum grip from a high-output tillage tractor at the top of the power tree, over many years the rubber-tracked, articulated machine existed in a category of its own, addressing the various downsides of wide/dual-tired tractors, steel tracklayers, or rubber-tracked crawlers using differential steering.

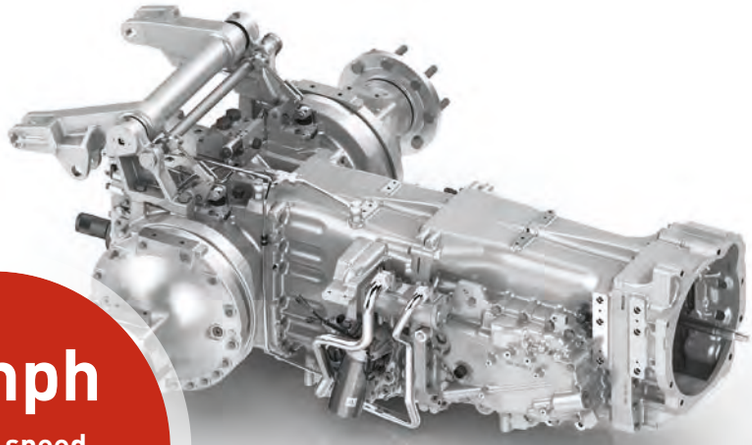
Competitor designs have entered the fray, but a recent Quadtrac transmission development means the machine can once again claim to be unique. Powershift gearboxes have been fitted to every Quadtrac to date, but Case IH has extended the availability of continuously variable transmissions up the power scale to the articulated tractor market, on the back of huge growth in popularity among farmers for their ease-of-use and fuel consumption benefits on smaller wheeled tractors.

While it has been in the CVT market for mid-power tractors since the mid-1990s, using its own CVT development (now as part of CNH Industrial), smaller sales volumes at this higher power level convinced Case IH and its parent to outsource its needs here to ZF. Availability is adjusted according to local markets, but in the UK, for example, the ECCOM 6.0-based CVXDrive transmission is available on the three most popular mid-range Quadtracs – the 470 CVX,500 CVX and 540 CVX, achieving maximum power outputs of 525hp, 558hp and 613hp respectively. Other models remain powershift only.

The new transmission option benefits the farmer primarily by the ability to operate at either a desired forward speed or engine speed, with Case IH Automatic Productivity Management software adjusting the engine and transmission management accordingly. As a result, the tractor can be programmed to

BELOW: **In the cab, visible differences are few, but include a split throttle for minimum/maximum engine RPM settings, and a slightly different Multicontroller joystick**

RIGHT: **ZF's ECCOM 6.0 – known as the CVXDrive in Quadtracs**



25mph

The top speed (40km/h) achieved by Case Quadtracs with CVXDrive

"THE MAIN ISSUE IN ENGINEERING THE NEW TRACTOR/TRANSMISSION PACKAGE WAS MATCHING THE ENGINE'S PERFORMANCE TO THE CVT'S SPEED MANAGEMENT"

Diego Rotti, product manager, FPT Industrial

operate automatically for maximum economy or maximum workrate.

The ZF CVT has been specially developed for applications in articulated high-horsepower tractors, and CNHi is the first customer, offering it as an option on not only Case IH Quadtracs but also wheeled Steiger models, and the wheeled New Holland T9 series, built on the same platform at the CNHi plant in Fargo, North Dakota.

Controlling the power

Providing stepless travel from standstill up to 25mph (40km/h), and 11mph (18km/h) in reverse, CVXDrive allows storage of three target speeds, adjustable via thumbwheel and buttons on the armrest-mounted Multicontroller joystick. The transmission incorporates a kick-down feature to boost acceleration, and 25mph (40km/h) is achieved at 1,640rpm.

There are four mechanical ranges, with automated range-changing under full draft load. The first time 100% mechanical power transfer takes place is below 6mph (10km/h), to match heavy draft application requirements. Four multiplate wet clutch packs, mounted on the four planetary gearsets, change the ranges without power interruption, with equal clutch speeds designed to smooth shifts and minimize clutch wear.

The hydrostatic pump and hydrostatic motor are a single unit, with no high-pressure pipes between pump and motor. A variable swash plate on the pump creates different speeds and allows the fixed hydrostatic motor to be operated in both directions. This is the key to Active Hold Control, where the hydrostatic motor eliminates the input speed from the engine, enabling the tractor to remain static when stopped on a hill, without

25 YEARS

FROM PROTOTYPE TO PRODUCTION

1992

NEW THINKING IN HIGH-HP TRACTION

The Quadtrac development team was founded in the late 1980s, not long after the parent company of Case IH had purchased articulated high-hp tractor specialist Steiger and its Fargo, North Dakota, factory in 1986. The first public showing of a Quadtrac prototype, based on a 300hp 9150, was at the US Farm Progress Show in Columbus, Indiana, in 1992.

1993

THE PATH TO PRODUCTION

The wheeled tractor platform on which the Quadtrac development was based was upgraded from the 300hp 9250 to the 335hp 9270. Isolation linkages and rubber isolators were included to protect the operator from the grip forces generated by the tracks traversing the ground.

1996

DAWN OF A NEW TRACTOR DESIGN

The 360hp production version of the Quadtrac was unveiled to North American farmers at the September 1996 Farm Progress Show in Amana, Iowa. It made its European debut at the SIMA show in Paris in February 1997.

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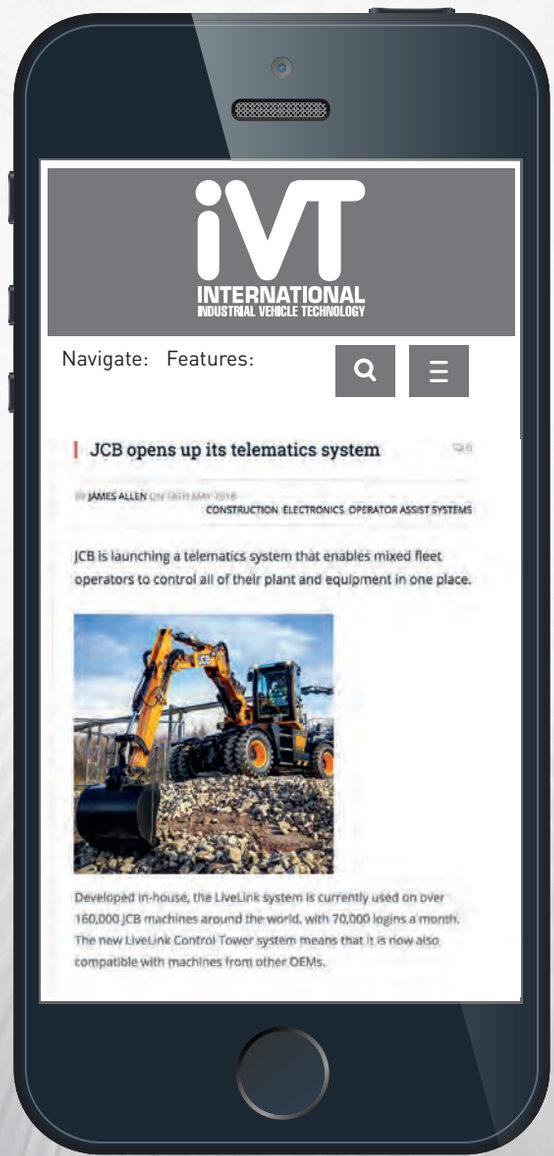

www.ivtinternational.com

8,949kg
Capacity of the rear linkage on Quadtracs

ABOVE: **Advantages for CVT at this power level include operation at reduced engine speed to optimize fuel efficiency**

RIGHT: **The artciulated Quadtrac has one of the tightest turning circles in its class**

1998
MORE MODELS, MORE POWER

In 1998, the original 360hp Quadtrac gained a 400hp big brother, and the two machines were then given 9370 and 9380 model numbers, equivalent to the wheeled models on which they were based. The 9380 was the largest in both wheeled and tracked ranges of tractors from Case IH. On February 25-26, 2000, Case IH employee Jean Imbert used the new 9380 to smash the world plowing record in southwest France. Coupled to a 17-furrow reversible Gregoire Besson plow, the Quadtrac covered 517 acres (209ha) in 24 hours, at 21.5ac/hr (8.7ha/hr).

2000
MORE COMFORT, GREATER EFFICIENCY

Later in 2000, four completely restyled 275-440hp STX Steiger wheeled models and two 375hp and 440hp Quadtracs were launched, with a new Surveyor cab, featuring curved glass, new armrest controls and a red leather ventilated seat. An upgraded 16-speed powershift replaced the previous 12-speed unit.

the operator applying the foot or hand brake.

In place of the usual foot throttle, Quadtrac CVX models are fitted with a drive pedal that controls the tractor's ground speed when in automatic mode. In manual mode, the foot pedal acts as a conventional foot throttle. An Eco Drive dual-hand throttle enables the setting of minimum and maximum engine speeds to minimize fuel use, and the engine droop function, which determines the engine speed down to which the RPM can drop under load. The Multicontroller also incorporates a power shuttle switch, working in parallel with the shuttle lever on the left of the steering column.

The tractor can be stopped temporarily – such as at road junctions – using only the brake pedal, returning to its previous speed once the pedal is released. Fast reduction of forward speed is possible by drawing back on the Multicontroller. Three different response levels for acceleration, deceleration and power shuttle modulation can be set via the Multicontroller armrest.

Efficiency first

Automatic Productivity Management (APM) is designed to ensure the most efficient operation of the machine, whether the operator or owner target is minimum fuel use or maximum output. APM coordinates the engine and transmission with the Multicontroller and drive pedal, automatically reducing engine speed to the minimum required for the tractor's workload, to cut fuel wastage. The tractor can also be operated in manual mode, without APM, with the transmission controlled via the Multicontroller and the engine speed via the foot or hand throttle.

"At 613 peak horsepower, the 540 CVX offers the highest available power of any CVT tractor available," says Vincent Hazenberg, Europe, Middle East and Africa product marketing director for Case IH.

"It's complemented by the Quadtrac 500 CVX and Quadtrac 470 CVX, which have respective maximum power outputs of 558hp and 525hp.

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2005

TO THE ENDS OF THE EARTH

Over two months in late 2005, several Quadtracs helped open a 1,000-mile (1,609km) over-ice route between Antarctica's McMurdo and Amundsen-Scott stations, enabling land movement of cargo and fuel. Some of the tractors were transported from Christchurch, New Zealand, to McMurdo Station, in the company of research scientists and other crew aboard US Air Force C-17 cargo aircraft.

2005

A NEW WORLD RECORD

In 2002, when the Steiger and Quadtrac tractors were re-engineered to meet Tier II/Stage 2 emissions legislation, the STX440 flagship had been replaced by the STX450. A year later, an STX500 was added, and it was one of those Quadtrac models that, in 2005, set another new world plowing record, covering 792 acres (321ha) in 24 hours using a Gregoire Besson 20-furrow reversible. On January 20, 2005, a Quadtrac STX500 also became the 50,000th Steiger-manufactured tractor since the first was built in 1957 on the Red Lake Falls, Minnesota farm of John Steiger and sons Douglas and Maurice, before the family moved production of its tractors to Fargo, North Dakota, where Steiger and Quadtrac tractors are still built today.

"But while we have added the new transmission option, we've not changed the engine. It remains the electronically controlled 12.9-liter Cursor 13 six-cylinder unit from our sister company, FPT Industrial, incorporating a single-stage turbocharger on the two smaller tractors and a two-stage turbocharger in the 540. This latter arrangement uses a smaller turbocharger to deliver low-RPM responsiveness, while the second, larger unit provides maximum boost at high RPM. Each turbocharger has its own cooling system, providing 30% faster response under load."

Maximum power of the largest 540 CVX is achieved at 1,900rpm, and maximum torque of 2,607Nm (1,923 lb-ft) at 1,400rpm. But although the engine is unchanged, engineers at FPT have put great effort into its operating parameters to suit the nature of the CVT, says Diego Rotti, a product manager in FPT Industrial's off-road engine division.

"The main issue in engineering the new tractor/transmission package was matching the engine's performance to the CVT's speed management," says Rotti. "That's because torque output needs to be adapted for the stepless transmission rather than the standard stepped powershift.

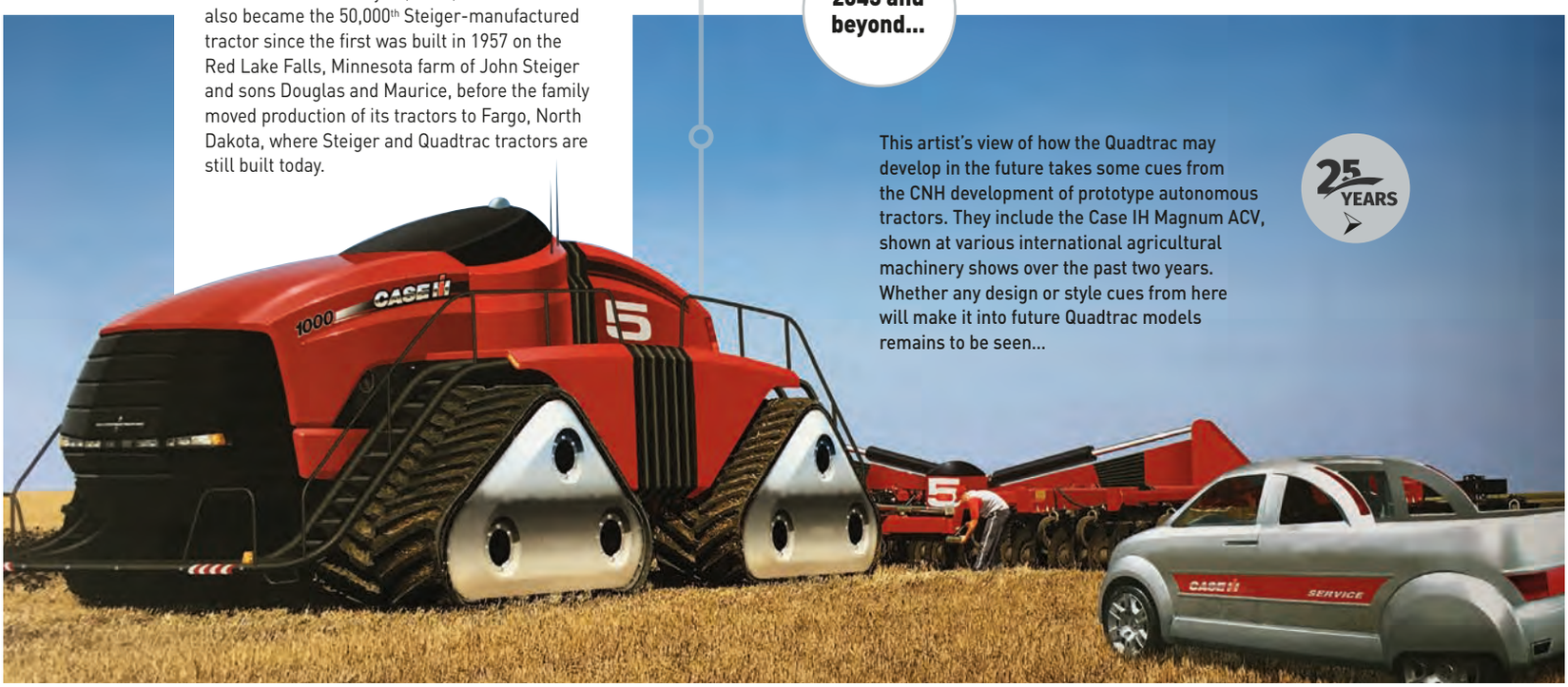
"The engines meet Stage IV emissions legislation through the use of the Case IH/FPT Hi-eSCR system. On the largest model in the Quadtrac CVX range, the Quadtrac 540 CVX, rated power (according to ECE R120 2) is 543hp, while Engine Power Management, introduced under load, takes this to 598hp, both measured at 2,100rpm rated engine speed. Maximum power of 613hp is achieved at 1,900rpm, and maximum torque of 2,607Nm at 1,400rpm."

The variable displacement pump that supplies the key hydraulic requirements is a pressure- and flow-compensating type, providing a maximum 216 l/min of oil flow, with a 428 l/min option. The system operates at a pressure of 210 bar, supplying up to eight remote valves.

2043 and beyond...

This artist's view of how the Quadtrac may develop in the future takes some cues from the CNH development of prototype autonomous tractors. They include the Case IH Magnum ACV, shown at various international agricultural machinery shows over the past two years. Whether any design or style cues from here will make it into future Quadtrac models remains to be seen...

25 YEARS



"CONTINUOUSLY VARIABLE TRANSMISSION TECHNOLOGY ENSURES FULL POWER AVAILABILITY AT LOW GROUND SPEEDS FOR SPECIAL APPLICATIONS"

Hans-Werner Eder, Quadtrac product manager, Case IH

These and the 8,949kg-capacity rear linkage are controlled electronically via the Multicontroller armrest.

User comfort and benefits

While the established Surveyor cab fitted to the Quadtrac CVX tractors is an evolution of the second-generation unit launched in 2000, there are some new features that come courtesy of the CVXDrive transmission introduction. The operator benefits from a slightly revised Multicontroller armrest, with a dual throttle for minimum/maximum speed settings, and a slightly different Multicontroller joystick to simplify the operation of the CVX transmission. Operating information, including engine speed, transmission forward and reverse target speeds, currently engaged target speed, and actual ground speed, is shown in the familiar Case IH pillar display in the right-hand A-post, as is a park brake/neutral/forward/reverse indicator and forward/reverse speed selection indicator, plus fuel and DEF (AdBlue) tank levels.

"Continuously variable transmission technology can bring a wide range of engine, fuel and work advantages to Quadtrac owners' businesses," says Hans-Werner Eder, Quadtrac product manager for Europe, Middle East and Africa.

"They include operation at reduced engine speed to optimize fuel efficiency, and enhanced operation through the achievement of uninterrupted peak power via stepless speed progression.

"It's easy to use, particularly for inexperienced operators, offers faster acceleration to field or road speed, reduces operator fatigue, ensures full power availability at low ground speeds for special applications and implements, and provides full hydraulic flow availability at low ground speeds, for applications such as drilling/planting. In addition to those fuel savings, the result is increased productivity with faster cycle times." **iVT**

2,607Nm
Maximum torque of the Quadtrac 540 CVX, achieved at 1,400rpm

THE ALTERNATIVES

Although the Case IH Quadtrac has always faced competition from differentially steered rubber tracked crawlers from the likes of Caterpillar (latterly AGCO) and its Challenger line, and John Deere's twin-tracked machines, for almost 20 years it had the four-tracked articulated sector to itself.

Then, in 2013, Russian-owned Canadian articulated tractor maker Versatile launched its take on the design. It combines Cummins power with a Caterpillar powershift, and features a track drive design with two mid-rollers rather than the Quadtrac's three. The company now offers models from 500-610hp.

Two years later, having for some years offered a wide range of twin-track rubber-tracked crawlers, John Deere introduced an articulated design, based, like those of its competitors, on its established articulated tractor range. Again, it chose to use a twin rather than triple mid-roller format. While Deere and Versatile argue that this avoids a weight-bearing spike being loaded onto any middle roller, Case IH's argument for three is that this layout ensures full ground contact at all times and smooths out any obstacle.

ABOVE: **Versatile launched its tracked, articulated tractor design in 2013**
LEFT: **John Deere's twin-tracked machines appeared on the market two years later**

On the Web

Watch a video of Case IH Quadtrac history at **www.iVTinternational.com/quadtrac**

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Out of control?

AS TODAY'S INDUSTRIAL VEHICLE DESIGN DEMANDS THE INCLUSION OF AN INCREASING NUMBER OF COMPLEX ELECTRONIC DEVICES, CAN THE COMMUNICATIONS PROTOCOL DEVELOPED IN THE 1980s – CANBUS – KEEP PACE? WE CHART ITS HISTORY AND ASK IF ETHERNET IS ABOUT TO TAKE OVER

The average industrial vehicle these days is a complex beast. Hundreds of yards of wiring and cables connect a mass of electrical components regulating and controlling everything from how hard you brake, to the fuel display.

For the vehicle to function effectively, these components – known as electronic control units (ECU) – need to be able to communicate with one another.

This interconnectedness can get very specific. For example, on a modern truck, speed data is also transferred to the entertainment systems, so that, when the vehicle speeds up, the stereo automatically increases in volume to compensate for the extra engine noise.

This internal communication is achieved using a system known as a vehicle bus. The first vehicle bus was developed in the early 1980s by General Motors as a way to link up the engine control module with the air-conditioning on Cadillacs.

Since then, a variety of vehicle buses have been developed. But the one that has had the biggest impact on both industrial vehicles and on the automotive sector is CANbus (CAN stands for Control Area Network).

The CANbus system was the brainchild of engineers at the German electronics giant Bosch. Created in the late 1980s, CAN's uniqueness, and the reason, presumably, for its future wide-scale adoption, comes from the fact that it is a protocol.

In other words, it is a set of rules that manufacturers can follow in order to ensure their products will cooperate effectively within a communications network.

This has enabled vehicle makers to use the CAN protocol as a blueprint for their own bespoke vehicle bus systems, says Holger Zeltwanger, managing director of CAN in Automation (CiA), a non-profit industry association that oversees the development and standardization of the CAN protocol.

"CAN is like an alphabet," says Zeltwanger. "It's just a set of characters, nothing more. It provides the tools to express, but


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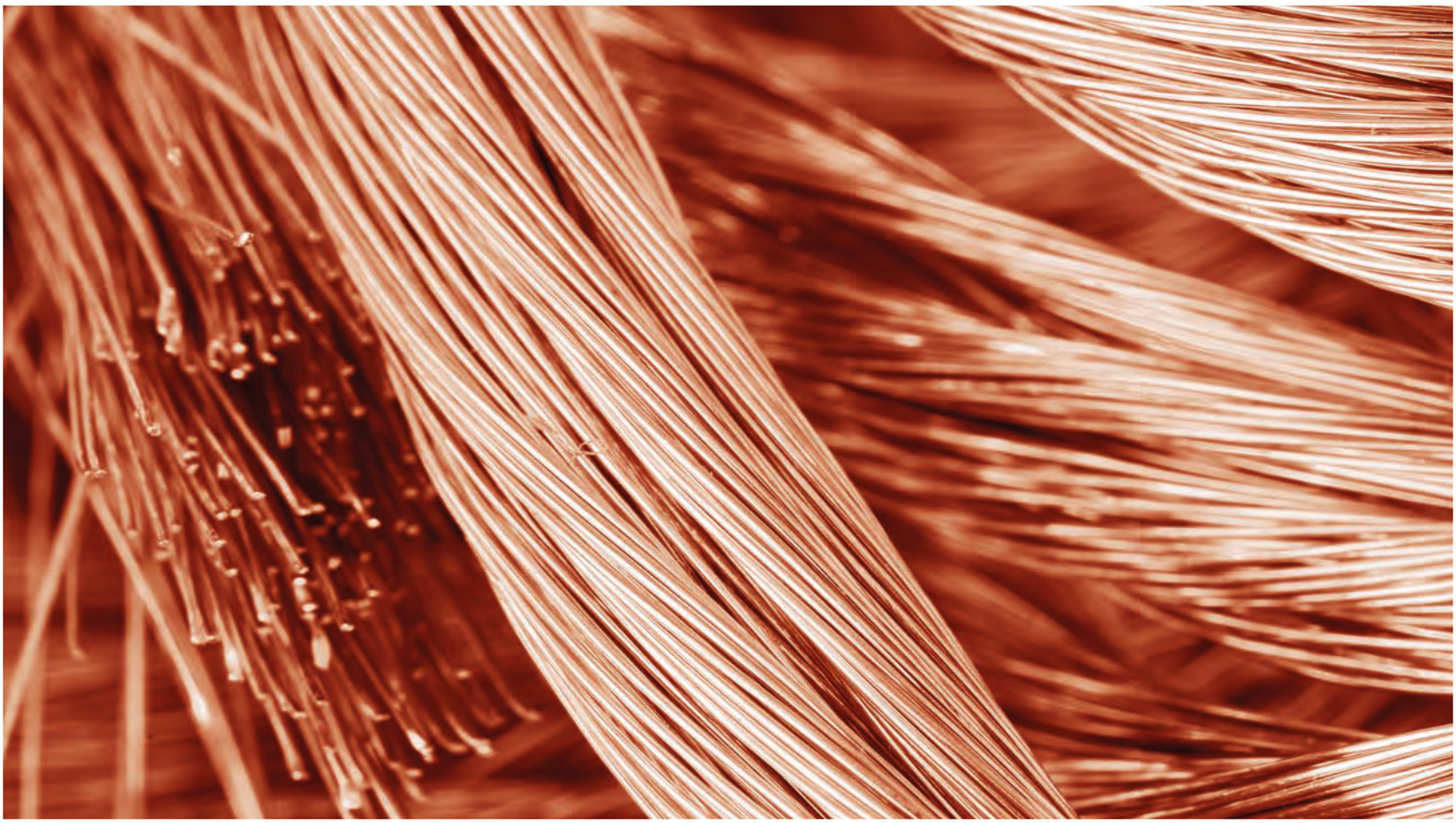


means nothing on its own. The language, so to speak, is created afterwards using the CAN protocol. In the case of car makers, they have their own proprietary systems based on the CAN alphabet."

This is why, for example, an electrical component from a Toyota won't work in a Renault – the two cars' communication networks speak different languages.

Things are different in the case of industrial vehicles. "As the volumes are lower and because there's a much bigger variance in the types of vehicles (a crane compared with a farm machine, for example), manufacturers need to be able to buy parts off-the-shelf and integrate them. Therefore, an open language is needed," says Zeltwanger.

In farming, for instance, the ISObus standard was created using the CANbus protocol to enable interaction between cross-branded farming equipment. ISObus is an open system, but manufacturers have closed the door to the system thanks to proprietary software.

"CAN FD WILL RISE UP TO AN ALMOST UNLIMITED NUMBER OF BITS, SO IT CAN CREATE MUCH HIGHER-SPEED COMMUNICATION"

Holger Zeltwanger, managing director, CAN in Automation

Farm equipment makers like John Deere have created proprietary locks on new software that prevents farmers from downloading the software anywhere except in John Deere dealerships or in authorized repair shops.

Since most of the new equipment requires downloads in order to make repairs, the measures effectively give equipment makers a monopoly on fixing breakdowns. To counter this, US farmers are hacking their own tractors to get around the draconian locks, using firmware cracked in Eastern Europe and traded on invite-only, paid online forums.

"They want to make the customers prisoners," says Zeltwanger. "That's the situation with US farmers right now and we are standing mainly on their side. I'm fighting for standardization so that everyone can use it."

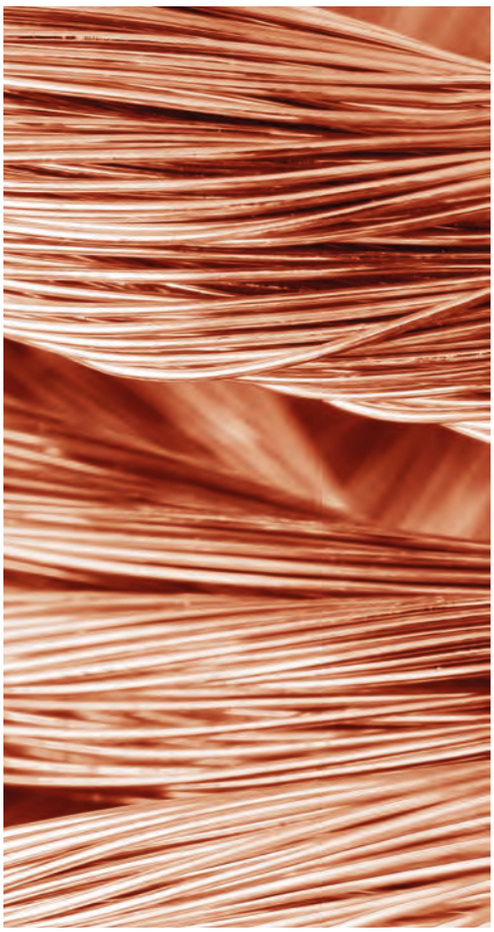
Car owners are no longer hostage in the same way as farmers, however. This is because 20 years ago the car industry was forced to standardize the diagnostic interface on cars.

This means that, even though car makers have gone to great lengths to create their own proprietary vehicle bus systems, the systems need to have a standardized interface anyone can connect to in order to get diagnostic information about the car. This leaves owners free to seek repairs wherever they want.

"The garages and workshops of these car makers are able to access a lot more diagnostic information, but the non-affiliated garages can find out enough to repair the car."

Pressure on the protocol

While CAN has given rise to a number of different vehicle bus systems, the protocol itself has not changed since it was first launched



HOW CAN CAME INTO BEING

When it came onto the market in 1991, two years before the first edition of *iVT* was published, the Mercedes-Benz W140 was the first production vehicle to feature a CAN-based wiring system.

But the real story of how the CANbus protocol came into being goes back much further, and can be traced to a landmark piece of legislation in the USA.

The 1970 Clean Air Act handed the US government the legal authority to crack down on air pollution caused by cars. In a bid to combat rising levels of smog in cities like New York and Los Angeles, the USA began forcing car makers to cut emissions.

Lowering fuel consumption made it harder for car makers to attain the required degree of control in vehicles without

A 1992 Mercedes-Benz 300 SE (W140), the first to use CANbus

the introduction of onboard computing devices. This led to the development of electronic control units (ECUs) in vehicles, which in turn led to the creation of the first vehicle bus systems in the early 1980s.

The CAN protocol came out of these early vehicle bus systems. CAN in Automation (CiA) head Holger Zeltwanger was one of its earliest advocates.

"I have been personally involved since 1992," says Zeltwanger. "I was an editor in those days and writing some articles about CAN. I was fascinated from the first moment and since there was nobody promoting it, I took that job on myself."

Since then, the CiA has grown from its original role as an advocacy group, to also providing arbitration in matters of certification. "We have a standardized test plan," says Zeltwanger. "The manufacturer can validate the product themselves or via a third-party authority."

Practically, there is a single independent test house, CS Group, in the German town of Wolfenbüttel, which does testing for the entire automotive industry. "If there's a dispute over the result of the test, we step in to arbitrate. So, for example, if a car maker thinks that the test house has made a mistake, we get involved."

Photo: Shutterstock

in 1991. However, in the intervening years, the amount of electronics inside a vehicle has grown exponentially.

"In the early days when CAN was developed, there were only about five ECUs in the car. In a modern passenger car today we have more than 100," says Zeltwanger.

To cope with the rising bandwidth that these extra components have created, a new version of CAN has been developed in the past few years. Known as CAN flexible data rate (CAN FD), it was released in 2012 by Bosch, although the first cars to integrate the new protocol won't be on the road till 2020.

"Classic CAN uses just one bit rate," says Zeltwanger. "So you communicate at just one speed. CAN FD can rise up to an almost unlimited number of bits, so it can create much higher-speed communication. The only limit on the speed is the conductivity of the copper wire in the cabling. The speed is therefore slightly less in heavy machinery simply because the cables are longer.

"It also allows for more storage capacity in the CAN frame. While classic CAN can hold 8 bytes of data, CAN FD can hold up to 64."

This storage capacity figure also happens to be the smallest Ethernet frame, which means that gateways can easily be built between CAN FD subsystems and the Ethernet. This is significant since Ethernet is being lined up as the next internal connectivity standard for most vehicle types.

The rise of Ethernet

The advantage of Ethernet is that it can transfer data at much higher bandwidths, meaning reduced connectivity costs and less cabling. This last factor is particularly enticing for car makers, who are in a constant battle to reduce weight to increase fuel efficiency. According to some estimates, switching to Ethernet could reduce wiring weight by around 30% – a drop of up to 45kg (99 lb) in an average passenger car.

But the switch to Ethernet will not mean the end of CAN, says Zeltwanger. Vehicle manufacturers are instead proposing to combine the two systems, with a backbone

MAIN IMAGE: **CANbus architecture requires heavy copper wiring, but Ethernet (above) can help reduce this weight by around 30%**

HOW DOES CAN WORK?

In its simplest terms, the CAN protocol is a model, says Holger Zeltwanger. "All the communication systems developed from CAN should follow this model and they do it well, more or less," he says.

The model describes different layers that function together to create an internal communication system between electrical components in a vehicle. One way to think of the different layers in the system is like envelopes, suggests Zeltwanger.

If you put a letter in an envelope, then send it to a company with its own internal mail system, it will be put inside another envelope as it moves within the company.

This is how communication is achieved within CANbus. The communication is enfolded within different layers as it moves between ECUs. These layers are known as data link layers (DLL), says Zeltwanger.

"The DLL allows for the possibility to communicate between two or more entities. The safeguard for the DLL communication is via the cyclic redundancy check [CRC], whereby a complex calculation is sent through the bus and, if the calculation makes it through uncorrupted, then you know that the communication is uncorrupted too."

"CAN will survive for the next 50 years at least"

Holger Zeltwanger, managing director, CAN in Automation

network based on Ethernet and sub-layered networks based on CAN.

"The backbone network connects the vehicle's main controllers to subcontrollers. The common approach will be to have four or five main controllers interconnected by Ethernet. Layered below that you will have the old technology."

In practice, this will mean that while the vehicle's speed will be overseen by CANbus subcontrollers in the wheels, speed data will be transferred to other parts of the vehicle via an Ethernet backbone.

Besides its increased bandwidth capabilities, the other reason for switching to Ethernet is the growing need for new vehicles to interact with their environment, says Zeltwanger. "If you think of automated systems, then you have to have information from outside of the vehicle, from cameras, satellites and meter sensors. You can't do that with CAN."

CAN will be retained for the sublayered systems – in part, because the hardware associated with Ethernet installation is bespoke and therefore costly. "You have higher bandwidths, so the cables and connectors have to be more strictly designed, whereas with CAN you can use any kind of cabling."

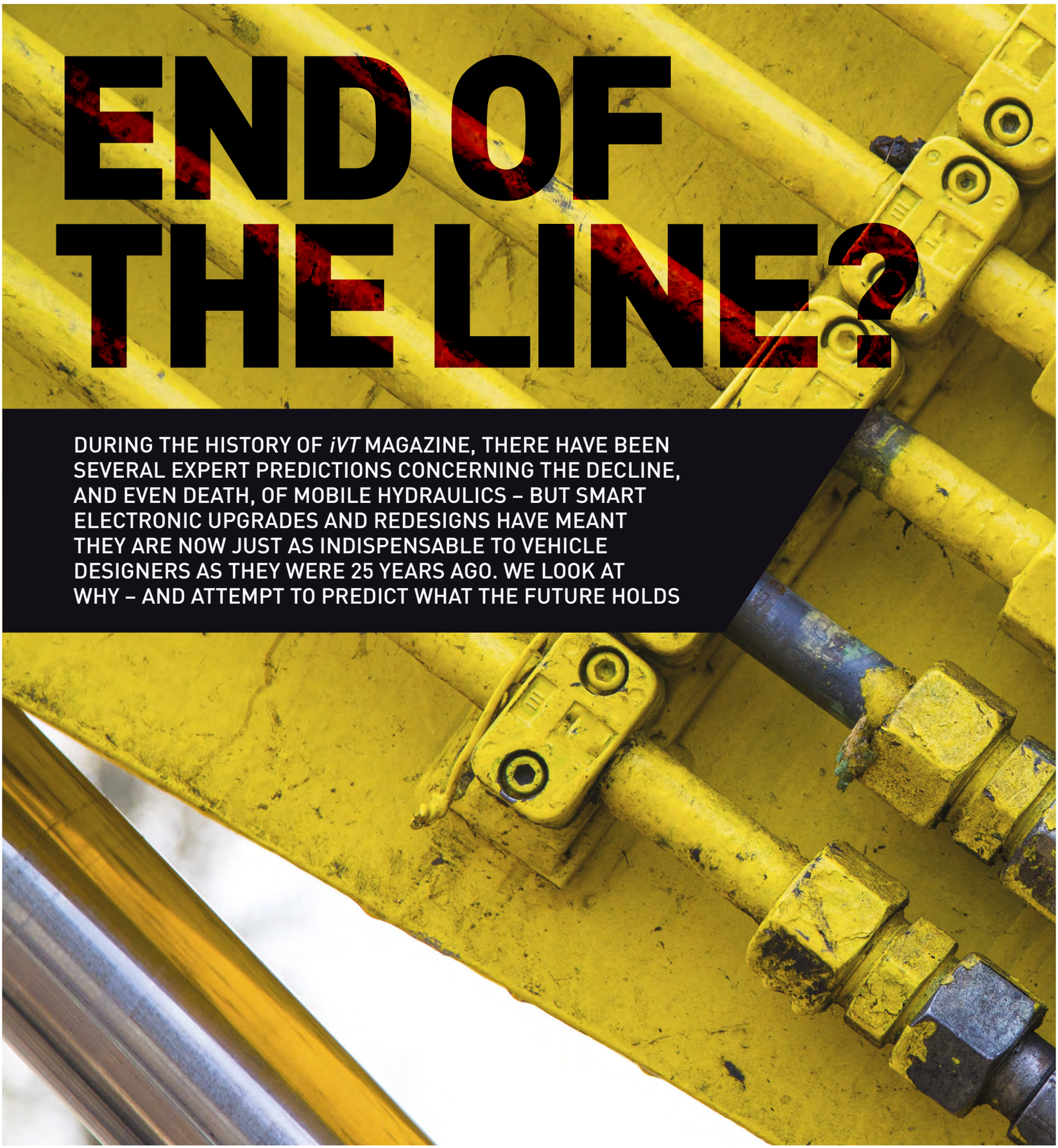
Another reason for keeping CAN is the slow-moving nature of the industries involved. "Car makers are only now starting to integrate CAN FD and they will stay with this technology for a minimum of two car generations before they even think about substituting it. CAN will survive for the next 50 years at least," says Zeltwanger.

"For industrial vehicles, the change could take longer. If you think about farming, it took nearly 20 years for them to adopt the CAN protocols. And even after they made that decision, it took another 15 years to develop the ISObus technology to a point where it could be put on machinery. Farmers are also conservative – they want to use their machinery for a long time.

"We are not in the business of smartphones. This is not a throw-away technology." **iVT**

GERALD SCHEFFELS, IVT INTERNATIONAL

END OF THE LINE?



DURING THE HISTORY OF *iVT* MAGAZINE, THERE HAVE BEEN SEVERAL EXPERT PREDICTIONS CONCERNING THE DECLINE, AND EVEN DEATH, OF MOBILE HYDRAULICS – BUT SMART ELECTRONIC UPGRADES AND REDESIGNS HAVE MEANT THEY ARE NOW JUST AS INDISPENSABLE TO VEHICLE DESIGNERS AS THEY WERE 25 YEARS AGO. WE LOOK AT WHY – AND ATTEMPT TO PREDICT WHAT THE FUTURE HOLDS

A study by market researcher Frost & Sullivan stirred up the European hydraulics industry in autumn 2011. It predicted that in the 2018 to 2020 timeframe the market share of electrical and hydraulic drives would be equal in agricultural machines. And by the 2025 to 2028 time period, the same would happen with construction equipment. The reasons were also given in the study: electrical drive systems would be more precise, control easier, and no risk of leakage. The result? A decline in the use of hydraulic systems, which would have a massive impact on manufacturers in the hydraulics industry.

Power of choice

Everybody in the industry knows that this forecast did not come true. The flexibility, durability and high power density of hydraulics are still unbeatable in mobile applications. In a more recent study (2017), Frost & Sullivan acknowledged this: "In the world of power transmission systems, fluid power systems have remained popular, owing to their high power density and cost advantages compared with electric systems, with hydraulic equipment being the undisputed leader in terms of power density." And further: "An electric system would require larger components to produce a similar force output, increasing the cost and complexity of such systems. This principle has enabled hydraulics to remain the power transmission system of choice among manufacturers of construction equipment, agriculture equipment, and other on-highway and off-highway mobile equipment."

No need to worry? Not quite. Mistake amended, everything okay then for the hydraulics industry? Just another example for the dictum, "It is difficult to make

predictions, especially about the future"? Well, not quite. The authors of the F&S study continue: "However, despite these advantages, concerns about hydraulic system efficiency and hydraulic fluid leakage persist. This has enabled electric equipment to cannibalize sales of hydraulic equipment, particularly in North America and Europe, where the hydraulic equipment market is saturated."

This is indeed true. There were times and applications when the engineers did not see an alternative to installing a hydraulic drive. Now they can choose between different options. This is especially true for the traction drives. An example: while rubber-tired harbor cranes are traditionally equipped with hydraulic drives, Noell has developed a mobile crane with electrical wheel drives (made by Oswald).

Electric replaces hydraulic?

There are many other examples for the trend of migration away from hydraulic toward electric solutions. For instance, JCB has just introduced its first-ever electric digger. The 1.9-metric-ton mini-excavator has an electric motor and three advanced lithium-ion battery packs, to deliver a full energy capacity of 15kWh. It can be charged by simply plugging it into a standard 230V domestic electricity supply. Once fully charged, it is ready to put in a full normal working day on the building site – digging with the same speed and power as its diesel counterpart. Super-fast charging will also be available at launch, slashing the charging time in half.

The19C-1 E-Tec mini-digger goes on sale at the end of year. According to JCB, its development was driven by customer demand for a zero emission machine that can work indoors, underground, and close to people in urban areas.

In a slightly bigger excavator class, there is Mecalac's e12, which was derived from the diesel-driven 12 MTX. Its 85kW combustion machine was replaced by electrical motors – and, of course, a large battery back. The engineers opted for lithium iron phosphate ($LiFePO_4$) to ensure a compact envelope of this articulated excavator. The $1m^3$ of batteries fit nicely under the hood. Mecalac claims that the energy storage system is sufficient for a complete working shift and expects to go on sale with the machine next year.

See *iVT*, March 2018, p28

See *iVT*, September 2017, p30

TOP: **Mecalac's e12 was on show to the public for the first time at Intermat Paris**

ABOVE: **John Deere's battery-packed SESAM**

BELOW: **JCB's first-ever electric excavator**

See page 48 of this issue

There is more to come

These two machines might set the foundation for a new generation of construction equipment with electrical instead of diesel drives, making do without hydrodynamic or hydrostatic drivetrains. Similar trends can be seen in agricultural equipment. There has been, for instance, a prototype of the massive Rigitrac tractor with four single-wheel electrical drives, and there is the SESAM from John Deere: an all-electric tractor. The abbreviation means 'sustainable energy supply for agricultural machines' and gives a hint that the farmers may use the energy they generate themselves (i.e. by biomass, solar or wind powerplants) to drive the tractor. Energy is supplied by two motors with more than 400 horsepower, which are coupled by a DirectDrive gearbox. In standard mode, one motor drives

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the axles and the other the working functions. If necessary, both motors can operate either the driving or the working functions, supplying plenty of power.

Working functions

So far, so good – or so bad, seen from the perspective of hydraulics. But taking a closer look at the machines described here, the spectator quickly notices that they may have an electric traction drive, but the working functions are still hydraulic. In applications such as lifting, towing, excavating and farming, the well-known advantages of power density and flexibility seem to be – for the moment – still unbeatable.

There are a few expectations, though. One is the electrification of the power take-off (PTO), which is identified by research company KGP as a key short-term trend in the agricultural industry (see *iVT* March 2018, p36). And there is Volvo's EX2: the prototype of a compact excavator which is really fully electrical – without any hydraulic component. The hydraulic architecture has been replaced with electric architecture, which incorporates electromechanical linear actuators that ensure quick signal feedback.

A fully electrical excavator

The Volvo engineers replaced the combustion engine with two lithium-ion batteries, totaling 38kWh, which store enough electric energy to operate the machine for eight hours in an intense application, such as digging compact ground.

At first, the advantages of this machine as claimed by Volvo sound fantastic: zero emissions, 10 times higher efficiency, 10 times lower noise levels and reduced total cost of ownership, compared with its conventional counterparts. Whether this will be the case, however, has yet to be proved. According to Volvo, the EX2 is purely a research project and there are currently no plans for industrialization. It stems from the company's earlier ELEXC research project, which was partly financed by the French government, as well as various other funding bodies in France. This project started in 2012 and concluded in 2015. Since then, Volvo CE has been working on other research projects connected to the EX2, such as durability tests.

This indicates, at least, that it is not easy to design a drive system for, say, the boom of an excavator without hydraulics. But this is exactly the aim of Volvo. Ahcène Nedjimi, electrics and electronics systems lead engineer and EX2 project leader, says, "The electrification of construction equipment will produce cleaner, quieter and more efficient machines – this represents the future of our industry."

The prototype machine, according to Volvo, delivers the same power and force as its conventional counterpart, as well as faster speeds in combined

"THE ELECTRIFICATION OF CONSTRUCTION EQUIPMENT WILL PRODUCE CLEANER, QUIETER AND MORE EFFICIENT MACHINES – THIS REPRESENTS THE FUTURE OF OUR INDUSTRY"

Ahcène Nedjimi, electrics and electronics systems lead engineer and EX2 project leader, Volvo

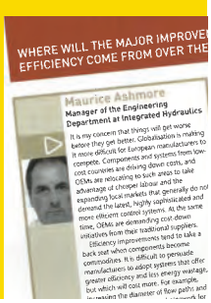
ABOVE: **Volvo's EX2 is one of the few electric prototypes to get rid of traditional hydraulics completely**

A DECADE IN THE HYDRAULICS INDUSTRY

It was 10 years ago, in our February/March 2008 issue, that Maurice Ashmore, manager of the engineering department at Integrated Hydraulics, offered *iVT* his predictions for what would happen in the hydraulics industry over the ensuing decade.

At the time, he said, "It is my concern that things will get worse before they get better. Globalization will make it more difficult for European manufacturers to compete. Components and systems from low-cost countries will drive down costs, and OEMs will relocate to such areas to take advantage of cheap labor and the expanding local markets that generally do not demand the latest, highly sophisticated and more efficient control systems. It is difficult to persuade manufacturers to adopt systems that offer greater efficiency and less energy wastage, but which will cost more."

A decade on, some of what Ashmore predicted has come true. But while cheaper hydraulic components are now available, there is still a need for high-quality from established brands. And OEMs are discovering that developing markets are beginning to demand more advanced vehicles.



RIGHT: **STW's SymonE battery-operated test vehicle, which among other things is used for the testing of electrified attachments**

THE FUTURE OF HYDRAULICS **IS SMART**

Making mobile hydraulics smarter by combining them with electronics and vehicle control systems is increasingly popular. Bosch Rexroth has demonstrated this with a new generation of controllers for mobile working machines, developed jointly with Bosch.

The new controllers with advanced multicore processors combine proven features, such as free programmability, with a new hardware architecture, a multitude of interfaces (including ISObus), and a future-proof software concept. Developed to meet more demanding system requirements, Bosch Rexroth is also creating sensors with a SENT interface, which in addition to all measured values, also transmit condition data to the controller.

IoT valve blocks

The growing smartness of hydraulics can also be seen in Bosch Rexroth's new network-capable valve block, EDG, which can 'translate' IT commands into specific movement sequences, ideal for forklift trucks and other warehouse equipment that can communicate directly with warehouse management IT.

The electrohydraulic valve block offers a load-sensing pressure limitation. IT systems use sensors to detect the goods being transported and their respective handling instructions. These specifications are sent via gateways to the electronic Rexroth control unit from the BODAS family, which translates these specifications into setpoints for the EDG valve block. The support function offered by IT thus has a direct influence on the implement hydraulics' power, acceleration and other parameters, providing relief to the driver.

Hitch hiking

A third example is Bosch Rexroth's EHC-8 system solution for tractors in emerging markets. This electrohydraulic hitch control meets the needs of emerging markets with tractors from 30kW upward. It improves soil cultivation as the basis for higher crop yields and increases driver safety.

The components are adapted to the climatic conditions of tropical and subtropical regions such as India, Southeast Asia, Africa and South America. Every single electronic device can cause severe problems in these areas because of high temperature and moist ambient air. The ECH-8 provides a solution that is easy to use, resistant to heat and moisture, and creates an important pre-condition for better yield – with a minimum of electrical and electronic components. The system is even monsoon-proof and was derived from a hitch control for higher performance classes.

movements. But the users in construction business will have to wait for a machine like this.

Electronics boost

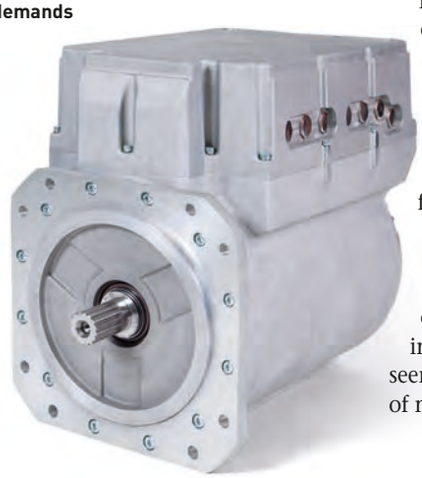
These examples show a trend that is more evolutionary than revolutionary. By combining hydraulics and electronics in the first step, and creating connections to higher IT control and management systems, hydraulics are becoming smart – if not intelligent. They can communicate with, for example, warehouse management systems or agricultural GPS and crop management systems. And they can be integrated into predictive maintenance and other IoT systems. In this way, the strength of traditional hydraulics is linked with the intelligence of electronics.

ABOVE: **STW's TCG data modules enable smart comms**

On April 18, HAWE Hydraulik and STW Sensor-Technik Wiedemann announced plans for a partnership to create integrated mechatronic control solutions for mobile machines. Together, the two firms – one an expert in mobile hydraulics, the other in electronic control systems for mobile applications – aim to implement complete systems, from hydraulics to automation and cloud-based concepts.

Based on an intelligent design equipment, the engineers of the two partners can address joint developments in order to generate systematic added value for the customer. Thus, topics such as energy efficiency, functional safety, automation, predictive maintenance and other digital or data-based functionalities can be tackled quickly and comprehensively in the future. And this, it seems, is the (near) future of mobile hydraulics. **iVT**

BELOW: **Surplus energy from STW's hybrid drive system PowerMELA can be saved to a battery and used later for other vehicle demands**



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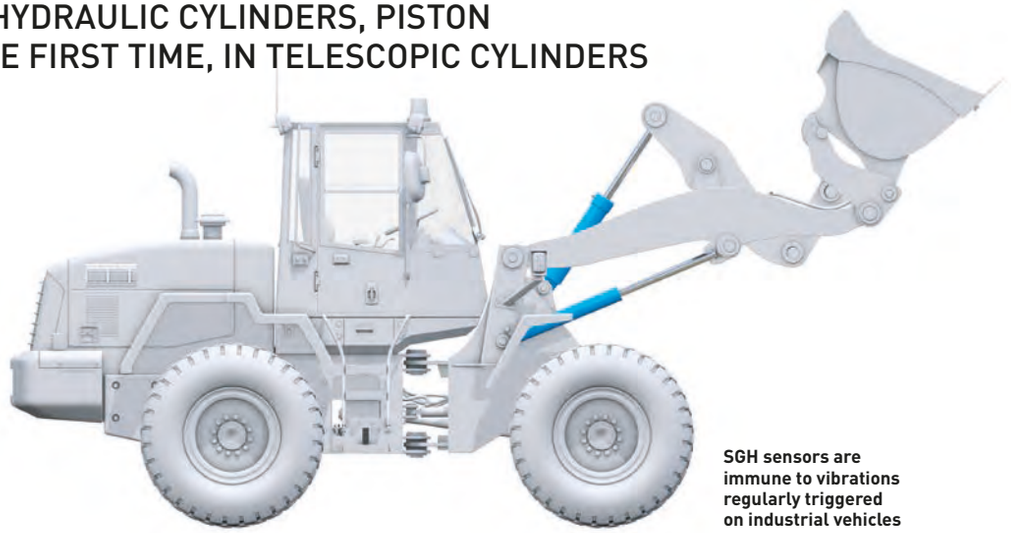
MATHIAS ROTH

Down to the wire

INNOVATIVE, NEW WIRE-ACTUATED ENCODERS ENABLE VARIABLE POSITION MEASUREMENT IN HYDRAULIC CYLINDERS, PISTON ACCUMULATORS AND, FOR THE FIRST TIME, IN TELESCOPIC CYLINDERS

With its new wire-actuated encoders, SGH25 and SGH50, Siko has expanded the measuring spectrum of the SGH series, which can now measure lengths ranging from 0-5m (16.4ft). This is made possible by an innovative, cable-based, functional design concept that fully integrates sensors, electronics and mechanics into the cylinder. The compact design is also suitable for large cylinder strokes found in hydraulic and telescopic cylinders of construction machinery, agricultural machinery or commercial vehicles. The sensors fulfill the requirement that the cylinder length should ideally not increase when a sensor is installed.

While the SGH10 wire-actuated encoder covers 0-1m (3.3ft), the SGH25 and SGH50 now extend to larger ranges. The SGH25 is suitable for medium stroke paths (measurement length 0-2.5m (8.2ft)), while the SGH50 covers stroke lengths of 0-5m. In order to meet OEM requirements for a cylinder design with as little change as possible after sensor integration, the larger drums, on which the cable is wound, have been tilted 90° on the SGH25 and SGH50, so that the installation length of the sensors is identical to the smaller SGH10, despite the different measuring lengths.



SGH sensors are immune to vibrations regularly triggered on industrial vehicles

Unique sensor technology

With the SGH sensors, which are 100% Siko developed, the company has a unique sensor technology that can even be used in piston accumulators and in telescopic cylinders (a global first). Their compact design can be completely integrated into a cylinder. This unique selling point is accompanied by a number of other advantages.

The intelligent SGH technology follows an innovative and functional design concept. Instead of using a rod-based measuring principle, SGH sensors are based on a flexible wire-actuator mechanism. If the cylinder is extended, the cable, which is wound up on a cable drum, is pulled out. The rotation of the cable drum thereby created is detected without contact by the sensor electronics and used to calculate the linear travel. This makes it possible to detect the position and speed of the cylinder precisely and completely at all times.

Contactless electronic scanning

The magnets used to detect the rotation are scanned by the electronics without contact through the pressure-resistant base plate of the SGH sensors. The electronics are fully encapsulated on the unpressurized side of the system. This means that the entire measuring system is built into the cylinder and is thus optimally protected from external environmental conditions. A clear advantage is that in contrast to a measuring system mounted externally on the cylinder, the sensor system cannot be damaged or negatively influenced or even destroyed by environmental influences.

Side attachment for special applications

The cable-based concept enables solutions that were previously unthinkable. Forklift truck designs, for example, may not exceed specified vehicle heights, but nevertheless should have the largest possible stroke. Siko meets these demanding requirements by intelligently delocalizing the SGH sensor in a housing laterally mounted at a 90° angle to the cylinder. As a result, the SGH sensors can measure 'around the curve' and be integrated into almost any cylinder.

Due to the unique lateral installation, SGH sensors can also be used in almost insoluble applications, including in applications with zero stroke loss

The SGH50 can be used in telescopic cylinders

tolerance, extremely small piston diameters or cylinders with mechanical cushioning.

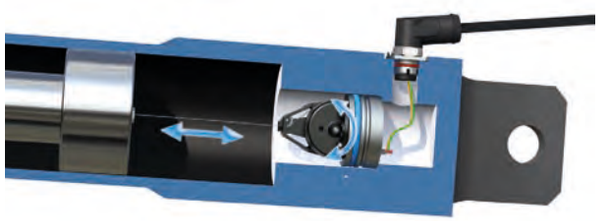
External environmental factors also include shocks or vibrations that regularly occur with excavators or dump trucks, for example. If an excavator bucket collides with hard ground, or the loading area of a dump truck locks in, these abrupt movements trigger vibrations. All SGH sensors are immune to them because the cable absorbs shocks and the entire SGH system can also use the hydraulic medium as a shock absorber.

SGH sensors are robust and resistant. In order to consistently maintain this level of quality, Siko attaches great importance to carrying out the product-specific trim of all mechanical and electronic sensor components itself and therefore designs power ratios, spring characteristics or drum speed itself. In addition, a special housing plastic has been developed for the SGH sensors, which achieves top performance even under the most extreme conditions and protects the entire system. One of these quality assurance measures is that SGH sensors are designed and tested for the service life of a cylinder. Thus, the SGH wire-actuated sensors fulfill the quality requirements of renowned cylinder manufacturers and OEMs.

Goodbye to piston drilling!

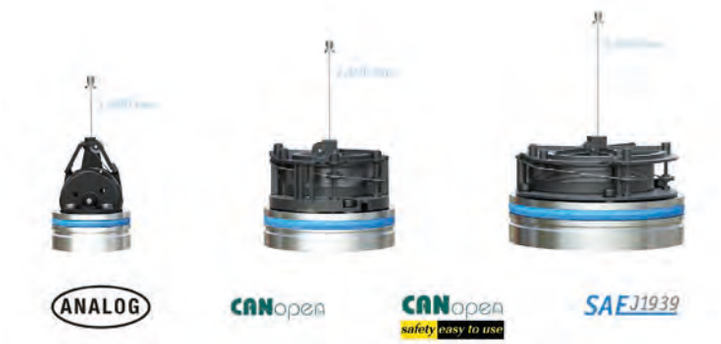
The innovative, cable-based design and functional concept of SGH technology ensure a big reduction in system integration costs. Comparing SGH sensors with the construction of magnetorestrictive sensors, it becomes clear: for the use of magnetorestrictive sensors, which requires a different length of the sensor rod for each cylinder corresponding exactly to the measuring length, a hole of at least that same length must be drilled in the piston. This hole is not required for SGH technology.

Ultimately, the elimination of this manufacturing step has a positive effect on the cylinder costs, as production times are shortened and the costs for piston drilling and assembly of the position magnet are removed. With SGH sensors there is instead just the cable, which is fixed by a small thread on the piston head. Thus the SGH50, for example, with a maximum stroke of 5m, offers the maximum potential for savings. A hollow bore required in rod-based sensors generally affects the structure and stability of the piston and thus the function of the entire cylinder. With SGH technology, cylinder manufacturers do not experience this problem.



The cable drum rotates via the cable pullout, making it possible to measure the distance

Lateral attachment is also feasible in case of design-related requirements



Learning and communicating

Where SGH sensors really show their strengths is in terms of variant diversity. The practical teach-in function is a valuable tool. It is standard in all SGH versions and offers a high level of functional and operating convenience.

An SGH sensor can be programmed for any measuring length. Within the measuring range of 0-1m, 0-2.5m or 0-5m, this intelligent function maps all lengths with a single SGH sensor and thus significantly reduces the number of variations for the cylinder manufacturer.

To ensure the transmission of position information to machine controllers of as broad as possible a range of machines, SGH sensors are characterized by a high variety of interfaces. Thus, the SGH technology can either be obtained with an analog interface for measured value transmission, or alternatively with the digital interfaces CANopen or SAE J1939. Even safety-critical applications can be operated with CAT3 or PLd-compliant versions (according to EN 13849) and redundant analog interfaces, redundant CANopen, redundant SAE J1939 or CANopen Safety.

Due to the complete SGH system integration in the cylinder, SGH sensors provide maximum protection against environmental influences such as dirt, dust and water. Protection class IP69K guarantees this. That's why the SGH position sensors are equipped with IP69K-compliant KV1H connector systems. The modular nature of the universally applied KV1H connections reduces effort and costs in manufacturing, service, design and logistics, as the KV1H connector system is extendable. Thus, the sensor always remains the same for different cable lengths or connection types.

A complete solution

Overall, the use of this variable function and design principle contributes considerably to minimizing the number of variations, as SGH sensors cover entire measuring ranges and do not require a separate sensor-per-measurement-length as is the case with conventional sensor solutions. Therefore, for cylinder manufacturers, the use of SGH technology optimizes both the entire development and production process, as well as downstream services such as logistics, with huge flexibility. **iVT**

Mathias Roth is mobile automation sector manager at Siko

MARTIN RIEDL

Human-machine interaction

MULTIMODAL HUMAN-MACHINE INTERFACES ARE READJUSTING NOTIONS OF WHAT IS POSSIBLE FOR OPERATORS IN THE WAY INDUSTRIAL VEHICLES ARE CONTROLLED

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

Today's complex user interfaces feature state-of-the-art graphics and 3D content. In some cases, subject to environmental conditions and ease of use, buttons and levers are replaced by touchscreens with multiple sophisticated functions. The rapid growth of technologies such as voice recognition and natural language understanding, gesture control, gaze detection and augmented reality are also likely to make an impact on the industrial vehicle sector. The potential to integrate such new technologies into the vehicle presents interesting scenarios for vehicle operation and driver optimizations, and in such an environment a multimodal HMI becomes highly beneficial.

A different way to interact

A multimodal HMI provides the user with different ways to interact with and control a machine. The user has the freedom to choose the method he or she prefers, according to the situation, differentiating between input and output (e.g. both hands on joysticks while issuing voice commands and directions or even using a combination of voice and gesture). Ideally there are no constraints; the user is free to select the mode that's best for the current situation. This results in natural, intuitive interaction between the user and the vehicle.

ABOVE: **HMI graphics are now high resolution**
BELOW: **EB GUIDE is reliable and easy to use**

Current modalities that are in use are hard keys (i.e. function keys + cursor keys), rotary input and touch displays. However, in some environments touch might be a challenge and this is where additional modalities such as voice control (in combination with touch) can come into play.

Other modalities such as gaze detection, gesture and augmented reality are still nascent. For example, the use of virtual reality glasses during operation still has a long way to go but it can be used to detect errors or during vehicle repairs. Similarly a head-up display could be used to visualize information such as an electronic fence during 2D/3D grade control.

Reliable, customizable and easy to use

Elektrobit's EB graphics user interface development environment (GUIDE) GUIDE 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 graphical and voice user interface, as well as touch and gesture operations. It supports various development phases – executable specification, modeling, rapid prototyping, simulation and target deployment. Its scalability and portability allows users to build compelling HMIs.

EB GUIDE allows developers to create and simulate a multimodal HMI in a desktop environment and later deploy this model with identical look and feel in the target. EB GUIDEmakes 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.

Download and try the Community Edition of EB GUIDE from the Elektrobit website to see how easy it is to develop a rich HMI. All the features, except the voice HMI, are available and the products can be tested for as long as is required. **iVT**

Martin Riedl is product manager for EB GUIDE at Elektrobit Automotive

EMILY COLDERWOOD

Advanced wheel loader tech

A RANGE OF SPECIALIST TRANSMISSION AND HYDRAULICS PRODUCTS FOR BOTH COMPACT AND LARGE INDUSTRIAL VEHICLES IS BEING LAUNCHED TO MARKET

Back in 1968, Kawasaki's Precision Machinery division entered the world of hydraulics and construction. This year is the division's 50th anniversary – half a century since it began supplying industry-leading systems and machinery. Marking the milestone, Kawasaki has launched a specialist series of products for the transmission and working hydraulics of compact and large wheel loaders.

The K8V pump, M7V motor and KC-FS electronic controller provide best-in-class efficiency and controllability, combined with low noise levels, creating a quietly brilliant solution for hydrostatic transmissions.

Opening up closed circuits

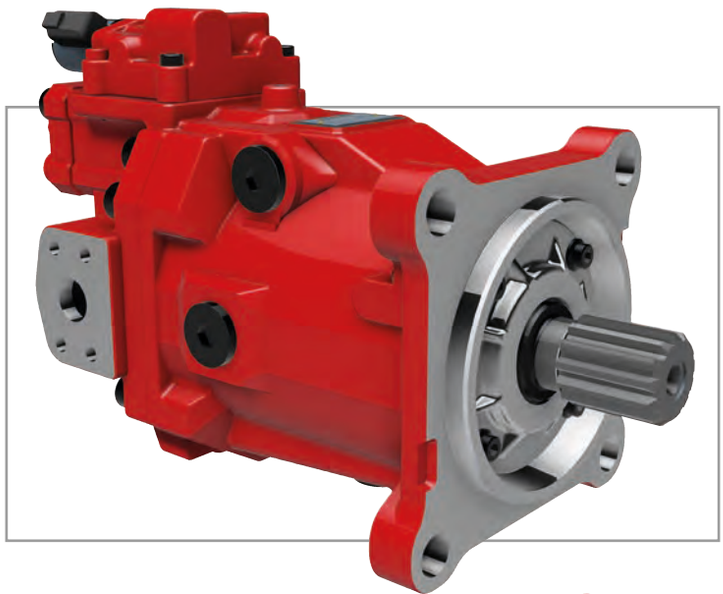
The K8V swash plate axial piston pump opens up the potential of closed-circuit applications. Available in displacements of 71, 90 and 125cc/rev, the pump has a continuous 420 bar pressure rating. This adds up to high efficiency across the entire operating range, precise flow control, low noise and a long service life.

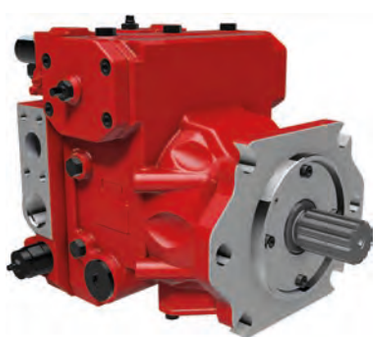
After years spent developing swash plate motors for construction machinery, Kawasaki has cultivated extensive expertise in low-speed performance. This has resulted in the M7V series of variable displacement swash plate axial piston motors – available in 85, 112 and 160cc/rev. With specially designed rotary components, the motor balances high-speed operation with smooth low-speed operation, while producing little operating noise.

Bringing the system together is the KC-FS controller. Automatically adjusting the component control to match the operating conditions, the controller gets more from the machinery, and from the fuel. It is certified to the functional SIL II safety level, meets relevant ISO and ISE standards, and works seamlessly with the K8V and M7V, getting the best performance from the whole system.

Kawasaki has also boosted performance and efficiency in larger wheel loader applications. The KLW series of post-compensated load-sensing control valves offers both low hysteresis and excellent pressure-drop characteristics.

The monobloc design features a spool for boom and a spool for bucket, with the ability to add two more sections for optional services. It features flow-sharing technology, and hydraulic and electrohydraulic control, as well as a 400 bar pressure rating, and a flow rate reaching 450 l/min.





LEFT: **The M7V motor, which is available in 85, 112 and 160cc/rev**

BELOW LEFT: **The low-noise K8V pump, available in displacements of 71, 90 and 125cc/rev**

BELOW RIGHT: **A KLW post-compensated load-sensing control valve**

The KLW also comes with the following wheel loader features: regeneration, for highest efficiency and lowest energy waste; lock valve, to cut down on boom drift; and ride control valve, offering better performance and eliminating external piping required by other products. And to offer a more comprehensive solution, the valve can be easily combined with Kawasaki's new K3VLS series axial piston pump.

With a rotary group designed by engineers at the Kawasaki Technical Institute in Akashi, Japan, the K3VLS swash plate pump builds on the brand's heritage of efficiency and usability. Available in 50, 65, 85, 105, 125 and 150cc/rev displacements, it comes with a range of control options: conventional load sense, torque limiting – with and without power shift, and electric displacement control.

Delivering the highest levels of efficiency and the lowest possible noise, the pump offers the operator both peace of mind and a peaceful working environment. **iVT**

Emily Colderwood is marketing and promotions officer for Kawasaki Precision Machinery, UK

A smart connection

BUILDING A QUICK-DISCONNECT HYDRAULIC COUPLER INTO A VEHICLE DESIGN HAS FAR-REACHING BENEFITS, INCLUDING IMPROVED PRODUCTIVITY AND EASIER TRANSPORT FOR LARGE MACHINES

ABOVE: **The A series is a carbon steel quick disconnect flat face**

RIGHT: **The APM range is designed for outdoor applications**

RIGHT: **The screw-to-connect VEP series can withstand high-pressure conditions**

A quick-disconnect hydraulic coupler may look like a simple and trivial product in a complex machine, but don't be fooled – it can lead to tremendous benefits if correctly selected and integrated into a design. Stucchi solutions can enhance quick hydraulic connections by optimizing designs to working specifications.

Even as the design of equipment and hydraulic circuits becomes more complex over time, the question of hydraulic connection is still widely overlooked. Indeed, a quick disconnect is often regarded as a simple device that doesn't require much attention and can easily be defined at the end of the design process. However, this approach often results in a series of issues to troubleshoot or in poor optimization of the equipment value. Frustrations that can be avoided by considering the quick disconnect early in the decision-making process and selecting the one most suitable to your needs.

From hard plumbing to quick disconnect

The first question that designers may want to consider is: "Do I really need a quick disconnect?" The reason being is that it is not unusual to see complex machines using only hard plumbing solutions in place of other potential options.

There are two main cases where one would definitively want to use a quick disconnect. The first is with hydraulic power tool attachments, when the tools need to be changed quickly and efficiently. Let's take the example of a wheel loader or an excavator: instead of losing time by tediously switching the hard plumbing of every single line each time you want to set up another tool (with the added 'bonus' of getting oil everywhere) you could use quick disconnects that would allow you to do the same job in an easier, cleaner and safer way. We estimate that a switch from hard plumbing to a quick-disconnect solution can save several minutes per connection/disconnection. Multiply that by the number of lines and connections required, and the clear gains become readily apparent. The precious time saved can then be used to focus on the job itself and thus increase productivity. More work done and less downtime: what's not to like?

Another recommended use of the quick disconnect is for modular assemblies, when large equipment needs to be disassembled for transport or storage. Similar to a tool change on an excavator, you probably wouldn't want to spend too much time setting up your equipment and would rather save it to focus on the job at hand.

One step further

Your equipment may already use quick disconnect couplings, but are you sure that they are the most suitable ones for your application?

In some cases the choice is driven by industry standards that have likely been defined at a time when the technologies available were totally different. For example, lots of equipment still uses poppet quick disconnects. Even if they are simple and quick to operate, these connectors can be easily contaminated and involve a significant spillage during each connection/disconnection. Fortunately these design limitations have been corrected with a new generation of products called flat face couplings.

These couplings present the major advantage of having no recessing on their mating face, meaning a spillage of oil close to zero for each connection/disconnection, an easy-to-clean design, and an optimized protection against contamination. Thus the lifetime of the product and the hydraulic components are extended with a cleaner circuit.

Switching to flat face is an investment that may cost the price of an upgrade up front, but will certainly pay for itself by saving money on spare parts, decreasing downtime and increasing productivity. Stucchi, whose profile inspired the ISO 16028 standard, offers a large choice of flat face couplings in different configurations, seal options and materials.

Stucchi goes a step further by providing answers to connect-under-pressure challenges. From push-to-connect ISO 16028 to screw-to-connect, these solutions will improve your equipment's value by making it easier, quicker and safer to operate. **iVT**

CHRISTIAN HOWE

Ringing the changes

SUPPLIERS TO OFF-HIGHWAY OEMS HAVE HAD TO BE ADAPTABLE IN AN INDUSTRY MARKED BY CONSTANTLY CHANGING REQUIREMENTS AND REGULATIONS

Curtiss-Wright's Industrial Group researches, designs and manufactures electronic throttle and joystick controls, human-machine interface (HMI) consoles, sensors, transmission shifters, hydraulic levers and power management electronics for on- and off-highway vehicles, including specialty construction vehicles. The company's portfolio of products is designed to work within the most challenging of environments, while maintaining an operating feel that is ergonomic and effortless.

The globalization of supply chains, rising labor costs and continuous improvements in operator health and safety have driven OEMs to design and develop highly efficient, flexible and safety-critical vehicles, including a vast array of trucks, machinery and equipment that increase productivity.

OEMs are now replacing multiple hydraulic levers and discrete components with electronic HMIs that integrate fully into armrest assemblies and provide operators with a wide range of new capabilities. And for many on- and off-highway applications, Curtiss-Wright's brands of Penny & Giles, PG Drives Technology, Arens Controls and Williams Controls are developing vehicle controls that incorporate multiple functions and can be operated with just one hand, or via finger or thumb activation. These controls typically incorporate push button switches, rotary thumbwheels, and joystick paddles and levers, which variously offer switched and proportional control of a vehicle's numerous features.

There have also been many trends and customer requirements that have affected Curtiss-Wright's approach to design and manufacturing. Rapid-design techniques have played an important role in reducing the cost of design, with much less time and therefore money devoted to prototyping. With respect to manufacturing, thanks to improved technology and CANbus wiring systems, component counts – and subsequently the materials used – have reduced, all of which has contributed to a cost-effective design and had a positive impact on reliability.

Curtiss-Wright's latest innovation – from its brand family of Penny & Giles – is the VTS2000, a dual-axis, vibration-tolerant tilt sensor offering an optimal combination of performance, safety and cost for dynamic, industrial vehicle applications.

ABOVE: **Penny & Giles' JC1600 electronic joystick**

RIGHT: **The vibration-tolerant VTS2000 tilt sensor**

The VTS2000 tilt sensor uses the latest inertial measurement unit technology and fast-acting software algorithms to filter out disturbances caused by vibration and vehicle motion. This provides output stability without the measurement delays usually associated with heavily damped, traditional sensing methods.

Each measurement axis of the VTS2000 has two sensing elements, which are constantly compared to ensure correct operation. If an error is detected, its condition is communicated to the host electronics to ensure a safe operating situation is assumed. Additionally, each output signal is calibrated to account for thermal drift, ensuring accuracy over the operating temperature range.

Powered from a voltage supply range of 6-48V DC, the sensor feeds output data over CANbus using the SAE J1939 protocol with a choice of baud and frame rates.

The IP67-sealed design offers exceptional levels of performance with respect to water, dust, shock, vibration and temperature, making the sensor ideal for use in hostile, on- and off-highway vehicle environments. Electrical connection is via an integrated four-pin Deutsch DT04 connector.

Another recent innovation from the Penny & Giles brand is the JC1600 electronic joystick which, as a CANbus version of its popular JC1500, makes the new, single-axis model an attractive option for OEMs of the latest heavy-duty, specialist off-highway vehicles, where strength and reliability, while maintaining smooth proportional control, is essential.

The JC1600 joystick utilizes contactless, Hall-effect rotary position sensor technology to provide reliable and accurate output signals via its CAN J1939 interface and an impressive lifespan of more than five million operating cycles.

Featuring a four-pin Deutsch DT04 connector as standard, the JC1600 is available with a range of joystick grips and handles, and features a rugged, low-profile design with 55mm (2.2in) under-panel depth and nominal 30° mechanical angle in each direction of lever travel. **iVT**

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

CLAUDIO TALAMO

Style and substance

WHEN CHOOSING MACHINE CONTROLS, ERGONOMICS ARE AS IMPORTANT AS STYLE TO PROFESSIONAL VEHICLE OPERATORS

The working environment, and ergonomics in particular, has been on the agenda for forestry machine manufacturers for decades, with a boost in the 1970s when new laws were introduced for workplaces, to keep employees healthy. Forestry is one industry where the number of fatal accidents is high, so the need to find safe technical solutions has been a strong motivator.

In 1992 Caldaro invented a joystick with a revolutionary, ergonomic design for forestry machines. Since then the company has continued to focus on ergonomics, as well as the working environment, more generally.

What are the most important things to consider when you work with ergonomics and machines? Fredrik Lundin, technical sales at Caldaro, says, "The old philosophy was to aim for a grip that was optimized to be held in one special way and still be able to reach all the functions. That possibly worked for a while, but one grip can never fit all operators. Today, we look more for solutions that improve the way the operator holds the grip."

The trend is to reduce maneuvering force. Less force is needed today, and it takes only small movements to steer a machine. In fact, many operators can perform incredibly precise operations using just two fingers with Caldaro's C15 mini joystick or the heavy-duty C14 joystick.

"Considering that forestry machines are costly, complex and used for many hours a day, the demands are very high," explains Petter Löfgren, technical manager at Caldaro. "Even aesthetics are becoming more important. Operators spend their whole working day in the cab, so of course they want to be proud of their equipment!"

It is not only a matter of the functions and precision; the feel of the joystick itself is important as well. For example, the Viper grip series is double molded to get a soft and flexible surface with superior comfort and safety.

RIGHT: **The heavy-duty C14 joystick offers incredible precision**
LEFT: **Ergonomics are crucial to the design of Caldaro's joysticks**

"Our joysticks are made for professionals," says Löfgren. "Pro operators don't look at the buttons while they work, so they don't need colored buttons. That's why our buttons are more elegant, and available in just one color as standard – although it's always possible to add colored buttons when a customer requests them."

Another critical factor is durability. Forestry machines carry out numerous operations every day, so to deliver high-quality joysticks it is necessary to guarantee that the feeling of perfection withstands rough, daily use for years.

"We provide the very highest quality and durability, and have accumulated much knowledge over the years," says Löfgren. "Sometimes ergonomic demands and the number of desired functions are not compatible, so we have to use our experience to give the appropriate advice to our customers." **iVT**

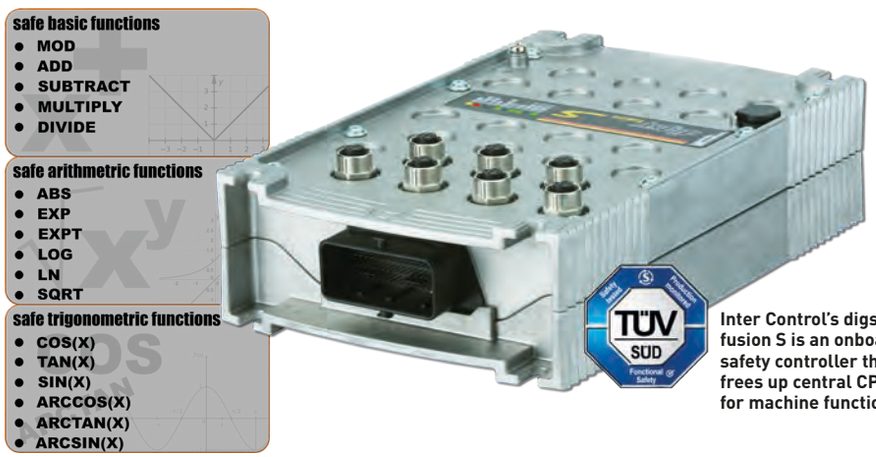
Claudio Talamo is CEO at Caldaro AB

ALEXANDER HOLLER

Smart, safe machines

AS MACHINES BECOME MORE COMPLEX, CONSTANTLY MONITORING SAFETY IS AN INCREASINGLY PROCESSOR-HUNGRY TASK, HENCE THE GROWING IMPORTANCE OF ONBOARD SAFETY CONTROLLERS

Off-highway machines are taking more and more advantage of the features that state-of-the-art electronics and sensors are offering. This leads to increased functionality, operator comfort and connectivity, resulting in higher productivity and uptime. These features also, however, increase requirements for functional safety and the overall complexity of hardware, communication, and especially software. Although meeting functional safety requirements does not *per se* create higher machine sales, the fulfillment of safety requirements adds a considerable workload for development departments.



Inter Control's digsy fusion S is an onboard safety controller that frees up central CPUs for machine functions

Maintaining performance

If diagnosis functions are mainly hardware-based, they neither have to be implemented via software, nor do they occupy central processing unit (CPU) resources needed for machine functions. Safety dual-core CPUs with their redundant CAT 3 architecture already facilitate diagnosis through the lockstep operation with cross-comparison. Valuable processor resources are saved for the machine function and power is not used up on carrying out internal diagnosis. Also, safe floating point operations are supported. Calculation results are compared automatically throughout the entire operation. Therefore, the user can focus on the application-specific diagnosis functions.

The usage of the dual-core safety CPUs is further simplified by the automated distribution of the application software on the two cores. The programmer has to write just one program which, once loaded in the safety controller, is distributed on the two cores and cross-compared within runtime automatically.

Gaining transparency

EN ISO 13849 demands software modularity and readability. One major step toward meeting this requirement is the clear separation of safe and non-safe functions. By doing this, a clear distinction can be achieved, enabling teams to commonly work on one project and providing the necessary transparency for upcoming modifications.

Avoidance of unnecessary effort

In theory, only the safe program needs to fulfill the requirements of the V-model. To put this into practice, non-safe functions must not interfere with safe functions. If the safety controller ensures the separation of safe and non-safe functions without the risk of interference, the effort of realizing non-safe functions can be reduced considerably.

The digsy fusion S safety controller from Inter Control ensures freedom of interference using various internal measures such as memory protection and defined priorities. As a result, documentation, reviews, validation and verification do not apply to non-safe functions. Therefore, modifications on the non-safe side can be accomplished much faster.

Increasing software quality

Well tested and pre-certified software modules increase software quality. These modules are organized in libraries and typically address functions such as data handling, data transfer, communications via Ethernet or CAN, I/O handling, sensor fusion, safety and diagnosis. As a result, the time-to-market is considerably reduced, because many functions can just be added to the software without coding them over and over again. Furthermore, pre-certified software modules reduce the documentation, test and review effort required on the V-model's module level.

Simplifying complex safe calculations

For some calculations, integer variables are insufficient and real variables are the first choice. Due to the properties of real variables, their usage in safe functions is restricted or even not permitted. To enable machine builders to use real variables for basic and arithmetic functions, the digsy fusion S provides a certified library of safe real functions.

Thus, the translation of virtual real operations in integer is in the past. For telescopic machines and autonomous vehicles, basic and arithmetic functions are insufficient. The calculation of load-moment limitation for cranes, elevated work platforms and ladders is based on trigonometric functions. Likewise, autonomous vehicles require trigonometric functions to control the steering. These applications need to process the functions in a practical, safe way.

With the digsy fusion S, the developer can use certified, safe trigonometric functions instead of lengthy programming of approximation tables to fulfill safety requirements. Calculations are executed by a redundant FPU for the required performance. Thus, the digsy fusion S unites current and future requirements in a single safety controller. **iVT**

Alexander Holler is general manager of the Electronics division at Inter Control

MARK WASS

Off-highway control

THERE ARE SEVERAL FACTORS TO TAKE INTO ACCOUNT WHEN CHOOSING A CONTROLLER FOR INDUSTRIAL VEHICLES

The extent to which the engine and onboard equipment can be controlled is arguably one of the greatest considerations for OEMs when choosing industrial vehicles and machines. With safety, reliability and performance all at the forefront of the designer's mind, the interface between user and machine is paramount.

A multitude of applications fall under the umbrella of off-highway, so controllers need to meet a wide range of objectives – from demolition to road building, agriculture to mining, construction and emergency services. With the increased integration of electronic controls, what should we industrial machine customers be looking for when determining a solution for these widely varying applications?

Versatile designs

The most recent product to be launched by Deep Sea Electronics (DSE) is the M643, which provides a high level of programmable control for smaller applications. Flexible user programming is provided via CODESYS 3.5 (C programming on request). The M643 can be used as a stand-alone controller or to expand the input/output (I/O) options of its larger brother, the M640.

The product is highly versatile. It can be tailored for specific uses across multiple applications and it allows future requirements of the off-highway industry to be met. Developed for vehicles and machines operating in the harshest environments, the controller, like others in the DSE family, has a ruggedized aluminum die-cast housing that has passed stringent EN, ECE and ISO testing for shocks and bumps, vibration, salt spray, EMC and electrical safety, etc. The controller also has E11-R10 type approval. Its rugged design allows it to be fixed directly onto the vehicle's chassis. It can continue operating at full load in varying climatic conditions from -40°C to 85°C (-40°F to 185°F).

DSE controllers incorporate a specialized breather to equalize pressure and reduce condensation while maintaining the IP67 rating for superior protection against the ingress of dust, water and other contaminants. The ratio between the number of I/Os and the size of the controller is optimized to provide a compact product that can be mounted onto machines with limited space. I/Os are fully configurable with inputs offering digital and analog capabilities, and with outputs offering digital, pulse width modulation (PWM) and pulse width modulation inverter (PWMi) capabilities, along with current monitoring on all channels.

ABOVE: **The M643 features a ruggedized aluminium housing**

LEFT: **The M640 is the larger brother of the M643**

Sophisticated features

Integral to the controllers' design is a powerful 32bit microprocessor with a 220MHz clock speed and 4MB of application memory, for fast performance and operating response times.

Four independent CAN interfaces are available for optimizing bus networks. Each one is compatible with J1939, CANopen and Raw CAN, offering a versatile framework for complex network designs that can integrate engine, transmission and other machine functions.

Ethernet is provided both as a program interface and communications channel.

The proven success of DSE's UK manufacturing and design of products is evident in the growing number of applications across the world, in which the products are being used. **iVT**

Mark Wass is control division manager at Deep Sea Electronics

JEAN-BAPTISTE DELCROIX

Smart power distribution

A BESPOKE PRINTED CIRCUIT-BOARD WITH HIGH-CURRENT PCB TECHNOLOGY IS PART OF THE STANDARDIZED POWER DISTRIBUTION SOLUTION THAT IS STREAMLINING THE DESIGN OF DIECI TELEHANDLERS

ABOVE AND LEFT: **The REDline Power Box Hybrid**

BELOW LEFT: **The box is used in all new Dieci vehicles, including the Pegasus**

Dieci is a leading European manufacturer of machinery for materials handling in agriculture and construction. The current portfolio comprises 17 product lines with a total of 143 models, which also form the basis for customer-specific solutions. This variety of products requires a high level of standardization of components.

For its optimized vehicle power distribution products, the company cooperates with Würth Elektronik ICS.

The electrical architecture of Dieci telehandlers used to be characterized by a complex wiring harness and multiple fuse and relay boxes. "It was a fully hard-wired solution that took up a lot of space and was difficult to install. That was no longer smart enough for us," recalls Stefano Gabrini from the Electrical department at Dieci.

Würth Elektronik ICS came up with a new platform concept for power distribution solutions just at the right time: A standard box with a customer-specific printed circuit board in which high-current fuses and relays are integrated with PCB technology combined with copper bus bars for high currents. The proposal by Würth Elektronik ICS, a specialist in PCB-based system solutions for signal and power distributors, piqued the curiosity of Italian machine manufacturer Dieci. The idea sounded good: main distribution is separated and fused near the batteries and the consumers close to the batteries benefit from direct switching and fuse protection.

Development in close cooperation

Within a few months, a joint team from Würth Elektronik ICS and Dieci defined the requirements, developed the customer-specific part of the solution called REDline Power Box Hybrid, and produced the first prototypes. "The biggest challenge during development was to fit all components on the PCB and meet the budget Dieci had set for us," project manager Florian Gackel recalls of the initial prototype development phase.

Among the quality assurance measures, thermography was particularly important. The tests using this method confirmed that the layout met Dieci's temperature specifications. The box, located close to the batteries in the engine compartment, is robust in terms of ambient temperature. The 237.5 x 205.5 x 58mm (9.4 x 8.1 x 2.3in) REDline Power Box Hybrid is specified for the temperature range -40°C to +85°C (-40°F to 185°F).

The range for the fuses in the high current range (150-250A) is designed according to protection class IP20. The IP54 sealed housing part contains the circuit board, which can be equipped on an area of approximately 90 x 90mm (3.5 x 3.5in) with all available ICS sockets such as mini, ATO and maxi fuses, and all common relay sockets up to high-current relay sockets.

"Thanks to Würth Elektronik ICS, we have further developed our vehicle electrics into a more innovative version. We have only benefited from this cooperation," says Gabrini. "The REDline Power Box Hybrid is used in all new Dieci vehicles and not only reduces the space required for power distribution, but also contributes to cost reductions by reducing installation time."

"The cooperation with Dieci is ideal because our contact partners are always well prepared for all technical questions," says Gackel. "Dieci is the perfect reference customer for our REDline Power Boxes because they utilize the full potential of our solution – robust standard housing units with an individual system solution for power distribution, signal transmission and control of vehicle functions that continue to function reliably under demanding thermal conditions. They have successfully streamlined the wiring harness and shortened the installation time." **iVT**

Jean-Baptiste Delcroix is product manager at Würth Elektronik ICS

DANILO PERSICI

Low pressure, no problem

THE LOW VISCOSITY OF FIRE-RESISTANT HYDRAULIC FLUID MEANS GEAR PUMPS MUST BE CAPABLE OF WORKING AT LOW PRESSURES. ONE SUCH SOLUTION THAT IS ALSO LOW-NOISE IS AVAILABLE ON THE MARKET

The FTP gear pump from Marzocchi is an ideal solution for low-pressure lubrication applications where low-viscosity fluids are required, such as fire-resistant ones. Typical applications include large lubrication systems, lubrication of the guides of machine tools, and the lubrication and cooling of the tools themselves.

Fire-resistant fluids are used whenever there is a possibility that a hydraulic fluid (also used for lubrication) may encounter a source of ignition, such as the surface of very hot equipment. Fire-resistant hydraulic fluids are specially formulated so they are more difficult to ignite and do not propagate a flame from an ignition source.

There are several types of fire-resistant fluids and they are generally classified as follows: oil and water emulsions, water-polymer solutions, and anhydrous synthetics. More specifically, the International Standards Organization (ISO) further classifies these fluids as follows: HFAE – oil-in-water emulsions, typically with more than 80% water content; HFAS – synthetic aqueous fluids, typically with more than 80% water content; HFB – water-in-oil emulsions, typically with more than 40% water content; HFC – water polymer solutions, typically with more than 35% water content (also known as glycol solutions, polyalkylene glycol solutions or water glycols); HFDR – synthetic anhydrous fluids composed of phosphate esters; and HFDU – synthetic anhydrous fluids other than phosphate esters. Examples include polyol esters and polyalkylene glycols.

The only fire-resistant fluids that are completely incompatible with gear pumps are the HFDR ones; for all the others, it is possible to obtain a configuration that makes them compatible. To avoid fast wear of the sliding contact parts, FTP pumps can be supplied, depending on the type of application with bronze or bronze/PTFE thrust plates.

Marzocchi FTP gear pumps are available in versions with or without a relief valve built into the cover, and maximum working pressure is 50 bar. The gear pumps have very high specifications for rotation speed and viscosity range.

FTP pumps are available with both unidirectional clockwise or counterclockwise rotation, and all commercial versions of standard gear pump flanges are available, in a displacement range from 7-35cm³/rev.

ABOVE: **The Marzocchi FTP gear pump is based on Elika gear technology**

BELOW: **The lower number of teeth makes the FTP pump a quieter option**

Designed for low noise

Marzocchi FTP pumps are based on Elika gear technology, an ideal choice for lowering noise levels. The Elika gears reduce noise levels by an average of 15dBA compared with a conventional external gear pump. The helical gears ensure the continuity of the motion despite the small number of teeth. FTP pumps are interchangeable with standard gear pumps. The low number of teeth reduces the fundamental frequencies of the pump noise, thereby producing less noise. The shape of the Elika profile, patented by Marzocchi Pompe, eliminates the encapsulation phenomenon typical of standard gear pumps, removing the main cause of noise and vibrations. Pressure oscillations and vibrations produced by the pump are reduced, therefore fewer are transmitted to the other components, reducing the overall noise of the entire hydraulic system. Specific compensation areas in the flange and cover, insulated by special gaskets reinforced with anti-extrusion, allow for fully free axial and radial movement of the bushings. **iVT**

Danilo Persici works in the R&D department at Marzocchi Pompe

WOLFGANG STADIE

Steering to safety

THE RIGHT AXLES AND STEERING SYSTEMS ARE ESSENTIAL TO ENABLE FIREFIGHTING VEHICLES TO MANEUVER QUICKLY AND WITH STABILITY, DESPITE THE LARGE AMOUNTS OF WATER AND EXTINGUISHING AGENTS ON BOARD

Airport firefighting vehicles are the ultimate high-tech machines. As well as having technical features that are required for efficient firefighting, they must also meet very high driving and maneuverability requirements.

One such vehicle is the Lion 8x8, an aircraft rescue and firefighting (ARFF) vehicle manufactured by Volkan, a family-run Turkish organization with 300 employees. A Lion 8x8 will be used at the brand-new Istanbul Airport – set to be the biggest in the world – when the construction of it is completed at the end of 2018.

Fit for purpose

The Lion 8x8 has impressive dimensions. It is 3m (10ft) wide and 12.5m (41ft) long. It can hold 16,000 liters (3,500 imperial gallons) of water and 2,000 liters (440 imperial gallons) of fire-extinguishing agents, giving a total vehicle weight of 45 metric tons. Despite its size, the Lion can move swiftly – at up to 140km/h (87mph) – thanks to its 1,300ps engine. In addition, the vehicle is able to pump 12,000 liters (2,640 imperial gallons) of water and fire-extinguishing agents per minute.

Stable steering

All four of the Lion 8x8's axles are driven. The front two can be steered mechanically with the steering wheel. For maximum maneuverability on-site, the rear axles have an electrohydraulic steering called EHLA Plus (Elektronisch-Hydraulische Lenk-Anlage), which is also manufactured by Mobil Elektronik. EHLA Plus enables the rear axle of the Lion to steer at an angle of ±10°. For maximum stability at high speeds, the steering angle of the rear axle is gradually reduced as the speed is increased. When the vehicle reaches 40km/h (25mph), the rear axle automatically centers to face straight ahead and is hydraulically locked. This function guarantees maximum driving stability.

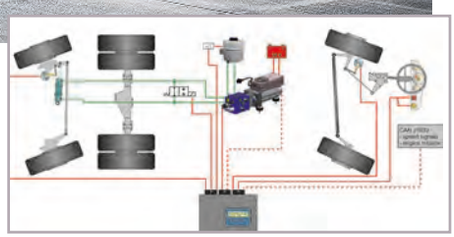
Meeting industry standards

The EHLA Plus auxiliary complies with the ISO 26262 standard and its critical safety features comply with the ASIL-D safety level.

Mobil Elektronik is currently preparing for the IAA Commercial Vehicles event in September 2018. A key topic of discussion will be how the ISO 26262 standard will affect the development of new commercial vehicles.

"These new regulations are a headache [for vehicle manufacturers]," says Mark Biebl, sales engineer of bus and truck applications at Mobil Elektronik. "We want to support our customers through the issue with our knowledge."

The company will also be displaying its steering system, the EHLA Eco Standard, with its newly developed power pack and independent hydraulic supply. The motor-driven hydraulic pump is only supplied with power during active steering – an effective energy-saving feature. No energy is wasted building up pressure when the vehicle is driving straight ahead for long periods of time, when it is traveling at high speed or when not being steered. These features are quite different from conventional hydraulic systems, where a hydraulic pump runs constantly, even if the auxiliary steering does not need any oil, taking power from the truck and wasting energy. As well as saving fuel, this system is ideal for truck modification, because it can be assembled quickly and can be fitted to vehicles where no conventional hydraulic supply is available. **iVT**



ABOVE: **One of Volkan's Lion 8x8 vehicles is currently being used at Istanbul Airport**

RIGHT: **Mobil Elektronik will exhibit its EHLA Standard Eco steering system at the 2018 IAA Commercial Vehicles event**

Wolfgang Stadie is head of sales and marketing Mobil Elektronik

BULLETIN BOARD

Superior sealed, reliable connections

Molex's FAKRA RF connector offers, which are available in Europe through **TTI** Europe, include printed circuit board (PCB) jacks, cable jacks and plugs, and sealed jacks and plugs. FAKRA connectors have a high-temperature plastic shroud that is fully compatible with lead-free reflow processes, along with a mechanical key feature and color coding to ensure a proper connection.

FAKRA II SubMiniature version B (SMB) connectors, with 360° rotation and a secondary locking latch, deliver easy cable routing between antennas and multimedia units while meeting the United States Council for Automotive Research (USCAR) requirements for onboard telematics systems. The FAKRA II SMB connector system also meets German FAKRA automotive standards, as well as retaining the same high-performing, cost-effective RF attributes as the original FAKRA PCB connectors.

FAKRA sealed connectors offer a sealed, in-line solution for onboard telematics and RF communications in today's automobiles. These connectors are widely used by manufacturers across Europe and the USA for applications that require a reliable connection in exterior cameras. Additional applications for FAKRA connectors include cameras, radio antennas, keyless entry or any system requiring an IP69K rating. They also meet USCAR specifications for automobiles, including autonomous cars, and commercial vehicles.

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Hydraulics for three-point linkages

CBM has 50 years of experience in the field, as well as strong technical knowledge. The company also pays close, ongoing, attention to the needs of its end users.

CBM designs and produces hydraulic top links for all ranges and horsepower of agricultural tractors, including high-range tractors over 400hp, and vineyard and orchard tractors.

Its hydraulic top links are fitted with CBM automatic top link hooks, which are used by all the major OEM tractor manufacturers. The range of hooks is: Cat.1, 2, 2HD, 3, 3HD and 4.

All of the models are made from a highly resistant, top-quality steel. They have also have long-lasting seals that are combined with chrome-plated and tempered rods, and that are highly resistant to wear and corrosion.

The hydraulic stabilizers are extremely useful in applications where floating and blocked functions are required. These two operating conditions can be achieved autonomously and completely safely, from the comfort of the driver's seat. The stabilizers can be activated at any height from the ground to create a gradual passage for the floating or blocked liquids, thereby avoiding the risk of accidental shocks and violent lateral oscillations that could damage the three-point linkage and other equipment.

The complete range of hydraulic top links and stabilizers includes a wide selection of models suitable for both the horsepower of the tractor and the client's specific requirements.

Tractors fitted with CBM hydraulic top links and stabilizers guarantee a high level of reliability when used in heavy-duty applications.

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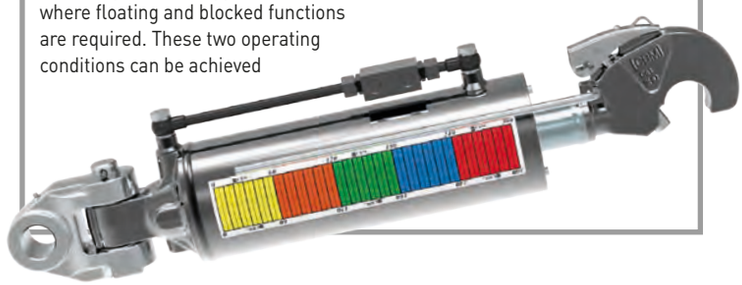

Adding an air of luxury to cabs

Whether you're restyling a cab to give it a second life or designing a control panel to integrate elements that give the vehicle an air of luxury, it can be done with just a few interior fittings, such as aeration grills and outlets.

In just a few years, **Kalori** has become a specialist developer of air diffusion components. The manufacturing of its parts starts with a rigorous selection process for the plastic materials to be used.

The design itself is also very important, because some assemblies work better than others. Twenty-five years of development and manufacturing experience has enabled Kalori to define its own efficient standards.

The production of molds, based upon rheological studies, is a precise operation, to guarantee a strong design and a high-quality component that is free of distortions.

The majority of components are available in chromed versions, and in a number of different diameters. Additionally, a new set of air diffusion components that is linked to a new control panel provides the user with a high-quality result.

Kalori has been a supplier to some of the largest manufacturers for many years. Let a little luxury work its way into your cab!

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Quote Ref: **514**

Displayed with clarity

Ametek Vehicular Instrumentation Systems' (VIS) rugged 7in (17.7cm) digital display provides operators of industrial vehicles with a real-time window into the status of all onboard systems and functions.

Engineers at Ametek VIS have refined and added capability to the CAN communicator C-COM 7G display. While the system retains its previous capabilities, it now also offers: an optional capacitive touchscreen for improved operator interface; audio and video capabilities that enable support of in-vehicle training videos, using existing vehicle cab speakers; and software development supported through its Linus-based board-support package or as a collaborative effort with VIS's experienced engineering team.

The 7G includes two CAN 2.0B (J1939 standard) ports, two USB 2.0 host ports, 10/100Mbps Ethernet and Bluetooth connectivity. Its screen offers 800x480 pixel resolution, 262,000 colors, in WVGA 16:9 format. It includes 512MB SDRAM memory and 4GB eMMC flash (solid state) hard drive storage.

An internal real-time clock has up to 11 days of back-up timekeeping with no battery connection.

Video capabilities include three single-channel, CVBS (composite video) inputs with NTSC/PAL/SECAM auto detection and worldwide NTSC/PAL/SECAM color demodulation support.

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Quote Ref: **515**

Robust magnetic multiturn encoders

Optical encoders can often fail in outdoor applications due to moisture getting into the sensor housing or breakage of the sensitive glass discs.

ASM Sensors presents a new magnetic multiturn encoder technology specifically designed for harsh environmental conditions.

The magnetic multiturn encoders PH36, PH58 and PH68 measure angular positions over up to 255 revolutions using a non-contact magnetic measuring principle with a resolution of 16bit. The sensor is unique because of its true absolute measuring principle. This means that even after a power failure a correct measurement result will be immediately available.

Posihall PH36, PH58 and PH68 multiturn encoders have a rugged aluminum housing with completely potted electronics. The encoders are resistant to shock, vibration and dirt ingress. The IP protection class is IP67 and up to IP69 with a suitable mating connector. The sensors work reliably and precisely in a temperature range of -40° to 85°C (-40° to 185°F).

Analog outputs are available at voltage 0.5-10V, 0.5-4.5V or current 4-20mA. CANopen and CAN SAE J1939 digital outputs are available. For safety applications, redundant sensor versions are available for both the Posihall PH58 and PH68.

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Quote Ref: **516**

An all-terrain solution for harvesters

For more than 25 years, **Hydrokit** has been developing hydrostatic axle drives that increase the capacity of harvesters in the most difficult conditions, such as on steep slopes or on muddy terrain.

Over the years Hydrokit has constantly improved its kits and the company now offers solutions to minimize the skidding of each wheel, to ensure optimum traction control. This system combines the flexibility of hydraulics with the control of electronics and features: a computer to control the anti-skid system on the rear axle; speed and angle sensors; radial piston motors to guarantee very high torque at low speed; and an oil flow control valve in the event of slippage.

Developed in collaboration with manufacturers and dealers, these custom kits are delivered complete with assembly instructions and a parts book. Hydrokit's team of fitters can travel throughout Europe to install the system on-site.

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SIGNPOSTS TO THE FUTURE

25 YEARS

AS *iVT* CELEBRATES 25 YEARS, WE'VE BEEN THINKING MORE THAN USUAL ABOUT THE FUTURE. THAT'S WHY THIS ISSUE IS PACKED WITH MORE CONCEPTS AND PROTOTYPES THAN EVER. HERE'S WHERE TO FIND FEATURES THAT INCLUDE KEY MACHINES...

Page 24

AUTONOMOUS ARMY

Volvo is building eight fully autonomous HX2s for its electric site project later this year. *iVT* got a closer look at the R&D center

Page 72

HYDRAULIC REVOLUTION

Volvo's EX2 electric excavator is the only major prototype to have done away with traditional hydraulics completely. Will the rest of the industry one day follow this lead?

Page 56

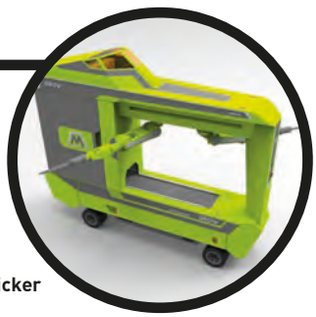
TRACK ON FIELD

Like *iVT*, Case IH's Quadtrac has been 25 years in the making. What will it look like in another 25?

Page 34

LABOR-FREE FARMING

Case IH's autonomous tractor has become an icon for the agricultural automation movement. *iVT* got all the latest news from the company's R&D center



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TAKE YOUR PICK

Industrial designer Amos Boaz has helped to design this autonomous tomato picker

Page 14

OLYMPIC STRENGTH

This fresh design for a wheel loader, from Alberto Seco, looks to make construction for the Paris 2024 Olympics one of the safest such projects ever

Page 48

MARS EXPLORER

JCB traditionally keeps its concept vehicles tightly under wraps, but this image from a new computer game that the company is involved with gives a glimpse of what could one day be reality

Page 16

FUTURE MINING

Jon Pope's autonomous dozer imagines a distant future when mining is one of the first industries to go fully autonomous in the USA

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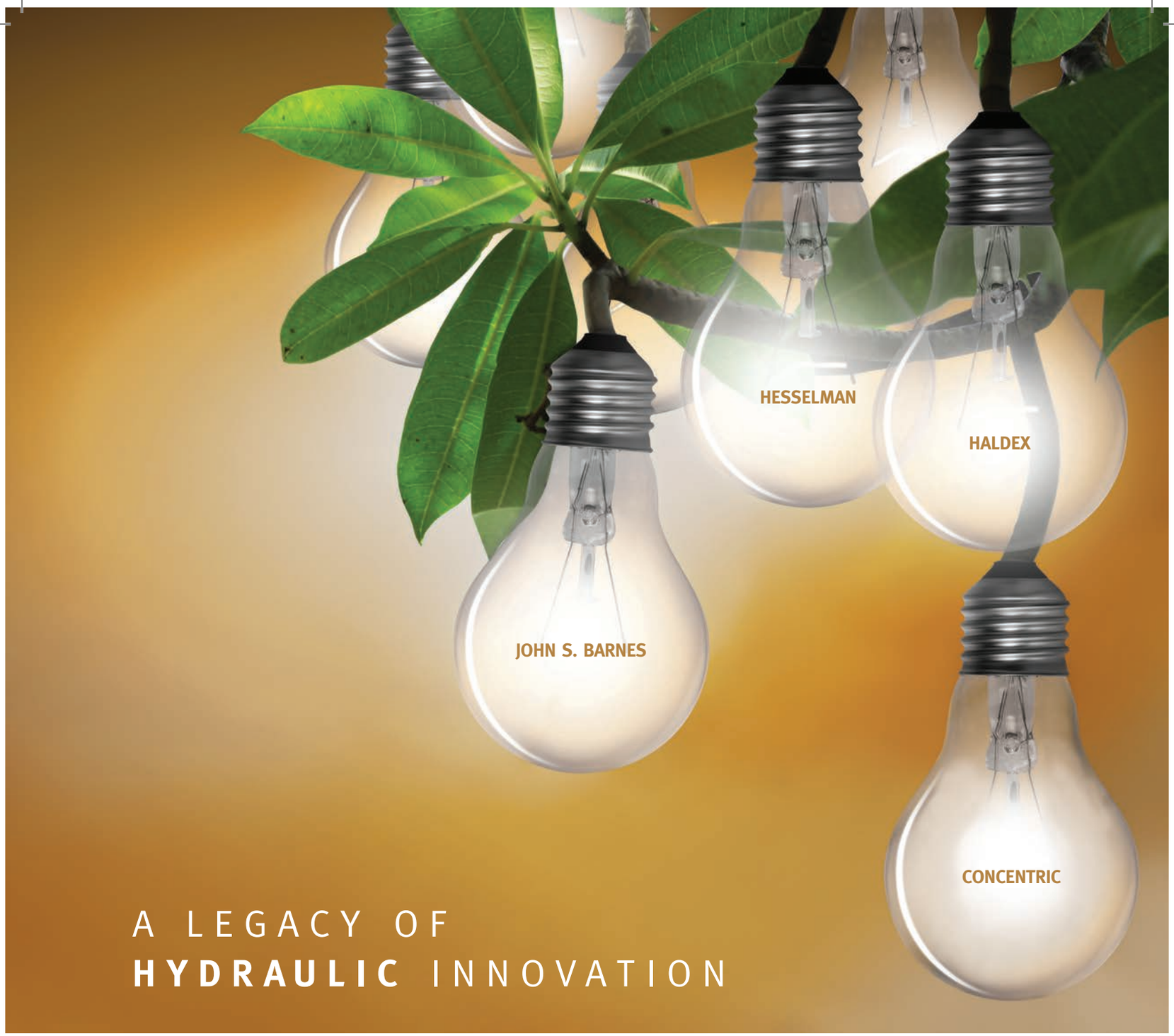

A LEGACY OF **HYDRAULIC** INNOVATION

From our origins as the John S. Barnes Company in 1929 through today, we've been the recognized global leader in the development of innovative hydraulic gear pumps, fluid motors and power units. No matter what name you may have known us by, the one constant for more than 86 years has been our commitment to offer our customers the latest hydraulic technology that meets their unique vehicle application requirements. Our wide range of products combined with our extensive application expertise, engineering support, testing capabilities and state-of-the-art manufacturing facilities allow us to provide value-added, sustainable solutions that consistently exceed our customers' performance expectations, worldwide.

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