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INTERNATIONAL INDUSTRIAL VEHICLE TECHNOLOGY

February 2014

Traction Technology

**Tyre inflation
systems**

Design Challenge

Future Americana

Show Preview

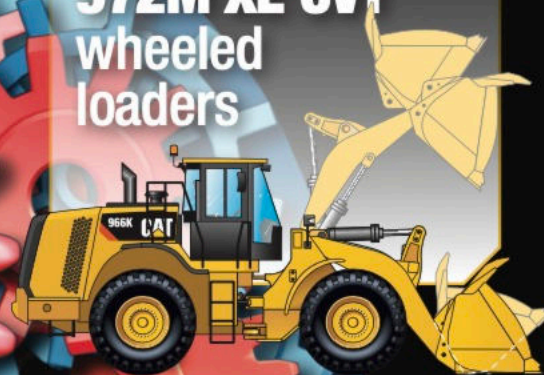
ConExpo/IFPE



New Vehicles

Aebi VT450 Vario
transport vehicle

**Cat 966M &
972M XE CVT**
wheeled
loaders



Split decision

**CVT powersplit technology has revolutionised the
agricultural sector over the last decade – but could
it play a similar role in construction equipment?**

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Given the huge advantages CVT has brought to the agricultural machinery industry, is there an argument for it making the switch into construction equipment?



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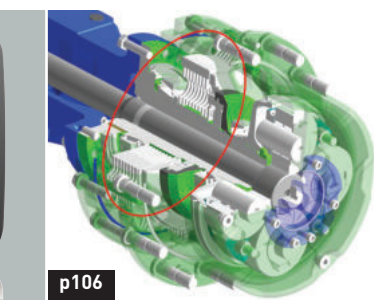
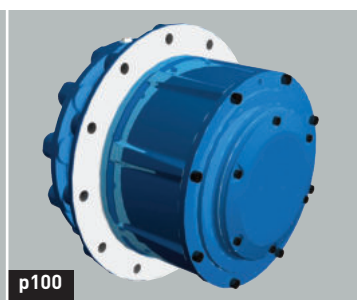
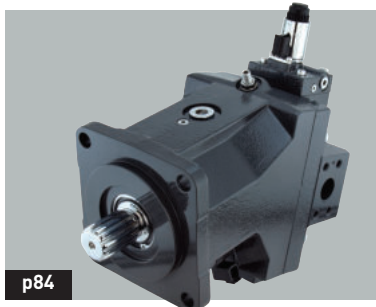
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NAF's bogie axle with PBBS ensures optimum traction can be achieved



FOREWORD

One of the challenges of editing *iVT* is trying to keep our broad readership base happy by covering as wide a variety of off-highway vehicles and sectors as possible. Conversely, one of the advantages is that even if we don't manage that for a few issues, there's invariably something in them to maintain the interest of the niche players in the meantime. For example, an engineer at one sweeper manufacturer told me years ago that he particularly enjoyed reading our articles on agricultural vehicles as there was always useful information regarding the implementation of electronics that he could transfer to his own application.

So given that we've extolled the merits of the ag sector's CVTs for 20 years, it's frustrating that this fuel-efficient and productive technology is taking so long to cross over into other markets. My recent trip to Volvo's Innovation Day revealed that the benefits are well known to the OEM and are being heavily investigated, so perhaps it's time we drew even more attention to the subject.

Is the sticking point purely cost or are there some major engineering considerations to be overcome first? That adapting or developing a CVT for construction purposes isn't quite so straightforward is evident in the time it took for Caterpillar's solution to reach the market. I think it was at the press preview of Intermat 2009 where Cat's PR machine informed us that a 'new and innovative' wheeled loader transmission would be unveiled a few months later – but it wasn't until Intermat 2012 that anything resembling that description, in the shape of the

966K XE, was finally displayed. However, two years on, and Cat has already brought in the next generation of this CVT loader, so there must be a demand, as our feature on page 34 reveals.

It's also quite revealing that neither John Deere nor CNH – OEMs with feet firmly in both sectors and a host of in-house CVT resources and experience – wished to comment on the topic. Yet as last November's Agritechnica revealed, you don't have to be one of the industry's big names to pull out some award-winning CVT innovations. Lindner's Lintrac may have drawn on the might of ZF and its TMT 09 (p9), but Aebi sourced the technology for its VT450 Vario (p42) from a relatively new player on the market that many might be unaware of.

If only I'd had time to cover more of that huge exhibition, who knows what else I could have uncovered? Nevertheless, now that I have finally stumbled upon the secret to pounding the aisles all day without succumbing to a mass of blisters, perhaps that bodes well for uncovering a few more surprises than usual at ConExpo. Always my favourite of the three major spring shows, despite being held in a city I detest, the innovations always seem to come thick and fast, so keep an eye out for me whizzing by, comfortably shod in lightweight Adidas walking shoes and a pair of luxurious Workforce socks, as I attempt to see everything the show has to offer. Failing that, I'll just sit at our booth all day (South Hall 3, 80032) and you can bring it all to me?

Richard Carr, editor, iVT International

Coming up in the June issue of *iVT*

• Design Challenge • OEM interview: Farmtrac • Mobile hydraulics • New applications for sensors • ConExpo review • CANbus • And the latest innovative vehicle case studies



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Off-Highway Products

WINNIPEG, CANADA – Over five years in development, Versatile's articulated 4WD 350-550hp models (six are available; namely the 350, 375, 400, 450, 500 and 550) have now achieved Tier 4i status alongside some major improvements in terms of power, servicing and ergonomic comfort.

The OEM's tractors have been powered by Cummins engines for over 40 years. Its new 4WD models have therefore integrated the QSX11.9 and QSX15 units, providing a useful 13% power bulge at 2,100rpm and achieving up to a 60% torque rise – an increase of 25% over previous generations.

A mechanical Quadshift transmission is standard on the four smallest models, and features four synchronised sequential and

smooth-shifting gears in each of its three ranges. Closely matched speed increments in the critical 5-13km/h band provide the flexibility for most operations. Maximum road speed is 35km/h.

Alternatively, Caterpillar has provided the entire 4WD line-up with its 16x4 powershift transmissions; the three smallest tractors using the TA19, the two largest using the TA22, and the model 450 having a choice of either. Both transmissions are programmable for auto-shifting and speed matching, and enable top road speeds of 40km/h.

Versatile's engineers have continued with the concept of the outboard single reduction planetary axle developed by the manufacturer in the 1970s, with all available power being

delivered through a large, precision-machined floating sun gear. The planetary hubs are suspended on large-diameter bearings mounted directly to the large axle tubes, meaning the load is supported by the axle housing assembly rather than the drivetrain components. This also makes them more capable of withstanding the increased bending loads associated with wide dual- or triple-wheel options.

A closed-centre load-sensing hydraulic system provides pressure and flow on demand for implements that require high hydraulic flow. Total flow of 220 l/min is standard, or 428 l/min can be achieved with the optional high-flow hydraulic system. When hydraulic power is not required, the system goes into

Absolute power



With new, more powerful engines and enhanced cab space, Versatile's 4WD tractor range has never been more suited to work on the prairies



Wide open spaces

▶ With an operator space that is 20% larger than previous models, at 4.97m³, and offering 7.98m² of window glass – up 14% from the previous generation – Versatile says its new cab is the largest in the industry.

Visibility was a major priority, with the new cab design – and that of the hood – boosting the view ahead by 35%. Steel ballast mounted under the front of the tractor aids that too, as well as improving service access.

The dash console was redesigned, making it narrower than earlier incarnations, while its display simplifies the data provided to the operator for improved readability. The view to the rear implement has been maximised too, aided by the use of a semi-active air-ride suspension seat with a 104° swivel range. An intermittent washer/wiper system and sun visors, at both front and rear, boost visibility that little bit further.

With standard tilt and telescopic adjustment, the steering console is tailored

to enhance operator comfort. Machine operation is via mechanical hydraulic levers with the flexibility to simultaneously perform multiple functions. Lever locks can be used to hold them in neutral, keep them out of the float position or held at retract. Optional on all models, electrohydraulic operation enables fingertip control, while hydraulic flow can be altered using the EHR monitor.

Other standard features include four 12V outlets, four cup holders, coat hooks and multidirectional vents, while the Deluxe cab includes a 110V AC power outlet and a 5V integrated USB port. A subwoofer is also provided to improve sound quality.



low-pressure standby to conserve energy and deliver more power to the drawbar.

Service with a smile

Ease of servicing was another key factor in the design of the new range. By removing their covers – with no need to remove the tyres – the planetary axles can remain on the tractor for routine maintenance, while axle oil-level sight gauges can be easily inspected on a daily basis. The gears can also be reversed to double the wear life.

Hydraulic and fuel sight gauges can be checked from ground level without the need to remove side panels or shields. The latter is protected behind the entrance ladder, providing operators with a quick view of the fuel level before entering the cab.

Refuelling is possible from either side, with a crossover tube enabling both tanks to be filled quickly – with overall capacity of 1,135 litres for the three smallest models and 1,514 litres for the 450, 500 and 550 ensuring uninterrupted working. With no SCR, the single-fuel technology also helps reduce maintenance.

In addition to aiding refuelling, the right-hand side ladder also provides access to the engine air cleaner. Gullwing-style side panels provide easy access to all under-hood components, while the front grille swings open to provide ground-level service access to the cooler/condenser package – which also swings open for servicing.

RIGHT:
A full-length fuel sight gauge is within the operator's eyeline while accessing the 4WD's spacious cab



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JIM MANFREDI, MACHINERY OUTLOOK

VOLVO'S GREAT HAUL

Terex has agreed to sell its rigid and articulated haul truck business to Volvo CE for approx US\$160m. Included in the transaction is the manufacturing facility in Motherwell, Scotland; the distribution of haulers in the USA; and a 25.2% holding in NHL, which manufactures and sells rigid haulers under the Terex brand in China. In 2012, these businesses (excluding NHL) had net sales of approx US\$370m.

"The truck business has been an important part of our company for more than three decades," said Ron DeFeo, Terex chairman and CEO. "However, trucks no longer fit our changing portfolio of lifting and material handling businesses. The sale reflects our strategy to manage our portfolio and focus on those businesses that provide the greatest returns for shareholders."

"This is a strategic acquisition that offers [us] considerable scope for growth," said Volvo CE's outgoing president, Pat Olney. "The addition of a well-respected range of rigid haulers extends the earthmoving options for customers involved in light mining applications at a time of renewed confidence in the sector. The addition of [the] articulated hauler range will enhance our position in this segment, particularly in high-growth markets."

BETTER PART OF VALLA

Manitex International has completed the acquisition of Valla SpA, for a total potential consideration of up to US\$1.2m, mainly based on an earn-out provision. Since its founding in 1945, Italy-based Valla has developed a full range of mobile cranes from 2 to 90 tons, using

electric, diesel and hybrid power options. Its cranes offer wheeled or tracked, fixed or swing boom configurations.

CANADIAN CLUB

Caterpillar and Shell are to test a new engine and fuel mix using LNG that they hope will reduce operating costs and emissions from oil sands mining in northern Alberta. Cat will leverage its experience with LNG in other applications, and continue development work to design and build a fully integrated dual-fuel mining truck where LNG displaces most of the diesel. It will test the design at Shell's oil sands operations located near Fort McMurray.

Shell will also retrofit existing trucks in its fleet with the new engine, as well as provide infrastructure for fuelling. Field testing is expected to begin in 2016 and last up to one year.

POWER SHARING

JCB and Kohler Global Power Group have entered into a partnership that will result in several of the OEM's compact machine lines being powered by Kohler engines. The water-cooled direct-injection engines (KDI), built at Kohler's Lombardini plant in Italy, will be branded 'JCB Diesel by Kohler' and meet Tier 4 Final without the need for a DPF, while providing an improvement of <15% on fuel consumption.

JCB has used Perkins engines in many of its compact machines for years, but the decision to move to Kohler was driven by the synergy in the technologies used by JCB and Kohler to achieve tough Tier 4 Final emissions legislation.

A JCB 35D 4x4 Teletruk forklift will be the first of its machines to feature one of the KDI engines.

Subscribe online at www.machineryoutlook.com



MORE UPTIME DOWN BELOW

ÖREBRO, SWEDEN – Set to be the most productive LHD on the market, and designed to match its 60-tonne capacity Minetruck MT6020, Atlas Copco's Scooptram ST18 completes its range of underground loaders in this segment.

The 18-tonne capacity LHD shares many common parts and control system components with the MT6020, reducing the cost of ownership. The OEM's Rig Control System governs all operational aspects, resulting in better muck pile penetration, reduced wear and tear, and a more productive loading cycle.

Many sustainable solutions contribute to maximising its

uptime. Automatic ride control and automatic declutch extend service life and reduce spillage; automatic traction control reduces tyre wear and fuel consumption; and machine wear and tear is further reduced through the addition of soft stops on the bucket, boom and steering.

There is an abundance of safety features too, including protection guards, automatic brake test, boom lock-up, redundant steering system, fire-suppression systems, safety latches and machine protection systems.

The Cummins QSX15 Tier 3 engine, providing 336kW at

2,000rpm, is matched with a dry-type air cleaner, catalytic exhaust purifier and silencer, exhaust heat protection, and L&M V-tube core radiator and charge air cooler.

A Dana TE 32 automatic powershift transmission provides fully modulated four-speed shifting.

The spacious ROPS/FOPS cab offers enhanced visibility to the rear, due to the sloping design and shorter power-frame structure. Extra leg room is provided by the Atlas Copco 'footbox'.

The ST18 can also run semi-autonomously or by using radio remote control.

STEP ON THE GAS

LINYI, CHINA – SDLG has launched two LNG-powered wheeled loaders in the shape of the 5-tonne LG956L and 6-tonne LG968N, claiming fuel-savings of around 40% in comparison with their diesel-engined equivalents.

Meeting the increasing market demand for fuel-efficient and low-emission, machinery, the loaders are

powered by high-torque Stage III Weichai electronic-injection engines that provide 162kW (LG956L) and 191kW (LG968N) at rated speed.

As one of the cleanest-burning fuels, LNG is also less corrosive to engine parts than traditional fuels, resulting in lower maintenance costs.

An internal ventilation system enables the engine to

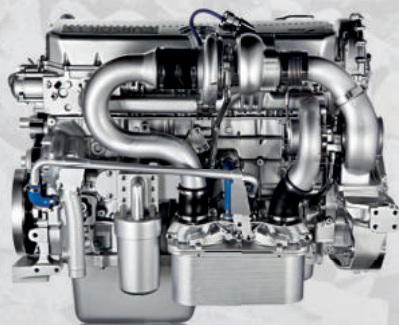
operate safely in ambient temperatures of up to 45°, while the shock-absorbent fuel cylinder ensures the gas remains functional at low temperatures.

The SDLG-designed VRT 200 countershaft hydraulic-shift transmission comes as standard on the 6-tonne model, with both loaders using an easy-to-operate multispeed clutch.

With a full bucket load for every cycle being vital, they feature maximum breakout force of ≥180kN (LG956L) or ≥210kN (LG968N). Their high tipping load and weight-distribution system help ensure stable operation even on the toughest terrain, while the standard rear-view camera and wrap-around glass boost visibility for the operator.



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PETER HILL, *IVT INTERNATIONAL*

OEM DEALS SECURED

A number of new OEM deals have surfaced, including a new customer for engine maker Deutz. Argo Tractors will use the new TCD 2.9 L4 and TCD 3.6 L4 engines in a forthcoming tractor range with outputs spanning 60-100hp and aimed primarily at the stock farmer.

Yanmar supplied engines for Argo's previous Landini and McCormick tractors in this class; Perkins and FPT Industrial are the group's long-established suppliers.

MTU secured agreement with Russia's Rostselmash to supply up to 3,000 engines over the next few years.

The Mercedes-Benz-based straight-six diesels, which MTU develops for off-highway applications, will span 175-500hp for forage harvesters and combines destined for Russia and export markets such as Poland, Romania, Hungary and Turkey.

In the tyre sector, Mitas has signed a long-term agreement to supply Mitas- and Continental-brand tyres for with Claas tractors and combine harvesters. This continues a collaboration that started in 2004 and will enable manufacturing and logistic delivery procedures to be optimised.

THE DUNKERQUE SPIRIT

A new manufacturing facility in northern France will be home to Kubota's 'upland farming tractor project' as the OEM prepares to launch into the 130-170hp sector. Its biggest tractor at present is a relatively lightweight 135hp model from the Grand X range.

The move is part of a strategy to increase revenues from grain farming in North America, Europe, Australia and Japan. At present, the OEM's best sellers are the compact tractors built in

Japan, Thailand and USA, groundscare machinery, and the harvesters and tractors it manufactures in Japan for paddy rice production across Asia.

Yasuo Masumoto, chairman, president and CEO, highlights that Kubota has successfully increased sales into the rice cultivation, vegetable, fruit, dairy and livestock sectors, but will need a share of the much bigger grain sector if it is to continue growing.

More than €40m is being spent on the factory near to Dunkerque, where operations are scheduled to begin from December 2014. Series production is expected to begin in the next quarter and managers predict the 3,000-unit annual capacity will be reached by 2017.

STYLE AND SUBSTANCE

The latest Claas Xerion and Deutz-Fahr Series 6 Agrotron TTV with MaxVision cab have been recognised by the 2014 German Design Awards as examples of good style and practicality.

Crediting Pierangelo Margutti of SDF and Fabrizio Giugiaro of Giugiaro Design, the awards described the Deutz-Fahr machine that won the transportation and public space category as "an attractive-looking agricultural vehicle that impresses both inside and out with its aesthetics and technology and thus does justice to the self-assurance of the modern farmer".

The Claas Xerion's new styling, penned by Thomas Oberhoff, ITH Technik, also received a special mention: "The dynamic line of its bonnet and the generous cabin combine technical and ergonomic demands of customers with their aesthetic expectation of an intelligent tractor," said the award citation.

SILVER STREAK

KUNDL, AUSTRIA – Winner of a silver innovation medal at Agritechnica 2013, Lindner's Lintrac is "the first tractor mower with an infinitely variable drive unit and passive steering rear axle", according to CEO Hermann Lindner.

The OEM worked with ZF to develop a new concept, the Terramatic TMT 09 transaxle for continuously variable work up to 100bhp, complementing the 3.4-litre Perkins turbo diesel nicely. This also provides 420Nm at just 1,400rpm, with a steep torque curve of over 40% enabling safe, powerful

starting when on slopes or for traction tasks.

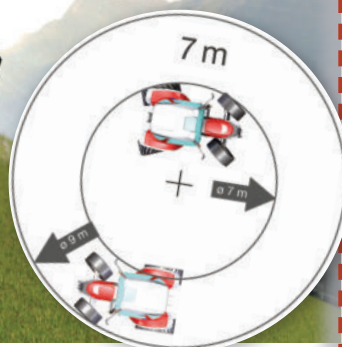
Because manual shifting is not required, the driver can fully concentrate on the task at hand, and stop or start on a slope without using the clutch or brakes.

Driving is infinitely variable from 20km/h in reverse mode to 43km/h forwards, with the low engine speeds helping to reduce fuel consumption.

The driver merely has to rotate the Ldrive control dial on the armrest to set the speed of travel in a dynamic and infinitely variable manner.

The CVT features a compact, lightweight design that is particularly efficient due to the high proportion of mechanical versus hydrostatic operation.

With decades of experience in four-wheel steer systems gained from the development of its Unitrac Transporter, Lindner was well placed to equip the Lintrac with high manoeuvrability. With a CoG below 850mm and the rear axle rotating up to 20° on request, outstanding yet safe performance on grades of up to 60% is assured.



SILENT RUNNING

KORBACH, GERMANY – Weidemann presented the prototype of its first fully electric loader at Agritechnica. Based on the OEM's type 1160, the eHoftrac's changeable 240Ah, 48V lead-acid battery provides enough power for two to four hours of normal work. Recharging takes up to eight hours, or six hours if using a quick charger.

The smart placement of the 400kg battery provides the loader with identical stability and tipping load to the standard 1160 Hoftrac. Its operating procedure remains unchanged,

and is also compatible with all attachments in Weidemann's product range.

Around 48% lower primary operating costs are forecast, although with the elimination of the hydraulic drive system, cooling water cycle, engine oil changes and the reduced number of wear components, this should be reduced even further. A 43% reduction in overall emissions is also expected.

"The battery drive completely dispels the exhaust problem from the barn and reduces the noise exposure for the operator [and] animals," announced Bernd Apfelbeck, Weidemann managing director.

"This is an interesting alternative to the diesel drive for many operations, especially as many [farms] now have their own power generation with a photovoltaic system."



WHAT'S NEW

HANDLING FOCUS

MICHAEL LEU, FORKLIFTACTION.COM

FUEL FOR THE FUTURE

Kalmar has demonstrated a dual-fuel diesel and LNG-powered reach stacker at the Port of Livorno in Italy. Director Stefan Johansson said using LNG as fuel is a "future trend in the vehicle and shipping industries" to reduce exhaust emissions.

"When more and more ports have LNG available, there will be possibilities to run other terminal products on LNG. LNG will reduce the carbon footprint... the demo unit shows up to 20% lower fuel cost per hour," he said.

The pilot is part of a Greencranes project aimed at developing eco-efficient alternatives for container terminals.

FROG WENT A-COURTING

The advanced technologies business unit of Oceaneering International has acquired a developer of automated guided vehicle systems and navigational hardware and software. Frog AGV Systems has about 70 employees, and gains substantial additional backing through access to Oceaneering's resources.

Frog has deployed more than 1,200 AGV systems over three decades. The systems employ patented navigation technology with sophisticated software and sensors to provide accurate guidance, autonomously navigating through complex pathways.

Oceaneering primarily provides engineered services and products – including submersible remotely operated vehicles – to the offshore oil and gas industry, with a focus on deep-water applications.

THE BUTLER DID IT

Brian Butler, president of Linde Material Handling North America Corp, has begun a two-year term as chairman of the board and one of the six executive

committee members of the ITA. He succeeds James Moran of Crown Equipment.

Other incoming officers are first vice-chairman Brett Wood, president and CEO of TMHNA; and second vice-chairman Scott Johnson, VP of business development for Clark Material Handling Co. Other executive committee members beginning two-year terms are Jay Gusler, director of operations for MCFA; Tim Quellhorst, SVP of Crown Equipment Corp, and Colin Wilson, president and COO at Nacco Materials Handling Group.

CHINESE DREAM

Kion aims to overtake Toyota as the world's largest forklift OEM by 2020 – and China has a major role to play, Frank Brandmaier, the group's head of corporate media relations, told Forkliftaction.com. "For years, China (has been) one of the group's most profitable markets," he said, scotching rumours that Kion's Chinese venture had been bleeding money.

"We are the largest international supplier and the number three overall in the Chinese market."

Brandmaier says products with the 'Made in Germany' tag are highly regarded in China. "But with Weichai Power as a strong partner at our side, we are also increasingly being perceived as a domestic supplier here in China.

"China is, without any doubt, a key market to reach this goal [to overtake Toyota]. According to studies, the Chinese market is likely to grow by more than 6% per year between now and 2017," he explained.

"We want to tap into this growth. That is why the Kion Group will continue with its targeted investments in China over the next few years."

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TURN ON A DIME



NEW BREMEN, OH, USA – Crown Equipment Corp has introduced the ST 3000-25 Series walkie straddle stacker, with a payload of up to 2,500 lb, into North and South America.

The machine's compact design, in combination with the X10 handle, ensure high manoeuvrability in tight

spaces – unlike the 11- to 13ft aisle widths that are required by a typical counterbalance truck, 6- to 7ft aisles can be created to maximise storage space.

With the products stacked vertically on an organised rack system, operators can enjoy quick access to each individual product.

Boasting some advanced ergonomics, the durable, cast aluminium control handle enables any function to be performed with the minimum

of effort. When in the near-vertical position, its brake override feature allows for accurate manoeuvring by enabling the stacker to easily turn in an area almost as small as its own footprint, and reduces the risk of damage to the truck, load and facility.

The combination of the low-profile power unit with a clear mast design provides a clear view when working with elevated loads or moving products through the facility.



PROPEL ALL BOARDERS

MJÖLBY, SWEDEN – Toyota Material Handling Europe (TMHE) has made some major changes to drivetrain options on several key ranges.

Following the exhibition of its first lithium-ion prototype at CeMat 2011, TMHE has been conducting extensive field trials with other lithium-ion trucks – including the BT Optio OSE250 and BT Levio LWE200, LPE200 and LPE240 models – in several multishift customer operations.

This has demonstrated the real business benefits that can be achieved in real-life applications, such as full recharge in one hour, which

can be spread across the working day, using natural pauses such as breaks or lunch times.

TMHE's lithium-ion range also reduces electrical energy consumption and costs by a significant 30%, which also means fewer CO₂ emissions and a reduced environmental imprint. The lithium-ion batteries used in the trucks typically have three times the lifespan of conventional lead-acid batteries.

In response to customer demand, the OEM is also now planning to eventually offer the entire Tonero range of diesel counterbalance trucks

with the choice of a torque converter or hydrostatic transmission. The hystat option will be first made available in the 2.0- to 2.5-tonne models.





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MEN OF MANY PARTS

IVT VISITED LIEBHERR-ETTLINGEN AND ASKED THE GUYS BEHIND ITS NEW COMPONENTS DIVISION WHY IT HAS TAKEN SO LONG TO MAKE ITS VAST ARRAY OF TECHNOLOGY AVAILABLE TO OTHER OFF-HIGHWAY OEMs

▷ I have some good news for our regular columnist, The Insider. In this, the very same issue in which he bemoans the withdrawal of CNH Power Components from the market, and the shrinking pot from which OEMs can source components, I can reveal there's a new(ish) player on the scene.

Liebherr, of course, is well known as a manufacturer of some of the largest and/or most impressive off-highway machinery around – and only slightly less well known is that it has produced many of its own core components throughout its existence. Yet by largely restricting their use to its own equipment for most of that time, it could also be accused of hiding its light under a bushel – so following a visit to the Ettlingen facility to find out more about the recent official launch of its external component sales company, I asked Gebhard Schwarz, MD of Liebherr-Component Technologies AG, why it had all taken so long.

"A comprehensive strategy only became

possible after the establishment of the Components Division in 2007 and the resulting pooling of the individual business units in the area of components," he explains. "We are now working in a structured manner, without haste, to develop and consolidate sales to external customers."

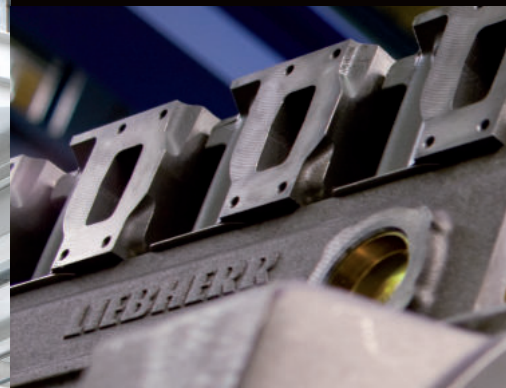
It's understandable why this process has taken a while – its broad components portfolio includes 16 product lines, consolidated in 14 business areas and manufactured at eight production sites across the globe. In Germany, the Biberach an der Riss facility produces planetary gearboxes and rope winches, large-diameter bearings, control technology and electrical machines; Kirchdorf an der Iller manufactures a variety of hydraulic cylinders and shock absorbers; and display and operation units, power electronics, control and regulation electronics and system solutions come out of Lindau. Bulle, Switzerland, is where diesel and gas engines, axial piston pumps and motors and fuel-injection systems

"WE ARE NOW WORKING IN A STRUCTURED MANNER, WITHOUT HASTE, TO CONSOLIDATE AND DEVELOP SALES TO EXTERNAL CUSTOMERS"

Gebhard Schwarz, MD,
Liebherr-Component Technologies



LEFT: Liebherr produced its first large-diameter bearing in 1955, but the range has been greatly extended due to recent demand from the wind industry



are produced; gearboxes are made in Dalian, China; and slewing rings and bearings in Monterrey, Mexico.

A further component production site is currently being established in Colmar, France. Ettlingen, Germany, is the base for remanufacturing of all major components.

Independence day

But before finding out more about the new division's plans, let's go back to the start – why does Liebherr feel the need to produce so many of its own components anyway? Stefan Heissler, member of the board of directors at Liebherr-International AG, attributes the main reasons to the group's corporate independence – both financial and technological – and the quality of its products. "It is important to us that we master key technologies – right down to the finest detail," he elaborates. "In this way, we have total control over the technological aspect of our products; therefore we do not have to make compromises and can provide our customers with tailored solutions developed by us. We can also partly determine our production capacities in this field and become less dependent on suppliers."

That's an attitude that harks right back to 1949, when Hans Liebherr could not source suitable gearboxes for his first construction crane, so decided to create them himself. But it wasn't until 2012 that Liebherr-Components AG – a

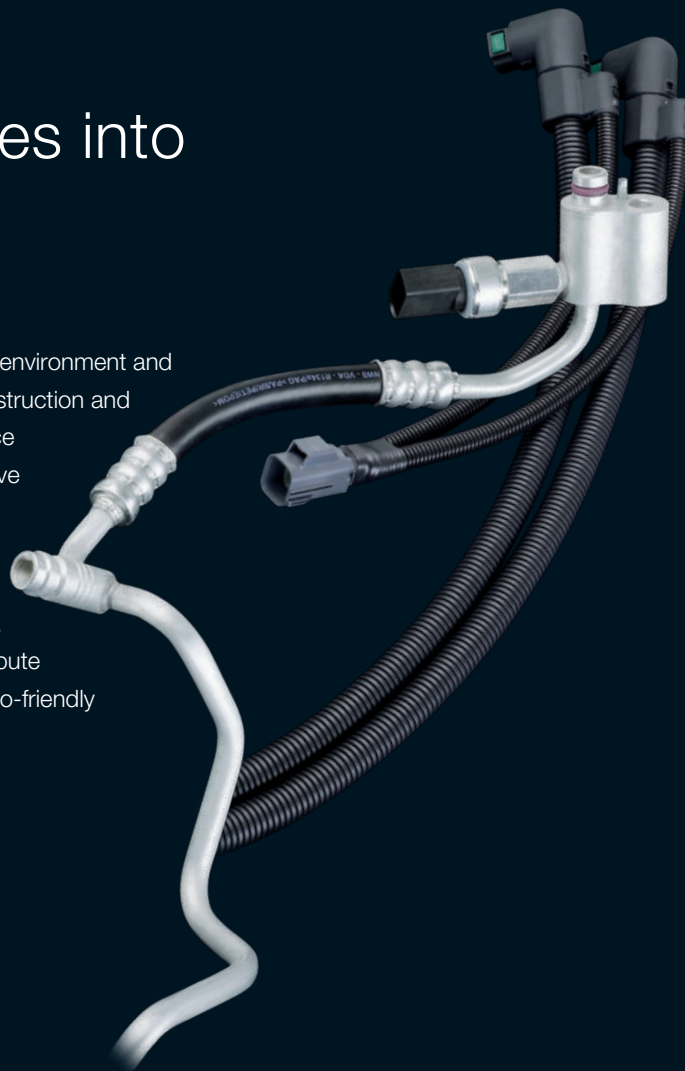


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The range of large-diameter bearings includes roller bearing slewing rings and ball bearing slewing rings with spacers or cages for the rolling elements



Electronic components are the biggest selling item in the range, with 100,000 manufactured in Lindau in 2012



central sales and service company – was established in Nussbaumen, Switzerland, providing customers with access to a central contact person for all product lines.

External customers are becoming increasingly important not just for capacity expansion and location questions, but the enhancement of the company's product portfolio, claims Schwarz. For this reason, over €200m has been invested over the past two years, with a further €370m planned for the next three, all aimed at enhancing the service to a target group that includes all heavy-duty off-highway OEMs, but construction, agricultural, forestry and maritime machinery producers in particular.

A conflict of interests?

So what can prospective customers expect – the very cream of Liebherr's component crop, or its previous-generation, less-advanced models? With a few exceptions, it appears to be very much the former, as Schwarz explains when I ask if there may be a danger that Liebherr's vehicles could lose much of their differentiation if their core components are sold to other OEMs – including those in the

construction equipment sector: "It is very important to us that we do not endanger the competitiveness of our end products. Therefore, the Liebherr components division focuses on the sale of individual components and subsystems, but does not sell control technology or complete systems which primarily differentiate our machines from competitors'."

On a similar note, is every component that is for sale one that is, or has been, used in a Liebherr vehicle? For instance, not being a recognised supplier of traditional compact equipment, the company concentrates on building its engines in the 160-765kW range – so, would any mini excavator manufacturers enquiring about availability of such parts be sent away empty-handed?

"We develop and produce a large number of components that are not used in our own machines, such as gas engines or numerous gearboxes," Schwarz says. "In the case of new developments for external customers, we're examining whether they fit in with our basic product line strategy and are economically practical.

"Our strength is in customer-specific, customised solutions, and

"WE HAVE TOTAL CONTROL OVER THE TECHNOLOGICAL ASPECTS OF OUR PRODUCTS. WE CAN PROVIDE OUR CUSTOMERS WITH TAILORED SOLUTIONS DEVELOPED BY US"

Stefan Heissler, member of the board of directors at Liebherr-International AG

co-operation with customers provides us with a great deal of impetus for the further technological development of our products. One specific example is the adaptation of our diesel engines for on-highway applications for a major Russian partner. Another is our range of large-diameter bearings and gearboxes that has been extended considerably due to demand in the wind industry."

Collaborate to innovate?

The news of that co-operation agreement with Kamaz was made public shortly after I had enquired about potential collaborations with OEMs, should a component not be readily available – or, the potential for JVs with other component suppliers to work on projects such as hybrids, CVTs or other advanced technologies. So, with mining equipment comprising a major part of the Liebherr portfolio, for



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supplier as being a more reliable or innovative option?

"Liebherr possesses a great deal of application expertise," he retorts. "In addition to a standard range of products, we supply a large number of customised special solutions that can be implemented quickly and flexibly by our small business units."

"No other company offers such a wide range of components, with all important components for both the diesel-hydraulic and the diesel-electric drivetrain being available from a single source. We definitely have great opportunities to become established on the market alongside more well-known manufacturers."

High-pressure sales

I put a similar question to Rudolf Ellensohn, MD of Liebherr Machines Bulle, regarding the common-rail fuel-injection system it had proudly launched at Bauma, boasting an impressive 2,200 bar and up to four injections per cycle. Nevertheless, my subsequent conversation with another engine manufacturer revealed it preferred to retain Delphi as its fuel-injection system supplier due to the perceived benefits of a production run in the hundreds of thousands per year. So how do you counter an opinion like this when you produce 'only' 10,000 engines annually?

"The development and establishing of an injection system always takes a considerable amount of time," replies Ellensohn. "We started production

instance, how much of its expertise in diesel-electric systems – an area that is surely ripe for growth across a range of off-highway equipment – could be made available? Just the components or help in designing the entire system?

"We do see growth potential for diesel-electric systems and would be very receptive towards development partnerships for complete systems," Schwarz replies. "There are some applications with requirements similar to those found in our mining trucks, and which do not compete with them."

"We are holding discussions and maintain business relationships with both component manufacturers and other OEMs, and are open to various forms of co-operation if they are technologically and economically viable. However, we are basically striving for growth using our own efforts and our own know-how."

Nevertheless, there are still certain core components that the company does not yet manufacture, but according to Schwarz could be on the cards: "Standard components and/or the current range of suppliers' components are often inadequate

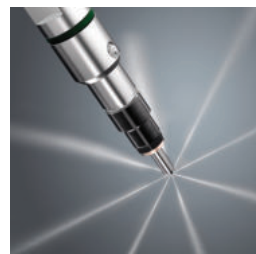
for our machines – this also applies to axles and transmissions. We are therefore evaluating different in-house developments in this area so we can cover special applications."

Would acquisition be an option to enable in-house production of certain parts then? "It has never been our prime goal to expand that way – rather we are pursuing growth by our own means so as to maintain our independence. We will basically continue to adhere to the principle of organic growth – but, if a company proves to be an ideal match for us on account of special components and characteristics, we would not rule out acquisitions or joint ventures in an individual case."

There certainly are big plans for the division anyway. In 2012, 18% of its sales were to external customers, second only to its own earthmoving division. Within the next 10 years, the objective is to attain a turnover contribution from external sales in each product line of between 30-40%. But I wondered if the sheer diversity of its component range could actually present a problem – might not, for instance, an OEM seeking a pump or motor view a specialist hydraulic

ABOVE: Approximately 40,000 hydraulic cylinders are produced in Kirchdorf each year

BELOW: Liebherr has high hopes for its new common-rail fuel-injection system





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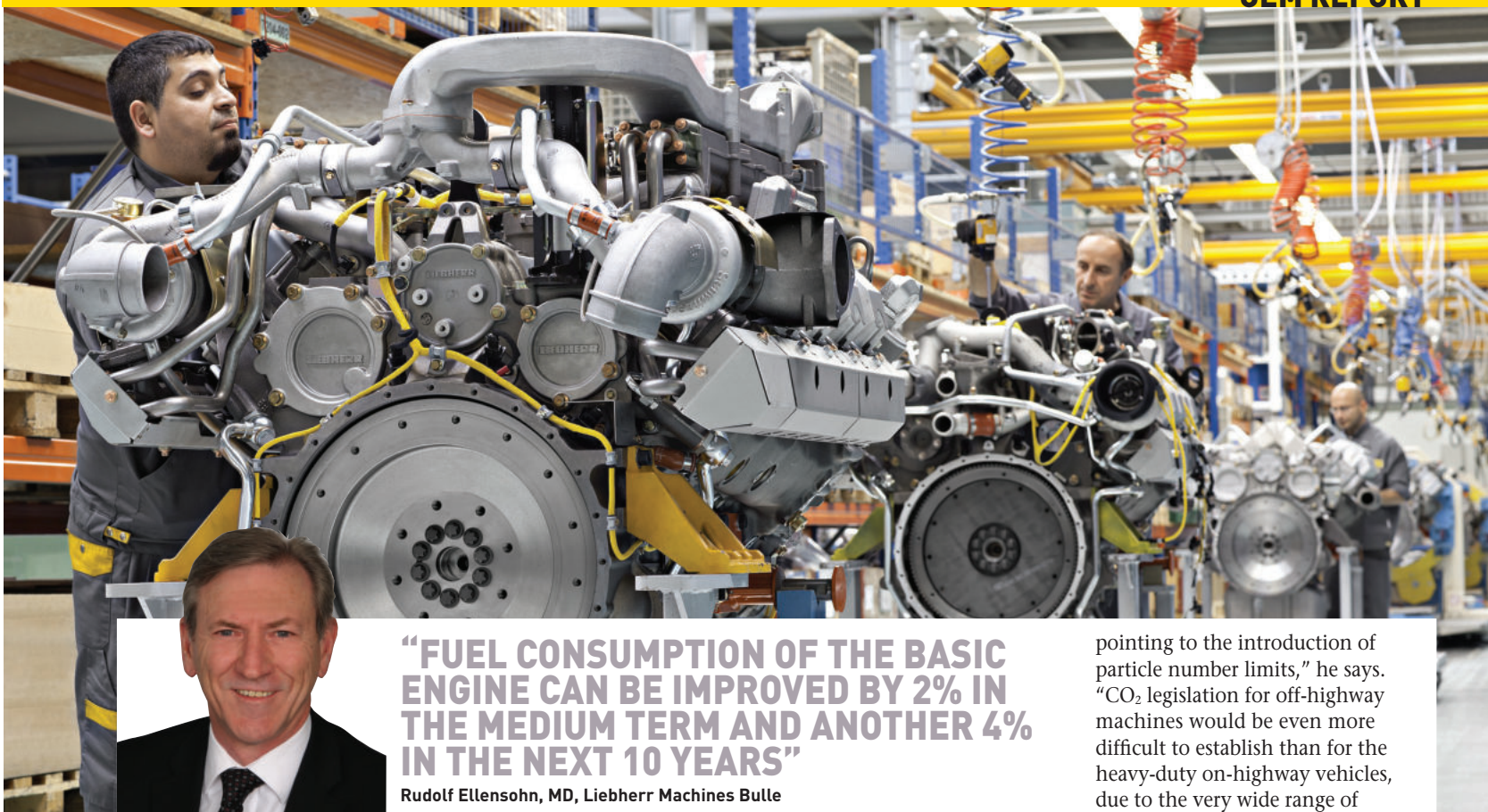
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“FUEL CONSUMPTION OF THE BASIC ENGINE CAN BE IMPROVED BY 2% IN THE MEDIUM TERM AND ANOTHER 4% IN THE NEXT 10 YEARS”

Rudolf Ellensohn, MD, Liebherr Machines Bulle

for a few thousand systems just two years ago, and in the next two years we will increase the volume to many thousands of systems. All the other manufacturers also started with low volumes for the introduction of systems such as common-rail.

“In that way, we’re not so different from the bigger players in this sector and we are convinced we offer an excellent alternative. Our solution is also showing some advantages in fuel consumption, so we are confident in getting customers for our system. Some OEMs have already started test programmes to evaluate the Liebherr common-rail system.”

Speaking of fuel consumption, Liebherr believes the time is now right to turn attention back to the topics of fuel economy and customer benefit that, due to the rapid adoption of Tier 4 Interim and Final have been largely neglected across the industry.

“The OEMs that we are working with had to transfer almost all of their engineering capacity into the introduction of the new engines and aftertreatment systems. Because of this, the development of energy recovery systems [i.e. hybrids] could not be completed in the way they

would have liked,” says Ellensohn. “From my point of view, the fuel consumption of the basic engine can be improved in the medium term by approximately 2% and by another 4% in the next 10 years by adding exhaust heat recovery systems currently under development.

“There is also a lot of potential to further reduce operating costs via the drivetrain, which could be a more effective approach. The key to future operating cost reductions will be the optimisation of the whole drivetrain, focusing on the real load profile of the individual operating cycles.”

The reason behind developing the in-house fuel-injection system was the knowledge that European emission legislation would continue to be tightened, and as such, the increasing of competence in this area would be more than worthwhile. Ellensohn certainly seems convinced that a future Stage V would cover particle counting rather than CO₂ reduction, for which he is at a loss to see how this could be monitored.

“All signs from the European Community and the various working groups investigating future emission limits for the off-highway sector are

pointing to the introduction of particle number limits,” he says. “CO₂ legislation for off-highway machines would be even more difficult to establish than for the heavy-duty on-highway vehicles, due to the very wide range of applications and duty cycles.”

To this end, the company is set to introduce a ‘coated’ DPF in tandem with SCR (but no EGR) to provide the lowest particle counts within the lowest installation volume, and requiring no active regeneration.

But given the already enormous reductions that have been made in exhaust emissions over past decades, the actual value that another stage could bring is very questionable. Ellensohn is in no doubt that the bringing of older machines up to current spec would have far greater impact – a view that is certainly shared by his colleague, Kurt Schöllenger, MD of Liebherr-Ettlingen GmbH – the component remanufacturing sites.

Three’s allowed

Schöllenger points out right away that there is no 100% clear definition of the term ‘remanufacturing’, and indeed his division offers a three-tier concept that covers all the bases for all major Liebherr components.

Exchanging a faulty part for a refurbished alternative minimises machine downtime to under 24 hours, and at 70% of the cost of a brand-new part, but with the same

ABOVE: Liebherr’s new common-rail system is fitted to all of its engines from four-cylinder in-line to V12 models

BELOW: In Biberach, Germany and Dalian, China Liebherr produces about 600 versions of planetary gearboxes every year, mainly slewing drives, travel drives and planetary plug-in gearboxes for winches





full new parts warranty. If downtime of 3 to 10 days is not a problem, the part can be removed and overhauled in Ettlingen for approximately half the cost of a new part, but with the same guarantee. Finally, for machines that are used for only a few hours each year, the 'classic repair', using reconditioned individual parts where necessary, offers 50% of the guarantee of new components. But there is a key tenet that runs across all of them – the remanufactured part must be equal in quality to a new one.

It's not just in-house components that can be handled though – Dana axles, and MAN and John Deere engines complement the portfolio. Ultimately, the aim is for all machine components to go into the reman process, so unless the manufacturers of other components bought in for Liebherr products already offer a reman service, the company will look to perform it on their behalf.

With up to 75% reductions in raw materials and energy, and the economical 'manufacturing' of out-of-production series made possible, the benefits of reman are clear, no doubt explaining why turnover quadrupled between 2006 and 2012. Yet a couple of my preconceptions were turned on their head, especially when I asked Schöllenger whether sales boomed when the economy was in trouble and vice versa.

"It is a cyclical industry, but the opposite way to your hypothesis," he declares. "It is a misconception that customers will choose new components in good times and reman components when they are



TOP LEFT: Remanufacturing old engines would prove to be of far more benefit to the environment than another stage of emissions regulations

TOP RIGHT: As much of a remanufactured product as possible will be reassembled from previously used and reconditioned parts

ABOVE RIGHT: Each reman component is subjected to strict new-component test protocols



"A COMPREHENSIVE REMAN PROGRAMME IS WHY OEMs AND END USERS CHOOSE TO BUY OUR COMPONENTS AND MACHINES"

Kurt Schöllenger, MD, Liebherr-Ettlingen GmbH

in trouble. The reason for this is that reman has gained a reputation as a first-rate maintenance method.

"Geographically, our sales are proportional to the population of Liebherr construction machines and components in the various markets – we have the largest populations in central and western Europe," he adds. "But we expect this to change in the not-too-distant future. Demand for reman components is increasing fastest in Russia and North America, so we will open subsidiaries in Nizhni Novgorod and Burlington, Canada, this year. We also have plans to establish similar operations in Brazil, as well as in South Africa and China, to keep up with the market growth in these regions."

In conclusion, I ask whether the growing importance of reman to Liebherr has had any effect on the way the OEM designs its machines.

"Yes, definitely. The designers of machines and components always consider remanufacturing needs,

such as the easy removal and good accessibility of key parts. But I think we should see all these developments in a more general context: good accessibility will simplify regular service as well as all maintenance activities, no matter whether you call it reman or repair.

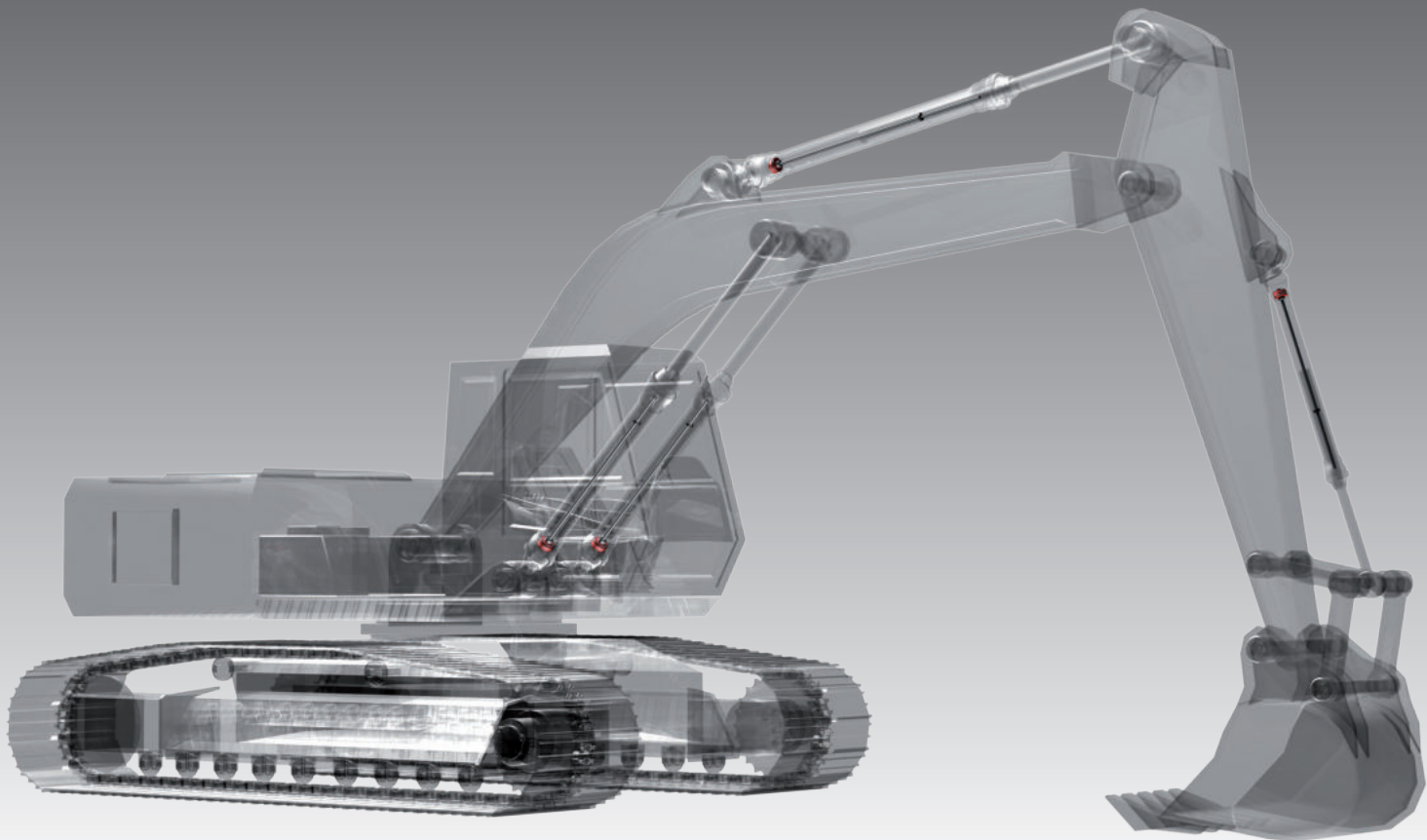
"Such a comprehensive reman programme is a key factor in why our customers – whether OEMs or end users – choose to buy Liebherr components or machines. It is designed to support new machine sales by establishing a complete lifecycle service package. Of course, third-party companies who choose to install components by Liebherr will benefit from that too – such a comprehensive reman programme reduces lifecycle costs considerably and makes them projectable far into the future." **ivT**

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ALREADY WIDELY USED IN THE AGRICULTURAL SECTOR, WHAT ARE THE ARGUMENTS FOR CVT POWERSPLIT TECHNOLOGY MAKING THE SWITCH INTO CONSTRUCTION EQUIPMENT?

▶ Continuously variable transmissions (CVTs) have been quietly gaining popularity over the past two decades – in the agricultural sector, in particular. Nevertheless, the technology is still to make the leap into many other off-highway applications, and there are still several obstacles to progress, as we shall see.

Considering the above, to gain an insight into what it takes to bring a CVT to market, it seems appropriate to start with a tractor. Claas launched its CVT-equipped Arion 500/600 at Agritechnica 2013 (see *iVT* November, p6). The new transmission, dubbed EQ 200, is offered on the OEM's medium-sized tractors in the 140-

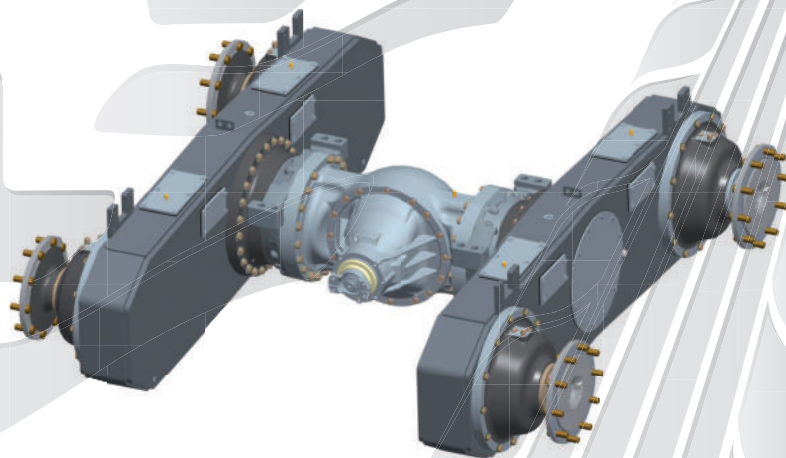
184hp segment. The basic design was originally mooted for a bus transmission, but was never realised due to the cost. The gestation period for the new gearbox was six years.

Jan-Willem Verhorst, head of R&D for powersplit transmissions at Claas Industrietechnik (CIT), takes up the story: "We examined the design and immediately saw some advantages. It took so long because, being a brand new product for us, everything started from scratch."

The design features an unusual step-planetary gear arrangement. "With this step system, there is a very smooth conversion from range one to range two," Verhorst notes. "Also, it maintains a flat efficiency



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POWERTRAINS: CVT

Claas's Arion 500/600 tractors use the EQ 200 infinitely variable transmission. Six years in development, it features innovations in both the mechanical and hydrostatic sections



“HOWEVER, THE OTHER BIG PART OF THIS STAGE WAS TO REFINE THE ELECTRONICS. THE PROGRAMMING WASN'T THE CHALLENGE HERE, IT WAS THE ALGORITHMS”

curve, which is very important. We did not want efficiency to drop off at higher speeds.”

Explaining the durability phase, he observes: “We were interested in the usual things, such as was there a rattle here, or a loose connection there. However, the other big part of this stage was the need to refine the electronics. The programming wasn't the challenge here, it was the algorithms.”

For example, take the simple process of slowing down. In a silage clamp, aggressive deceleration via the driveline is desirable, while on a slippery road it is preferable to do it smoothly and gradually by lifting off the foot throttle.

Verhorst continues, “When it came to maintenance, we thought very carefully about how to design it to be easy to look after in the field. We know in the real world things do break, so the sensitive bits such as hydraulic pipework and the

hydrostatic units are external to the box, but hidden behind a cover plate under the cab, so they can be renewed without dismantling the whole thing. This was really important for the design.”

Pondering the lack of penetration across the rest of the off-highway industry by CVT designs, Verhorst suggests cost is the main issue: “I know other companies are working on CVTs for wheeled loaders, but the purchase price still remains a drawback for those applications. On a tractor, we can afford that in specific markets because of the increased precision CVT offers, say between PTO and speed, giving better output on the ground.”

“In other applications where transmission smoothness is not so important, customers are not willing to pay any extra. However, this could perhaps stimulate simpler mechanical designs for construction equipment in the future.”

THE OEM VIEW #1

“I think the market will move to use more CVTs in the future, especially given the ‘ease of use’ of these machines. However, the challenge is to make sure they are competitive on cost and hence offer the right value to our customers.”

MICK MOHAN, GROUP
ENGINEERING DIRECTOR, JCB





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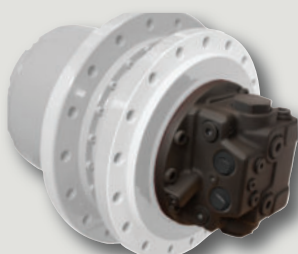
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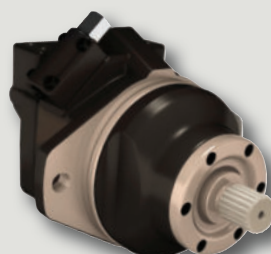
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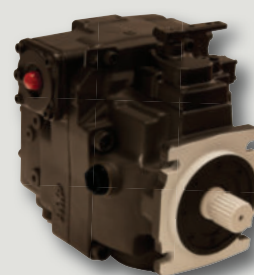
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Out of the field

Volvo CE is one of those OEMs scrutinising the cost benefits of CVTs, as Gunnar Stein, global director of driveline systems at its Technology function, confirms.

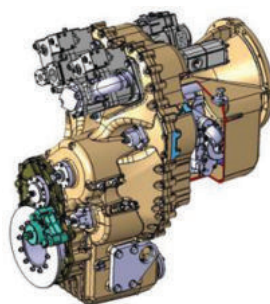
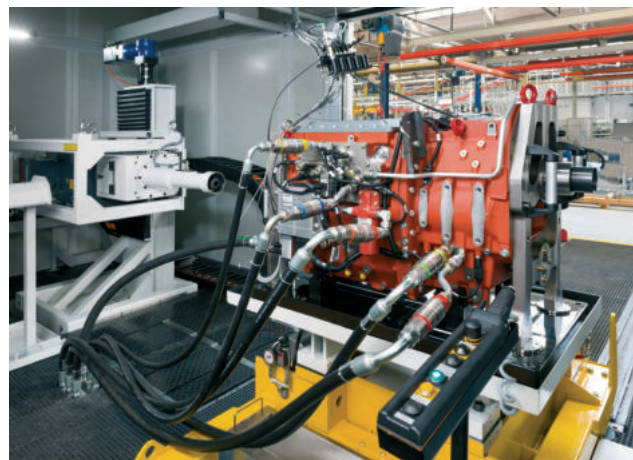
“Stepless transmissions and drivelines are a key focus area for us and we are exploring various options that we think have the potential to be effective in the future. The big question is ‘will they add value for our customers?’ Every technology option comes with a price tag so it needs to offer a definite benefit that outweighs the increased product cost, for example, in fuel efficiency.”

Stein sees the financial angle as being especially important when forecasting the growth of CVTs beyond agriculture. “It will need further development in order to be viable in construction equipment. This will require a big investment in terms of time, money and the manufacturing equipment needed. Tractors benefit from larger volumes per machine size than construction machinery, which enables a quicker payback – that’s one reason we’re seeing a large time gap in the use of this technology.

“From a pure technology standpoint, it’s not rocket science anymore – but that doesn’t mean we should make a half-hearted decision.”

Volvo has confirmed, however, that the wheeled loader is a very favourable candidate. “We can decouple the engine speed from the wheel speed, which can provide a

RIGHT: Following assembly, each EQ 200 transmission undergoes almost half an hour’s testing on the end-of-line test stand



ABOVE & RIGHT: CVTs, or electric wheel motors, as used in Volvo CE’s Gryphon concept both offer the benefits of stepless drive



“STEPLESS TRANSMISSIONS AND DRIVELINES ARE A KEY FOCUS AREA FOR US AND WE ARE EXPLORING VARIOUS OPTIONS THAT WE THINK HAVE THE POTENTIAL TO BE EFFECTIVE IN THE FUTURE”

Gunnar Stein, global director of driveline systems, Volvo CE



major advantage in wheeled loader applications,” Stein says. “It allows us to run the engine at the most efficient operating points. There isn’t a big need for the decoupling of systems in other applications, such as dump trucks, where most of the power goes into the driveline.”

From the design perspective, Volvo is championing the hydrostatic powersplit but nevertheless remains open-minded towards other concepts and technologies – such as cone-type belt-driven CVT – that could be used in smaller machines. Hybrid solutions are also being investigated.

Comparing different installations, Stein notes, “The technology would be very similar but the transmission concept would depend largely on the machine. A wheeled loader has a large drop from the engine to the axles; this is not the case with tractors. Also, this application

requires good, frequent forward/reverse shifts – which calls for a different design.”

The big step, thinks Stein, is a more widespread acceptance of stepless technology. “This can be achieved with CVTs or electrical systems, including wheel motors. We will see more electronics, but our intention is to make the machine easier to drive – rather than more complicated – and the functionality through the driveline will enable this. When we think a step further than CVT technology, there is even a chance for hybrid machines. The total cost of ownership will then determine which technology is the best choice.”

The possibility of storing energy in a wheeled loader application is very appealing for the company too. Thinking aloud, Stein suggests, “We could downsize the engine and

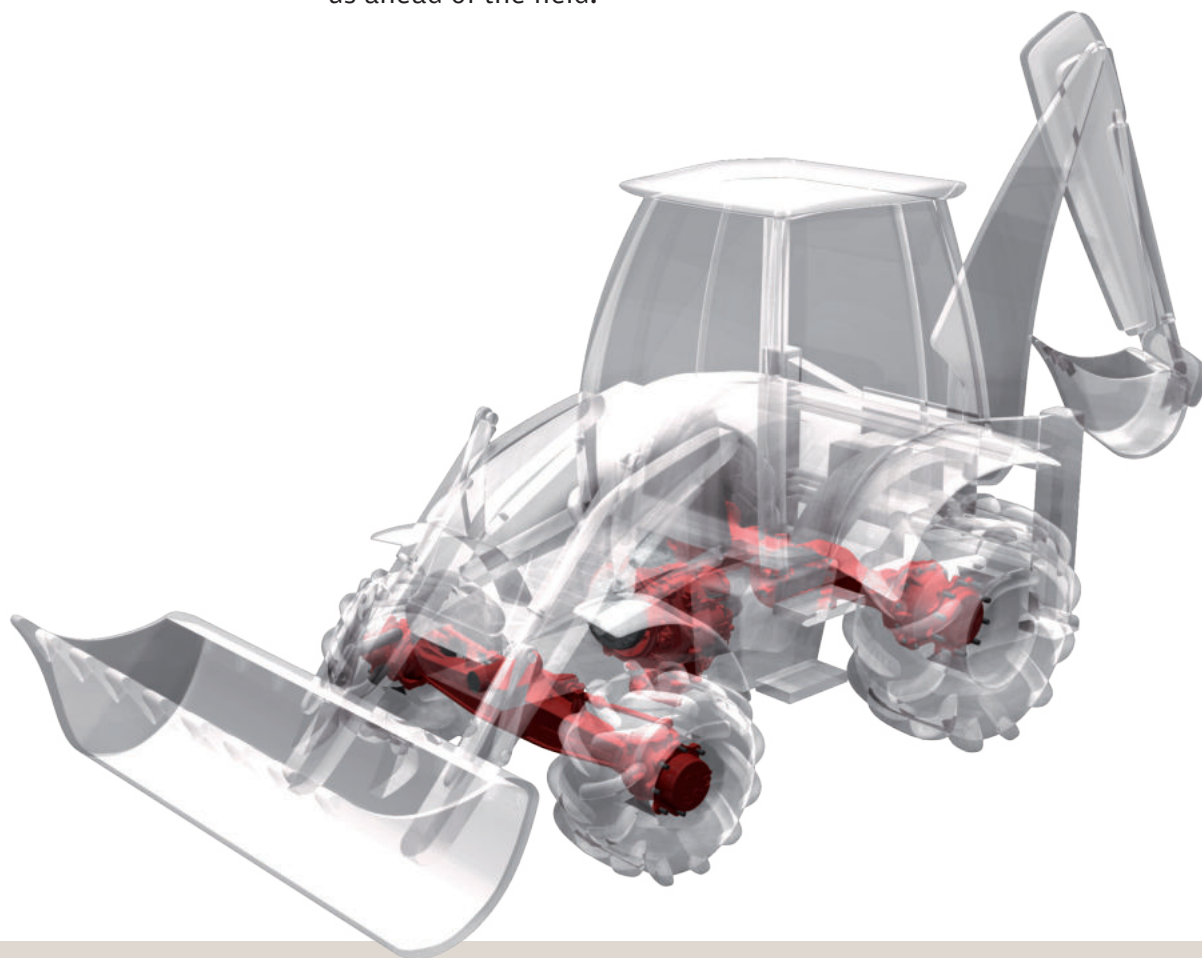


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supplement it with energy from the storage device to cover peak power demands.

"In principle you can combine CVT with a variety of energy storage devices, but I think it's probably beneficial to limit the amount of different systems used – such as electric, mechanical or hydraulic – for cost and complexity reasons.

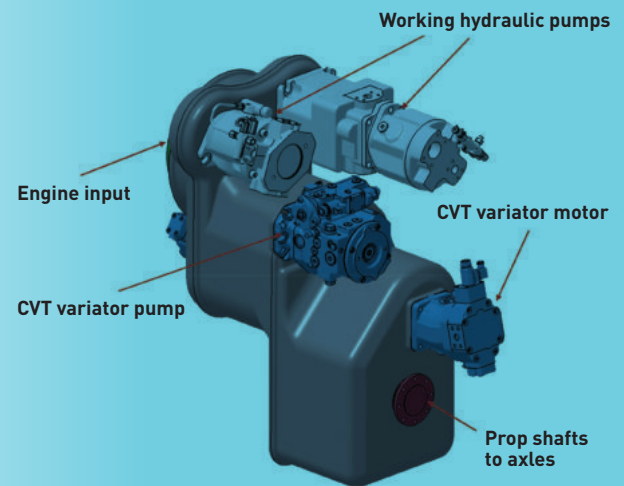
"For example, the combination of hydraulics, to provide the stepless functionality, with a mechanical flywheel system is questionable. Electrical systems for driveline technology may even provide more benefits and synergies if we can stay within one technology and make all the driveline components run more smoothly and efficiently together."

HORSES FOR COURSES

Austrian company VDS-Getriebe produces CVT layouts and concepts for power ratings ranging from below 40kW to above 1,000kW. The figure (right) shows its recommended CVT layout for wheeled loader applications.

Heinz Aitzetmueller, general manager, explains, "The reasons we choose the specific layouts are mainly driven by the vehicle's installation requirements. In our opinion, CVTs will become more and more popular in tractors, even in low-powered tractors below 120hp, as well as in high-power applications in wheeled loaders and telehandlers.

"There will also be a wider range of CVT systems ranging from hydrostatic/mechanical powersplit to electric/mechanical powersplit."



WHEN THE PLANETS ALIGN...



Rob Smithson, VP of Powertrain Innovations Engineering, explains why Dana has taken a different approach with its CVT design.

IVT: What is different about your CVTs?

The VariGlide Continuously Variable Planetary (CVP) technology offers a unique combination of controllability, robustness, flexible packaging and, above all, is low in cost, which doesn't exist in any other technology. The CVP's patented geometry combines planetary kinematics with continuous variability to achieve this.

Are there many design options? Will cone-type belt-driven CVTs ever be widely used on smaller machines?

Belt CVTs will always face limitations in terms of durability and torque capacity, particularly at low speeds. This is fundamental to the basic physics of a cone-belt variator. So, no, we don't expect to see widespread adoption of cone-belt variators.

Due to their low efficiencies, pure hydrostatics are limited to machines that don't need much power at the

wheels, such as turf care or low-speed applications. While hydromechanical transmissions use a combination of gears and hydraulics to overcome the efficiency limitations of hydrostatics, they are limited by their inherently high costs for smaller machine applications.

What does the future hold for the NuVinci?

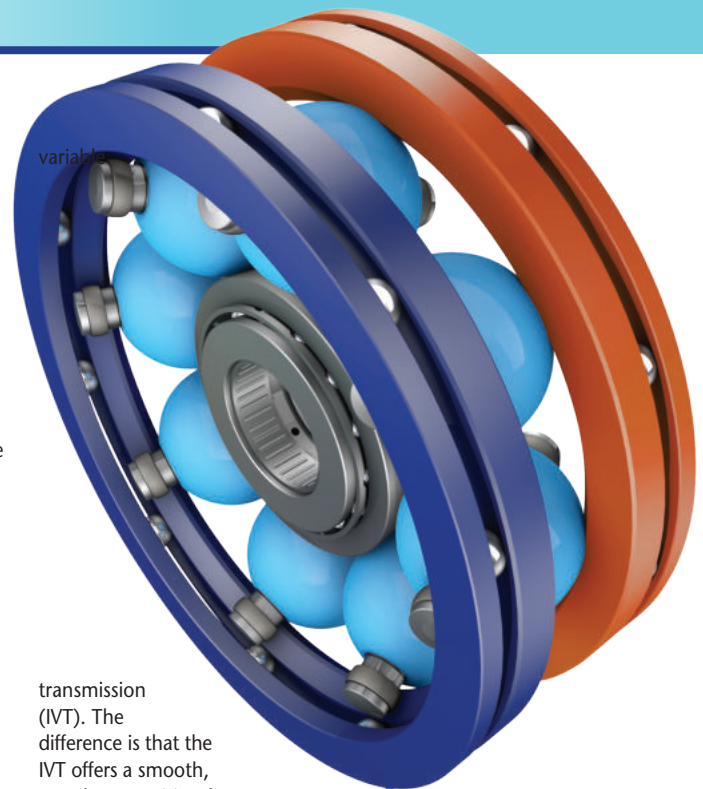
NuVinci is the brand name used by the original developer of the CVP technology, Fallbrook Technologies Inc. Fallbrook will continue to use this brand name for bicycle transmissions – where more than 100,000 have been sold to date worldwide – and for other applications outside of the fields licensed to Dana.

We hold the worldwide exclusive license to applications of the CVP technology for primary transmissions in light vehicles and for a broad array of off-highway applications. In these applications, we will use the brand name VariGlide to differentiate our larger, higher-power CVPs from those intended for bicycles. Dana is presently working with a number of OEMs in both the light vehicle and off-highway markets on moving towards production implementations, but we cannot yet commit to any specific application production dates.

What benefits could CVTs offer construction machinery?

Construction vehicles may either use a CVT or, more likely, an infinitely

variable



transmission (IVT). The difference is that the IVT offers a smooth, seamless transition from forward to reverse through a powered neutral point, whereas the CVT offers an infinite number of ratios between two forward ratio extremes, but will generally have a conventional reverse.

Any variator technology, including our CVP, can be placed into a power path with conventional gearing to achieve IVT operational characteristics. The CVP has a novel characteristic in that the variator itself can produce IVT operation with no extra gears or shafts simply by changing the torque path through the CVP. This can be done

Planetary balls positioned around a central sun transfer torque to the driveline in Dana's VariGlide Continuously Variable Planetary (CVP) technology

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WHEN THE PLANETS ALIGN... (CONTINUED)

permanently, so that the device is always an IVT, or on the fly using conventional wet clutches and one-way clutches to produce a dual-mode CVT/IVT.

In terms of vehicle operation, an IVT enables productivity improvements by speeding up certain manoeuvres that require a transition from forward to reverse, allowing infinite adjustment of speed to precisely fit operational conditions and reduce fuel burn.

How would a CVT in one class of vehicle differ from another?

Some applications will be more suited to CVTs than IVTs, some are obviously higher power than others, and still others might require either a very wide range of operational speeds (such as high transport speeds combined with low working speeds, for example) or a very narrow range of speeds combined with precise control (such as materials handling, for example).

Each of these applications brings its own unique constraints on the complete transmission design, but the VariGlide technology's versatility in powerpath

selection and operational modes allows for the same basic CVP to be used in many applications, thereby improving economies of scale.

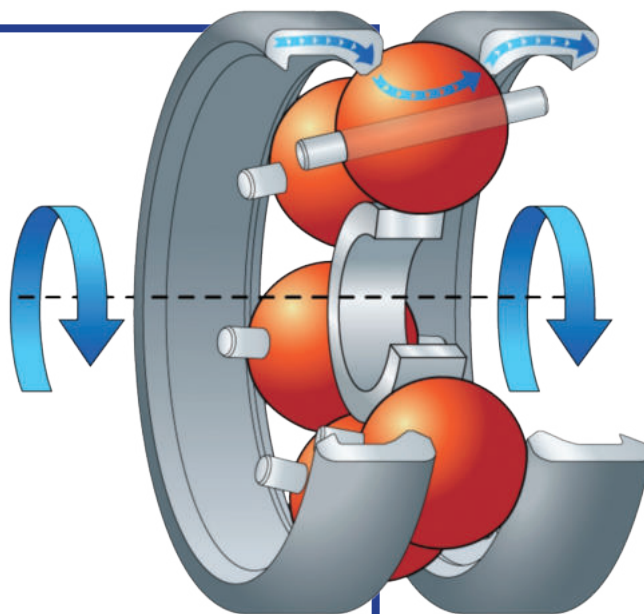
How much will CVT design influence engine design in the future?

In certain applications, a wide-ratio CVT may enable the use of HCCI engine technologies, which require the engine to operate in a somewhat narrow speed range for optimum efficiency. And with its planetary kinematics, the CVP also makes an ideal summing device for two prime movers – for example, an electric motor and a small diesel could easily be combined into a hybrid arrangement.

Until we perfect a 100% efficient engine and transmission, we believe there is always an opportunity to gain more in fuel economy!

What advances will we see over the next 10 years?

We believe that VariGlide technology is the most significant leap forward in



CVT design in the past half-century, or arguably even longer.

On the horizon, there are a number of potential incremental advances, but the costs of 'exotic' materials, such as ceramics, will have to come down considerably before they are seen as practical in off-highway applications.

ABOVE: Speed ratio changes with contact radii ratio, meaning the angle of the balls controls speed ratios through varying contact diameters

Active research

LiuGong currently offers a variety of transmissions across its diverse range of products, but is also very interested in developing CVTs. Ed Wagner, director of test and new technology, says, "We are actively researching CVTs at the moment, especially for the more advanced markets which are highly sensitive to fuel cost, and we see the day coming when most mid-sized applications will offer a CVT option."

"The days of cheap fuel are long behind us, and so as the price of a barrel of oil goes up, so does the percentage of fuel-related costs to the operator. Depending on the type of machine, we know a CVT could make up to a 30% saving in end users' fuel bills."

Wagner can't go into too many details about the research and won't be drawn into discussing possible launch dates, but he is able to offer hints about the direction. "From the design perspective, what you will see is greater use of the planetary-type

THE OEM VIEW #2

"CVT in construction machines is becoming more interesting, by offering the highest efficiency across the full speed range. The huge variety of work tasks reflects the need for the technology."

At present, Liebherr is mainly developing CVT for construction machines, especially for wheeled loaders, articulated trucks and other applications. Our studies show that CVT is not suitable for high weight classes, such as our TA240 articulated truck. We see more potential for the technology in smaller trucks.

Although we are closely examining the general potential in the agricultural sector, it is not a major priority for our company."

GEBHARD SCHWARZ, MD, LIEBHERR-COMPONENT TECHNOLOGIES

Shown at Bauma 2013, Liebherr's L 586 XPower prototype used ZF's cPower CVT, but Liebherr is now working on its own system



POWERTRAINS: CVT

transmissions, which lend themselves well to having a dual path; one mechanical and the other either with electric motor generators or hydraulic pumps to vary the speed. This is a well understood concept, which we'll no doubt see in more applications, probably starting with our wheeled loaders."

Currently LiuGong is accessing the implications for the vehicle's purchase price, as well as what a

continuously variable transmission means in terms of engine design.

Despite differing approaches, it does seem that market forces, in particular fuel costs, are conspiring to ensure that CVTs will be fitted to more than just tractors in the future.

Strange to think, but describing something as 'somewhat agricultural' used to suggest crudely engineered. Perhaps it's time to rethink the expression. **IVT**

"DEPENDING ON THE TYPE OF MACHINE, WE KNOW A CVT COULD MAKE UP TO A 30% SAVING IN FUEL BILLS"

Ed Wagner, director of test and new technology, LiuGong

POLAR OPPOSITES?



Mark Mohr, ZF Friedrichshafen AG's director of industrial technology, shares his thoughts on CVTs past, present and future.

IVT: As CVTs have been used for so long in tractors, why is it only now that other sectors are interested?

In tractors, the CVT is focused on optimising the agricultural process. This is especially so in combination with implements such as seeding machines, where a constant engine speed under changing driving conditions is very important.

For other machines, such as wheeled loaders, fuel consumption is the priority. However, CVTs can provide additional new degrees of freedom because the engine, drivetrain and working hydraulics can be optimised, which makes the technology interesting for a lot of applications.

What do you see as the current ideal design for a CVT?

Before we started to develop the cPower transmission, we did a detailed study to analyse all possible CVT concepts, with the goal of finding a common CVT for use in agricultural and construction applications. We learned that there is not one ideal CVT for both applications, due to their different requirements and load cycles. Therefore we decided to develop a special one for construction applications.

There are several characteristics that help make a system ideal for these applications.

In a wheeled loader, it is most important to control the torque during bucket filling, in combination with an excellent reversing performance. To ensure a high efficiency hydrostatic/mechanical power-split in all ranges, as well as an efficient gear set, a low number of open clutches is necessary.

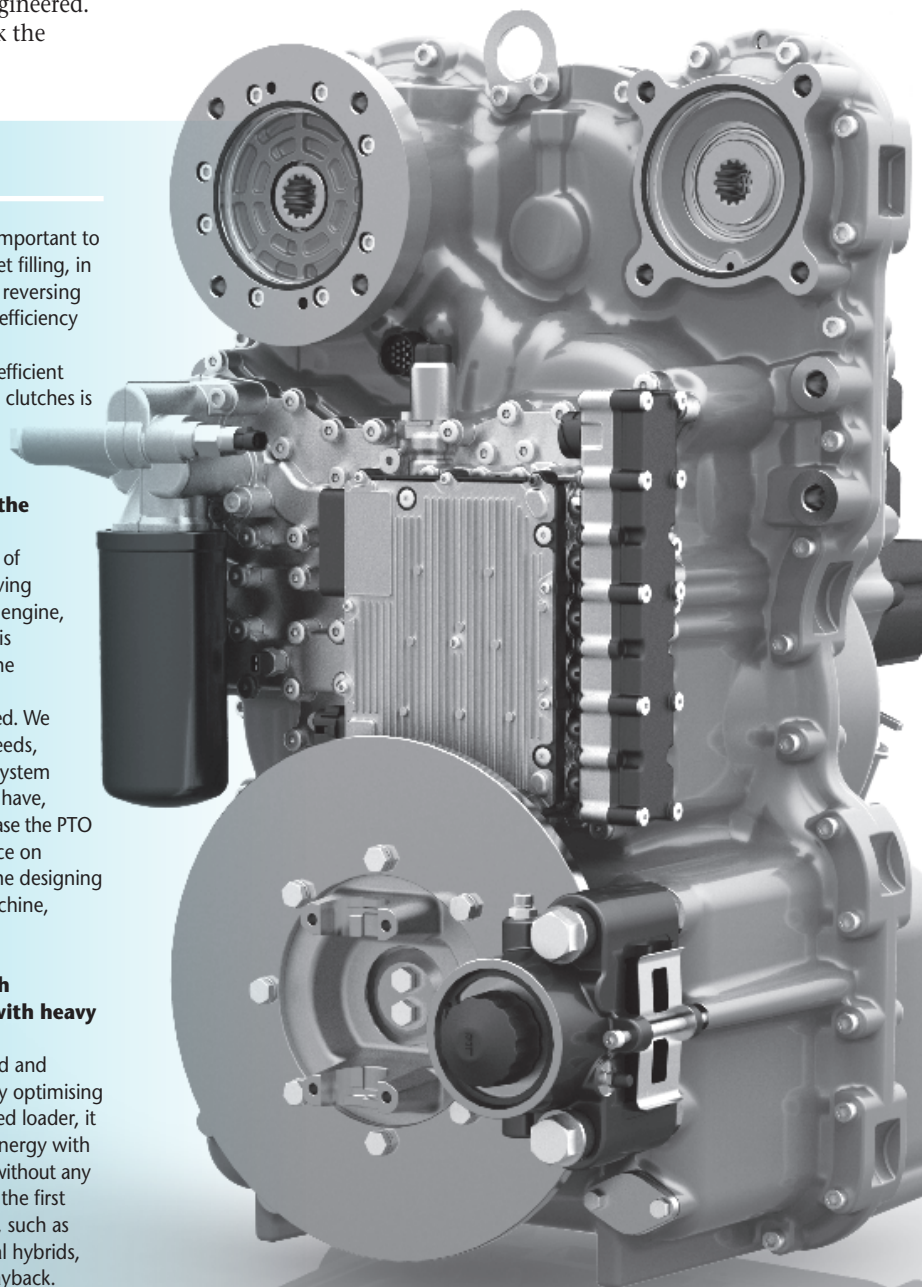
How much will CVT design influence engine design in the future?

The CVT permits a high degree of freedom. We can adjust the driving strategy to the demands of the engine, so to use the full potential of this technology we are operating the engine in areas where they are not ordinarily used. We will use much lower engine speeds, and that influences the whole system including the hydraulics, so we have, for example, been able to increase the PTO ratio. Also, as there is an influence on emissions, we have to look at the designing the whole system together: machine, engine and driveline.

Will CVTs ever hook up with KERS-type devices to help with heavy bucket lifts?

We have analysed a lot of hybrid and energy-recuperation systems. By optimising the machine system of a wheeled loader, it is possible to recover braking energy with the hydraulics or the auxiliaries without any extra storage units. This will be the first step, but all other technologies, such as electric, hydraulic or mechanical hybrids, still have a problem with the payback.

But I'm sure we will see more of these systems in the long term, and our analyses show that they can be combined perfectly with a CVT transmission.



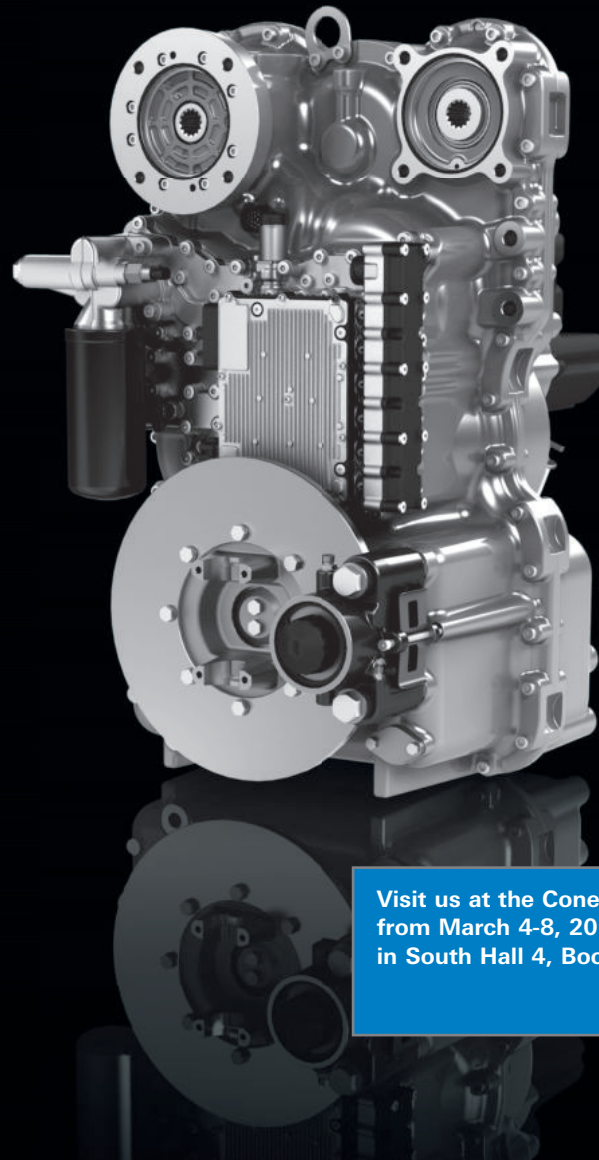
ABOVE: ZF's cPower CVT combines hydrostatic and mechanic drive concepts for fuel savings up to 25%

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WHEELED LOADERS HAVE TRADITIONALLY BEEN AVAILABLE IN TWO FORMS – COMPACT MODELS WITH A HYDROSTATIC DRIVELINE, AND LARGER, MECHANICALLY DRIVEN VERSIONS. WITH ITS XE MODELS, CAT HAS COMBINED THE DISTINCT BENEFITS OF EACH INTO ONE TRANSMISSION

▶ In a world where evermore stringent emissions regulations jostle with customer demands for increased performance, any rise in tonnes moved per litre consumed productivity is likely to be well received. However, while the laws of diminishing returns force OEMs to talk of single-digit percentage improvements – if they are lucky – back in 2012, Caterpillar surprised many with claims of a potential 25% economy improvement for one of its mid-size wheeled loaders.

The machine in question was the 966K – not the standard 966K, but the 966K XE, boasting the company's first mainstream continuously variable transmission. Of course, there is nothing new about CVT – the technology has been commonly used in on-road vehicles, and more recently on agricultural tractors, for some years. What is perhaps novel is the way that Cat has gone about incorporating two drive systems – one hydrostatic and one mechanical – in a single machine.

A standard wheeled loader of this size would typically use a powershift automatic transmission with a torque converter; indeed, that is exactly what's on offer in the standard 966K and pretty much every other Cat

wheeled loader above this size. The alternative, traditionally seen in smaller models, is a full hydrostatic driveline, with a hydraulic pump and motor driving either the axles or wheel motors. Although this is efficient in a smaller machine, heat generation increases and overall efficiency drops away as vehicle size grows.

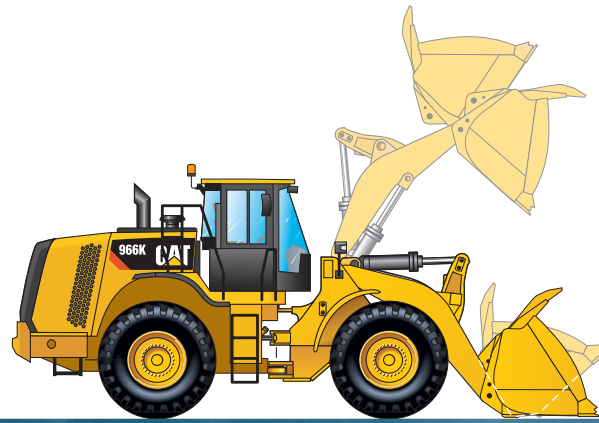
The hydromechanical CVT transmission is therefore designed to combine the two transmission systems, so as to improve efficiency throughout the operating range, using the instant torque of a hydrostatic system at low speeds and the efficiency of a mechanical transmission as speeds rise.

Add another

This year's ConExpo in Las Vegas will see Caterpillar move on from that original 966K XE with the launch of the 966M and the larger 972M. Both wheeled loaders will also be available in XE versions, equipped with the hydromechanical CVT driveline.

The company is understandably coy about exactly how many 966K XE machines have been sold so far, although one suspects it must be enough to push the technology into

CASE STUDY



Cat's latest 966M and 972M models are available with a choice of drivelines: standard powershift with torque converter, or in XE form with a hydromechanical continuously variable transmission



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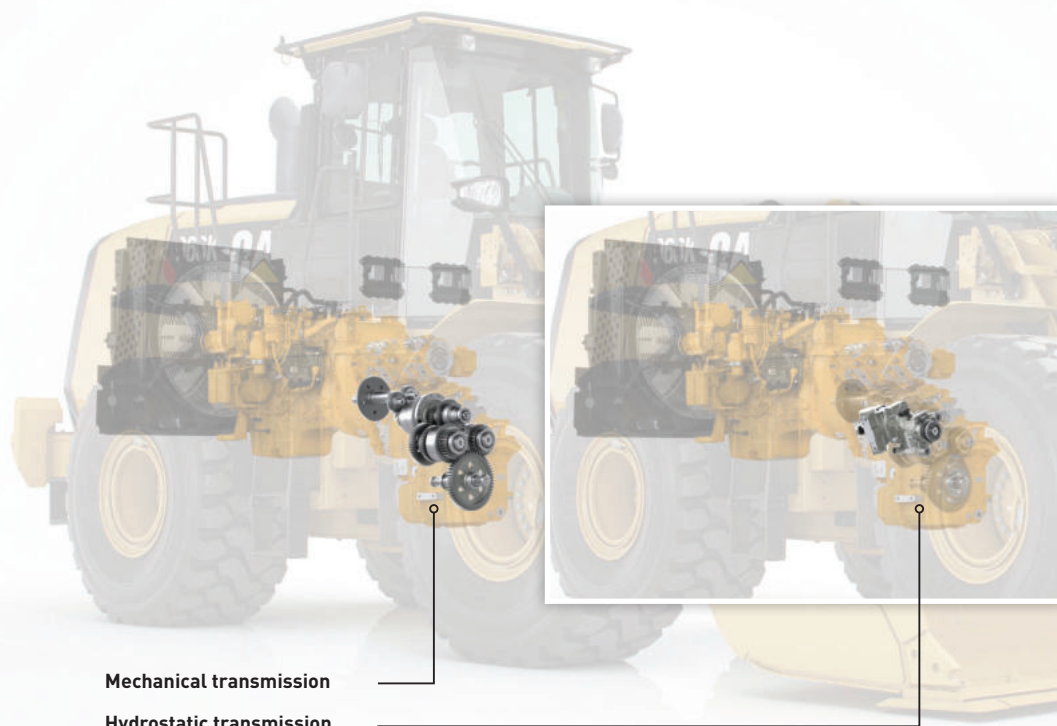
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Mechanical transmission

Hydrostatic transmission

“THE 966K XE TRANSMISSION REDUCES FUEL CONSUMPTION IN ALL APPLICATIONS, BUT THE ADVANTAGE IS EVEN GREATER IN TRUCK LOADING AND SHORT LOAD-AND-CARRY APPLICATIONS”

additional models. Cat's European medium-wheeled loader product and application specialist Thierry Brasseur admits that, “Although distribution of the 966K XE was limited to a few European countries, sales exceeded our expectations.

“The XE machines will, of course, provide a better return on investment in applications with higher hourly fuel rates, or higher operating hours than average. The XE transmission can reduce fuel consumption in all applications, but the advantage is even greater in truck loading and short load-and-carry applications, where the torque converter lock-up of a conventional powershift machine doesn't engage.”

Setting standards

Caterpillar's standard M Series machines now boast lock-up clutch torque converters and a split-flow oil system in the planetary transmission, both of which are aimed at reducing fuel consumption. Yet even with a promised 10% improvement in fuel economy over the K Series models they replace, this more traditional route still falls some way behind the advanced XE models with their CVT drivelines.

So how does the XE transmission work? The wheeled loaders have a mechanical transmission working in parallel with an infinitely variable hydrostatic variator. The hydrostatic

pump sits below the transmission input shaft and because there is no requirement for a conventional torque converter, there are no hydraulic losses in the system.

Engine power is split at the input spur gears and recombined using a planetary gearset. The planetary ring gear speed is determined by the hydrostatic motor. With the hydrostatic pump fully swivelled to one side, there is no output to the transmission, slowing the planetary ring gear. At that same point, the mechanical transmission output increases machine travel speed.

However, as the pump goes past zero displacement, the motor rotates in the opposite direction, increasing transmission output and machine speed. In effect, the hydrostatic part of the transmission plays a major role at lower speeds, providing instant acceleration and strong torque at the axles, without the need for a power-sapping torque converter. As speeds increase, the mechanical transmission takes on more of the drive work.

The hydrostatic variator provides ratio flexibility, so the machine is never in the wrong gear. This helps reduce heat build-up under heavy load and prevents slipping and excessive wear at the tyres. This continuously variable gear ratio approach enables Cat to run the engine more efficiently at a lower

ABOVE: The combination of two distinct drive systems improves efficiency throughout the entire operating range

BELOW: Not your usual brake and accelerator, but the XE models are said to be easier for a novice to operate

rpm, reducing noise and emissions and conserving fuel.

Easy rider

The machine operator is presented with a very simple set of controls and can simply put the machine in 4F and allow the transmission to automatically change ratios if desired. The cab has two pedals on the floor, but they are not strictly a throttle and a brake. Indeed, the right pedal is not really a throttle at all, in the traditional sense of being attached to the engine's fuel system, but offers control of both throttle and rimpull.

The left pedal is what Cat calls a modulated neutraliser, integrating speed control, retarder and service brakes in a single pedal, depending how hard the operator pushes. By gently pushing, the operator can



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also control rimpull through the modulated neutraliser. If he pushes further, a continuous retarding strategy is activated, which then smoothly downshifts the engine and transmission, regenerating braking power to drive both hydraulic and cooling fan pumps. Fully depressing the pedal brings the service brakes into play – though by now the requirement for actual braking will be greatly reduced, extending service brake life and reducing maintenance costs for the customer.

The operator can also set the machine speed for downhill driving using the pedals and then maintain that speed without touching them any further. The machine will hold on a grade without rollback, with no input from the operator.

The operator can also programme ‘virtual’ gears into the transmission, in effect varying speed limits to suit site conditions and regulations. The loader’s maximum speed in forward and reverse gears can be separately limited, and there is no requirement to downshift when attacking a face, as the machine will automatically reduce speed and increase rimpull to drive the bucket into the material. Should more hydraulic power be required for the boom or bucket lift, the power sent to the transmission through the left pedal can simply be reduced.

Doing more with less

Cat says that while the machine is aggressively digging, the XE model probably consumes half the energy that would be used by a conventional powershift transmission, with no loss in terms of productivity and tonnes moved.

A side bonus for would-be customers is the OEM’s claim that the XE machine is easier for a novice operator to get to grips with. Plus, the systems will prevent abuse and overspeeding of the engine, while extending service brake and tyre life.

The XE transmission has been built as a modular component, so can be installed in either machine without changing other components, such as axles. “We have designed the CVT as a drop-in alternative to our powershift transmission to facilitate the manufacture of both versions,” says Brasseur. “System integration is one of Caterpillar’s main strengths and advantages, and the transmission is designed and assembled by Caterpillar.”

Speaking of axles, the OEM has now upgraded them on the M Series machines, with lower oil levels and new bevel gear shrouds to prevent oil-churning losses. The axles also feature a new multiplate disc-type differential lock to improve traction.

“The differential lock can be compared to a multiplate clutch,”

ABOVE: There’s no need to downshift before digging into the pile – XE models will automatically reduce speed and increase rimpull

BELOW: Even in standard powershift version, the new M series models are claimed to offer 10% fuel efficiency improvements over their predecessors

adds Brasseur. “It reduces tyre scuffing as it doesn’t automatically engage when the machine is steered, like other traction aids do.”

The machines now have external calliper disc parking brakes mounted on the input shaft of the front axles, rather than the drum brakes of the K Series. Cat says that calliper brakes offer a higher capacity and that, as they are external, they do not suffer the inefficiency of wet parking brakes, or face the additional maintenance requirement to regularly change and cool the oil in a wet disc setup.

In full flow

The 966M and 972M also benefit from extensive changes to their hydraulic systems. Cat has opted for a monobloc hydraulic valve on the new machines, reducing weight and cutting possible leak points by 40%. The valve block also incorporates the ride control boom suspension valve, and ride control now comes with two accumulators for a greater payload range. Auxiliary third and fourth hydraulic functions can be added at the factory, or in the field with the addition of a second remote valve.

Both machines have revised hydraulic implement pumps with larger displacements for increased

WHILE THE MACHINE IS AGGRESSIVELY DIGGING, THE XE MODEL CONSUMES ROUGHLY HALF THE ENERGY THAT WOULD BE USED BY A CONVENTIONAL POWERSHIFT



CASE STUDY



“THE M XE MACHINES HAVE A SECOND PUMP, WHICH INCREASES DISPLACEMENT BY 27% OVER THE M SERIES POWERSHIFT VERSIONS”

hydraulic flow at lower engine revs. A thermal bypass valve has also been added to improve hydraulic oil warm-up.

“The displacement of the pumps has been increased by 14% from the K to M Series,” reveals Brasseur. “In addition, the M XE machines have a second pump, which increases displacement by 27% over the M Series powershift versions.”

Although the XE machines, by virtue of their CVT systems, do carry a premium over powershift models, Cat claims that the payback time is only two years at today’s fuel prices. And that’s not taking into account the additional productivity on offer from the CVT-equipped machines.

So surely the system will become standard across the OEM’s wheeled loader line-up? Apparently not yet. At present the CVT option will be offered only on these two mid-weight machines.

“Other mid-size wheeled loaders are being investigated,” Brasseur reveals. “However, the XE CVT isn’t available on any other models at this

BELOW: Short truck-loading operations are an area where the fuel-saving benefits of the CVT will be most noticeable

time and may never come into production elsewhere. Caterpillar maintains a very comprehensive portfolio of drivetrain technologies – hystat, powershift with lock-up torque converter, continuously variable transmission with parallel path technology, electric drive, hybrid and others – evolving with technology capabilities and costs, and with energy prices to provide our customers with the best solution for their application.”

Conditions apply

For now at least, the 966M XE and 972M XE demonstrate that a parallel

A QUIET LIFE

▶ The 966M and 972M loaders are powered by Tier 4 Final Caterpillar C9.3 ACERT diesel engines. These are rated at 316hp (232kW) in the 966M and 341hp (251kW) in the larger 972M.

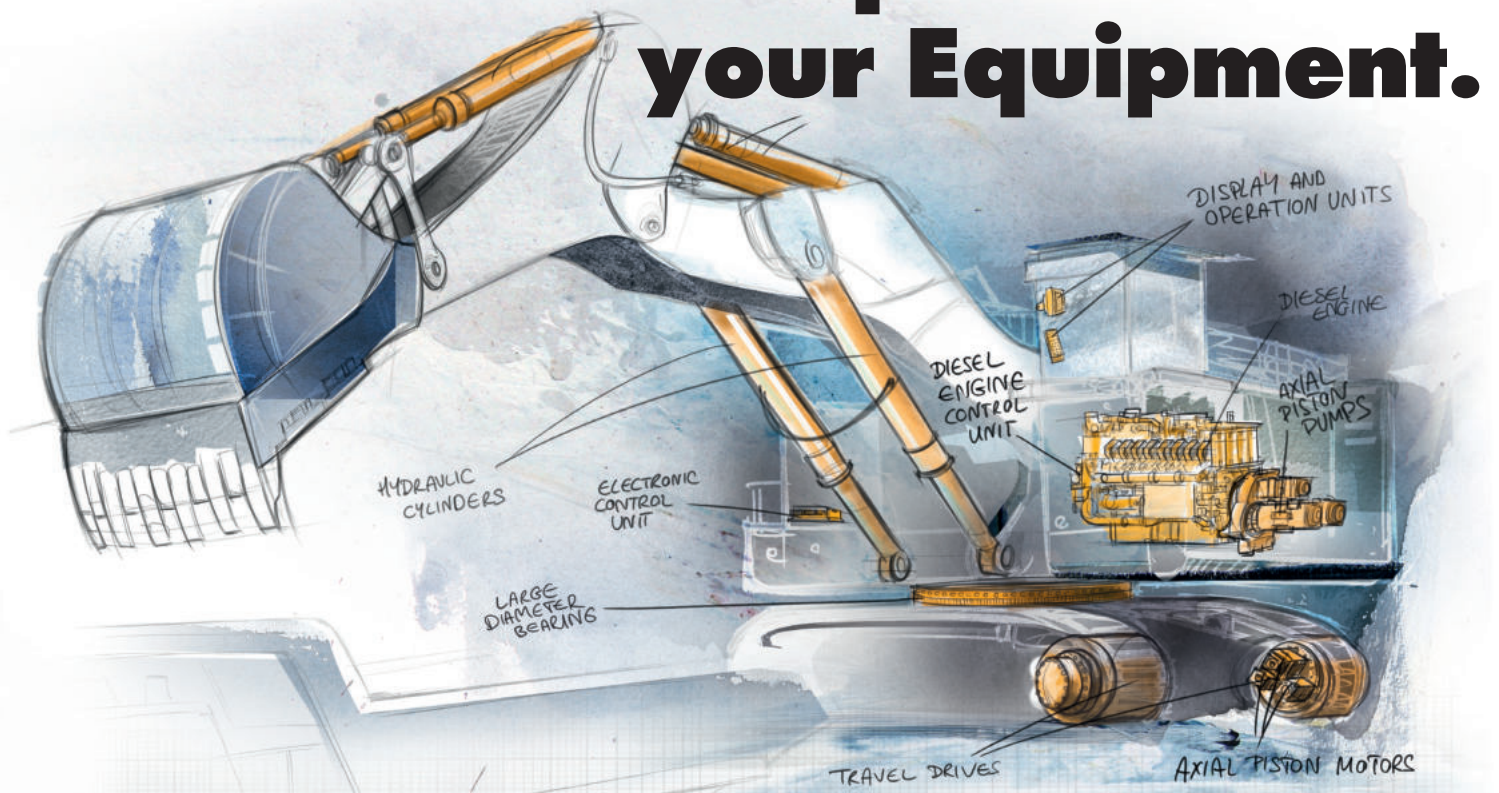
While both powershift machines have an operator sound pressure level of 69dB(A) in the cab and an external sound level of 108dB(A), the XE machines register just 67dB(A) in the cab and 105dB(A) outside, a massive cut in noise levels due in part to the lower engine revs and reduced cooling fan speeds.

path continuously variable hydromechanical transmission is not only possible but, in the right site conditions, can be a more than viable proposition.

Certainly customers will need to look at their individual operation, type of material, length of carry and topography to work out whether the CVT option will provide the required savings over a conventional powershift transmission to justify the additional purchase cost. Having proved the technology on the 966K XE, though, it certainly appears that Cat has made CVT a viable mainstream option. **ivt**



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IN BRINGING THE BENEFITS OF STEPLESS DRIVE TO ALPINE FARMING THROUGH THE DEVELOPMENT OF A COMPACT CONTINUOUSLY VARIABLE TRANSMISSION, THE WINNER OF THE 2014 TRACTOR OF THE YEAR SPECIALISED CATEGORY PRESENTS THE IDEAL MIX OF CHARACTERISTICS – FOR ON-HIGHWAY USE OR WORK ON STEEP HILLS ALIKE

▷ Crisp, fresh air; mountain peaks towering above dense pine forests; and the clanging of cowbells as a herd of hardy Brown Swiss cattle graze their way across the wild flower-strewn upland meadows of an Alpine farm. It's an idyllic image that belies the realities of farming at altitude on slopes so steep that only the bravest or most foolhardy farmer would contemplate operating anything other than specialist tractors and machinery.

Traction and stability are the key words here because this is no place for top-heavy vehicles or trailers, narrow track widths and skimpy tyres. The daunting prospect of a potentially catastrophic slide or roll into the treeline – or into oblivion in the valley below – sees to that.

Instead, farm vehicles need a low centre of gravity and grippy tyres, which is why the tractors and self-propelled vehicles used by farmers working upland slopes in the Alps and other mountain ranges in Austria, Switzerland, Italy and Germany are quite distinct from their lowland counterparts. None more so than the 'transporter' – a truck-like vehicle with a forward control cab positioned where it can be mounted as low as possible, and small diameter wheels to keep the outfit as low slung as is feasible.

Mechanical power take-off and hydraulic drives are available to the implements but, unlike conventional

tractors, these vehicles work mostly with interchangeable bodies for collecting forage, spreading manure, transporting logs or simply as a self-propelled general-purpose trailer.

Unfortunately, these highly specialised vehicles are rarely seen outside of their European Alpine heartland. Swiss manufacturer Aebi is one of the established manufacturers and has created a bit of a buzz with its latest model, the VT450 Vario. For one thing, this multipurpose transporter is unusual in that it is being made available in two forms – an agricultural version for the duties described above, and the Viatrac municipal model, which can be fitted with Aebi Schmidt's snow-clearance and other kit for highway maintenance work.

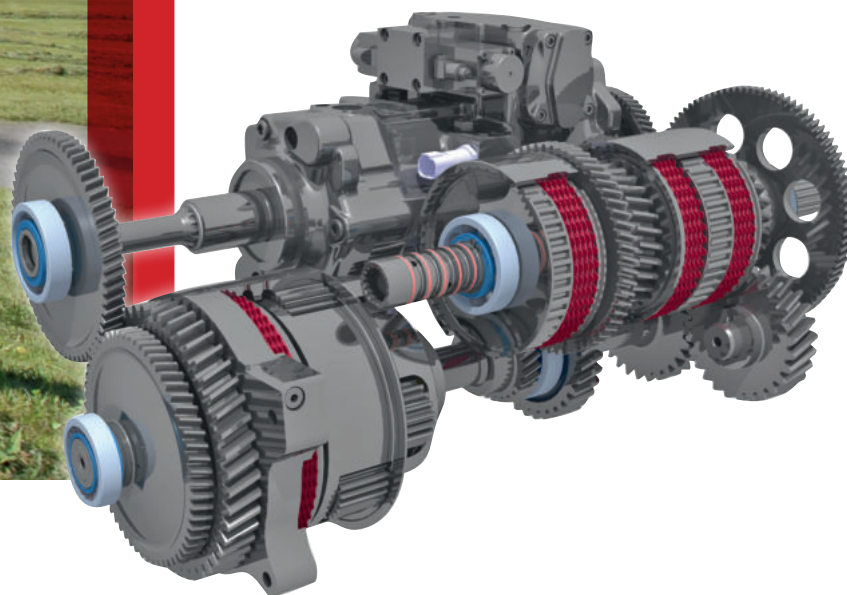
"In either of these forms, the new VT450 Vario is a very versatile vehicle," says Philipp Hohl, product manager at Aebi. "It was important for us to produce agricultural and municipal versions because we are established in both markets, while the bigger sales potential offers economies of scale through the increased production volumes."

Point of interest

The other thing that adds interest to the VT450 – and in fact is said to make it unique – is the adoption of a hydromechanical powersplit transmission, which accounts for the 'Vario' reference in the vehicle's

MAIN IMAGE: The Aebi VT450 Vario brings CVT advantages to Alpine farming

LEFT: Purpose-built CVT from VDS Getriebe



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“VDS GETRIEBE DEVELOPED A VERY SPECIFIC VARIABLE-SPEED TRANSMISSION THAT FITS IN TO OUR TRANSPORTER AND WHICH MEETS OUR CUSTOMERS’ REQUIREMENTS”



title. It does not, however, indicate the source of the transmission – AGCO’s Fendt division might have been first to apply the term to a continuously variable transmission (CVT) but it now has much wider usage. In fact, the VT450 Vario uses a CVT from a manufacturer founded in 2009 that specialises in the development of innovative drive systems for a wide cross-section of applications, from small on- and off-highway vehicles to railway locomotives.

“VDS Getriebe developed a very specific variable-speed transmission that fits into our transporter and meets our customers’ requirements,” says Hohl. “The design is light and compact, and provides the simple driving characteristics of a hydro transmission, with fine adjustment and secure speed control.”

VDS (Variable Drive Systems) may be relatively new in drivetrain engineering but the Austrian company certainly does not lack expertise – its employees are specialists with a great

deal of experience in transmission engineering, from concept to mass production.

The company’s location holds a clue as to the source of some of this expertise: the company is based in Wolfen, close to the town of Steyr, which has a strong history of CVT development. The S-Matic design – one of the first tractor CVTs – was developed by the off-highway transmissions unit of Steyr-Daimler-Puch for Steyr’s agricultural tractors built nearby. That transmission business was acquired by ZF not long afterwards; it still builds the S-Matic as a heavy-duty alternative to its Ecom design.

VDS chief Heinz Aitzetmüller points out that while CVTs based on the principle of hydrostatic-mechanical powersplit have been on the market for more than a decade and are well accepted in agricultural applications, production costs have been too high to put the technology into small or specialist vehicles such as low-power tractors and handling

ABOVE LEFT: Transmission and front axle layout – note lock-out wishbone independent suspension

ABOVE RIGHT: Forward control cab and small wheels keep everything as low to the ground as possible

machines. “We’ve developed a new system of powersplit transmission characterised by a simple and modular concept that is suited to agricultural, construction, handling or municipal applications,” he says. “Among the challenges we had to meet are low production numbers and specific installation requirements for different vehicles.”

Twin planet

The VTP (Variable Twin Planetary) transmission integrated in the Aebi transporter is a compact powersplit design that provides infinitely variable speed control for vehicles of 70-100kW (90-130hp).

“It uses only hydrostatic drive for low speeds, and up to three powersplit ranges for higher working and travel speeds,” Aitzetmüller explains. “It’s the transmission output via twin planetary gearsets that is the defining design feature, together with small hydro units; the VTP achieves high drawbar pull and a wide speed range with this combination.”



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In addition, he says, the VTP transmission is a simple and cost-effective design that can easily be adapted to meet specific installation requirements. It comprises an input shaft from the engine with spur gear drive to the hydrostatic unit, which incorporates a variable pump and a constant output motor. These are arranged back-to-back for the Aebi VT450 Vario application but can also be arranged as separate units in different configurations to suit other vehicle installations.

The reverse gear and clutch assembly is followed in-line by second and third gear clutch packs; alongside is a shaft that transmits drive from the hydrostatic unit to the sun gears of the tandem planetary units.

At the beginning of the first powersplit range, the hydrostatic drive rotates in the opposite direction to the mechanical branch so as to reduce the output speed. The more the variable piston pump is pivoted towards zero, the less the rotational

speed of the mechanical branch will be reduced.

Once the variable piston pump is positioned at zero, there is no longer hydrostatic drive, which means the output is purely mechanical. Then, by swinging the variable piston pump in the positive direction – so that the hydrostatic and mechanical branches now rotate in the same direction – maximum velocity within the first powersplit driving range is achieved.

ABOVE: Viatrac is the municipal version equipped to handle Aebi Schmidt's snow clearance vehicles and other equipment

BELOW: Steep slopes mean that manure spreaders (pictured) and hay harvesters, etc. are best carried rather than towed



Shifting between forward and reverse is achieved at synchronous speeds, and between the first and second powersplit forward gears using friction clutches with gap compensation.

Full speed ahead

"Among the advantages of the VTP transmission are the increased gear ratio in powersplit gears due to the double planetary unit, and that just two powersplit gears are required to achieve sufficient maximum speed with standard hydrostatic units," says Gerhard Hörmann of the VDS testing department. "High efficiency is obtained due to the small hydro units and low speed differences in the open clutches, even at high travel speeds."

Dry sump lubrication also helps in this respect; in short, Hörmann suggests, the VTP is a robust, cost-effective design for smaller vehicles, with a modular concept around the core unit comprising the clutch shaft, countershaft, planetary



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RIGHT: Shapely console in the two-man full-width cab

gearset and housing that enables a variety of installation arrangements to suit different vehicle types.

Don't interrupt

As for efficiency, the new CVT provides the familiar characteristics of uninterrupted power flow, which benefits productivity and driving ease, Hohl points out. And the ability to run at, for example, 40km/h with reduced engine speeds is good for fuel economy, too.

A key feature is that hydrostatic-only drive is available for speeds up to 7.3km/h forwards and in reverse. Thereafter, two hydromechanical ranges are provided for the Aebi transporter application, providing 7.3-32km/h for field work and off-highway travel, and 31-50km/h for road travel.

As with CVT-drive tractors, the travel direction can be selected and ground speed regulated at high or low engine revs via a multifunction joystick located on the centre

WHERE NEXT FOR VTP?

► Candidates for the VTP transmission, VDS's Gerhard Hörmann says, include compact and vineyard tractors, small telescopic handlers, forestry vehicles, road sweepers and the like. These would all benefit from CVT drive, typically have 70-100kW (90-130hp) input power from an engine with 2,200-3,600rpm engine rated speed, and are often built in modest volumes of 25 to 200 units a year.

Small, multipurpose transporter vehicles such as the Aebi unit certainly fit that description, of course, and with the new transmission, the Swiss OEM now has a unique feature for its top model 15 years after starting to make vehicles of this type.

According to Philipp Hohl, in the Aebi VT450 Vario, the transmission fulfils a long-held demand of many customers: "The transmission will securely hold the vehicle on sloping ground, even without the brakes applied, and thanks to the purely hydrostatic drive at low speeds it is possible to smoothly start and reverse the vehicle on sloping and difficult terrain," he points out. "This ensures a constant high level of safety, which is further enhanced by the rotary switch that can be used to set a maximum driving speed."

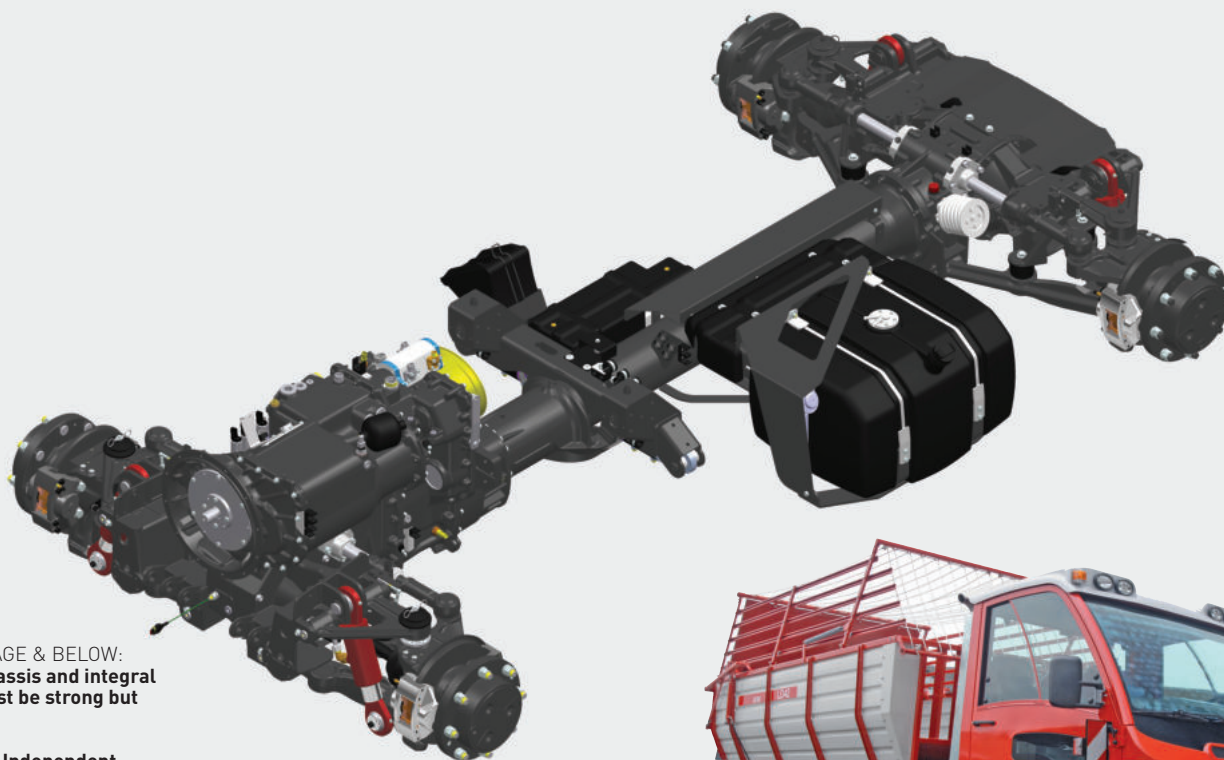
"THE TRANSMISSION WILL SECURELY HOLD THE VEHICLE ON SLOPING GROUND, EVEN WITHOUT THE BRAKES APPLIED"



console of the two-seater full-width cabin. Alternatively, by moving the joystick to the fully forward position while the vehicle is stationary, speed can be simply regulated using the accelerator pedal.

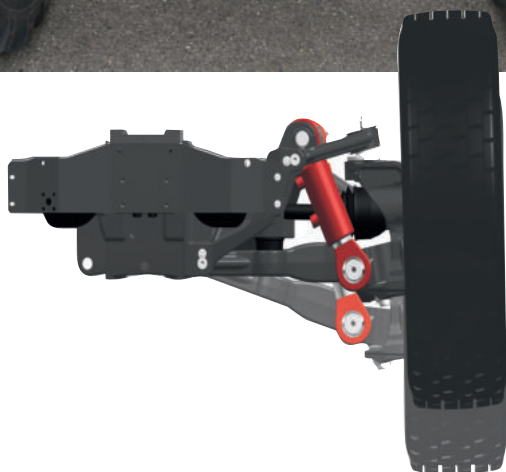
There are other features packed into this pint-sized vehicle to ensure it is able to handle the rigours of the Alpine environment, including permanent four-wheel drive with centre and axle differential locks for ultimate traction.

CASE STUDY



MAIN IMAGE & BELOW:
Tough chassis and integral
axles must be strong but
compact

BOTTOM: Independent
suspension at both ends
can be locked solid



A compact hydropneumatic suspension system with adjustable ride height and 100mm of wheel travel is provided by independent double transverse links both front and rear. The hydraulic transverse stabiliser on the rear axle can be switched off and blocked.

Also, the suspension at either end can be locked out when operating heavy deck-mounted equipment – at the rear by remote hydraulic control from inside the cab and manually at the front.

The front-engined chassis rides on 17in or 18in flotation or tractor-grip Alliance tyres, while all-wheel steering is available for maximum manoeuvrability. The Starco Schaad double-wheel system is a further option to reduce ground pressure and raise the stability factor.

Driving force

Engines for all of Aebi's transporter models have been supplied since the late 1990s by VM Motori – now a wholly owned subsidiary of Fiat

rather than General Motors (GM). Because of the municipal version's highway role, an engine with Euro 6 emissions compliance must be used, so the 2.97-litre four-cylinder to R754EU6 spec is ahead of most other agricultural vehicles in this respect.

It provides 80bkw (109bhp) peak output at 2,600rpm according to ECE R24 measurement, and 420Nm of torque between 1,100rpm and 1,400rpm. Selective catalytic reduction (SCR) and a particulate filter deal with emissions issues.

Transporter vehicles such as the Aebi VT450 Vario play a key role in providing the means to efficiently and safely harvest forage for livestock, and perform other routine operations on farms in mountainous regions. The development of suitable CVT technology for this and similar vehicles gives farmers in these areas the same speed control and driving ease as their lowland counterparts, with added safety resulting from the uninterrupted drive that a powersplit transmission provides. **ivT**



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▷ Tracks or tyres? It's been a thorny subject for many years, particularly for designers of tractors and other agricultural vehicles. So for those for whom the benefits of each system hold particular appeal, several solutions have recently been offered, such as quadtrack systems that can be switched with the wheels when required. That's not the most user-friendly arrangement, of course, so a solution that combines the best of both worlds is often more suitable.

Take the Galileo system, for instance – a track that 'deforms' into a wheel for on-highway use (see *iVT* June 2008) – or at least, that's how it used to be. Because taking pride of place on the Mitas stand (with whom Galileo now shares a technology licensing agreement) at Agritechnica, was the CupWheel, the next stage in combined tyre/track evolution.

It's a rapid evolutionary leap though, one that shares precious few similarities with the previous design, as Avishay Novopolski, co-founder and CTO of Galileo Wheel, explains: "The current solution offers a much better solution in a far simpler way. The previous concept was a very sophisticated track with a very sophisticated undercarriage that imitated some of the benefits of a wheel. But the CupWheel is a very simple wheel by structure – and price – but very sophisticated in terms of design and benefits."

It's not very easy to describe the CupWheel. From a distance, it looks pretty much like an ordinary tyre, but on closer inspection, its 'concertina-shaped' sidewall becomes evident. So when air pressure drops, the sidewall folds, rather than collapses, enabling

RIGHT: Trials with a Lindner Unitrac have demonstrated the effectiveness of the Galileo CupWheel in sandy terrain

BELOW & MIDDLE: The CupWheel – the latest evolution of the Galileo system – presents a huge footprint at ultra-low tyre pressures

BOTTOM: Early incarnation of the Galileo system – a tyre/track combo



the outer circumference to change its shape freely while retaining the same rolling circumference, and thereby move about the wheel centre in all directions. This offers natural runflat capabilities at high speeds, while retaining structural stiffness for superb handling capabilities at any pressure. 50km/h on-highway speeds can be achieved, with the comfort, durability and reliability claimed to be comparable to that of a traditional off-highway tyre.

Bigfoot exists

When at 0psi, a gigantic footprint is produced, an alteration in geometry that provides an estimated threefold increase in ground contact area, a similar reduction in soil compaction and enables tractors to gain drawbar pull with vastly improved flotation. The tyre's ability to work at 0psi on the road allows travel between fields without suffering damage.

Its 30-0psi air pressure zone provides unparalleled flexibility and versatility for farm machinery that could not previously be used with

tyre pressures lower than 12psi. This delivers traction and drawbar pull comparable to that of conventional tracked vehicles, with the subsequent 20% reduced slip yielding a 20% reduction in fuel costs.

Unparalleled flotation will allow farmers to enter their fields in muddy conditions, performing time-critical jobs while limiting ground damage. Balance is greatly improved too, which could help vehicles maintain a straighter course than traditional wheeled machines, enabling more consistent spraying.

Further reductions in terms of fuel consumption result from the 5% greater rolling circumference, regardless of deflection and air pressure. In addition, a traditional tyre requires more power to climb over obstacles, but the CupWheel's footprint effectively enables the vehicle to 'crawl' over them instead, decreasing the power required while enhancing operator comfort.

This makes the Galileo system particularly suitable for forestry vehicles, which have to combine

TRACTION TECHNOLOGY

superb manoeuvrability and traction with minimal damage to the ground. Indeed, Novoplanski claims that the concept is suitable not just for other off-highway vehicles, such as construction machinery, but even traditional on-highway vehicles.

Whereas a conventional tyre's high profile enhances its vertical shock absorption capabilities, that same flexibility hinders the required horizontal stability of the vehicle. Avishay Novoplanski expects future CupWheel tyres to offer a higher aspect ratio without reducing the side stability. The Galileo tyre is likely to cost the same as ordinary radial models and is produced using existing manufacturing technologies. It will be marketed as 'Pneutrack' by Mitas under Galileo's license.

At the flick of a switch

Off-highway customers can be a conservative lot, of course, so should more conventional tyres be preferred, several suppliers are now offering systems that enable tyre pressures to be adjusted from inside the cab. ZF, for instance, will be equipping its Terramatic and T-7000 transaxles, as well as the axles in the Terrasteer series, with an integrated rotary transmission lead-through for tyre pressure control.



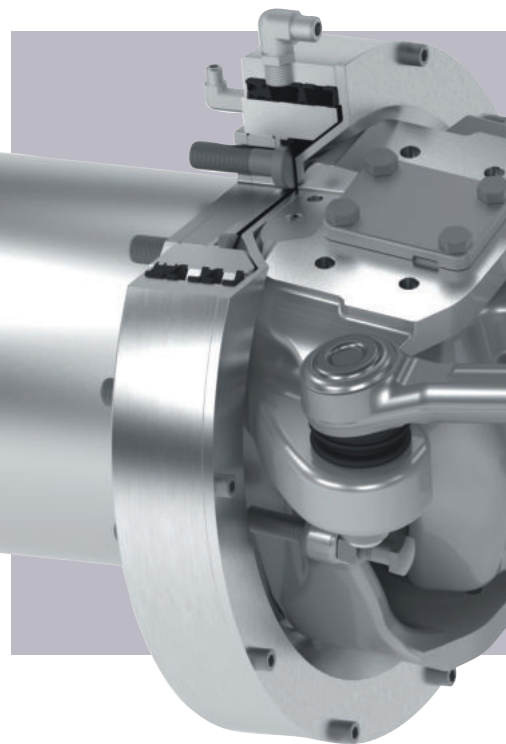
improve fuel efficiency up to 3.3%

BELOW: The Spicer CTIS adjusts tyre pressure to provide the optimum footprint on any terrain

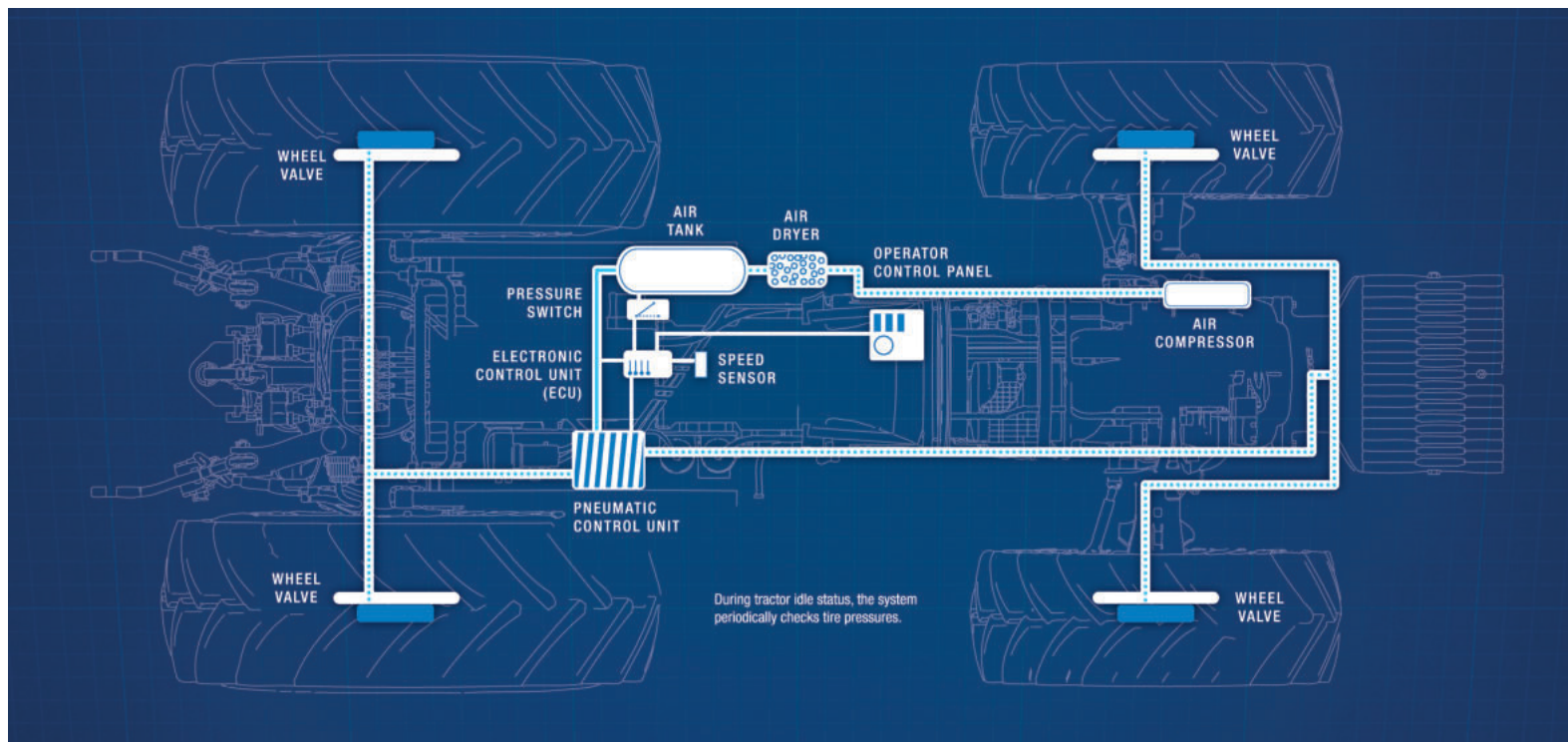
The tyre pressure can therefore always be optimally adapted to the current driving conditions, even when on the move. To enable this, the OEM can directly integrate the operation of the system into the electronic and pneumatic vehicle architecture or, as an alternative, implement it via a special control panel in the cabin.

The construction is based on a kit system, which the customer can order as an additional feature on the axles and transmissions. Through the position at the power output, the rotary transmission lead-through is fully integrated into the transmission and axle concept, and offers good accessibility.

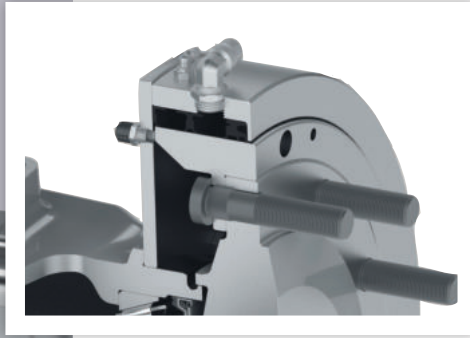
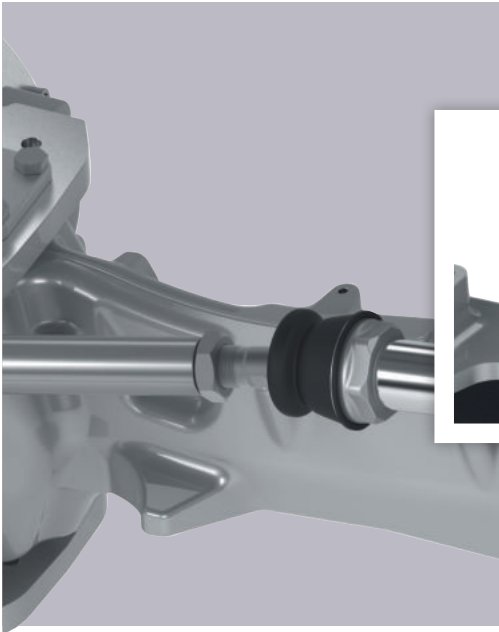
The construction is suitable for both double-flow and single-flow systems. The lines are accommodated, and protected from damage, in the rim well and on the shaft bell. With a diameter of at least 10mm, the rotary transmission lead-through has also been rated for use with powerful compressors, enabling short filling times. Its seals are only ever under pressure during the actual pressure control, which results in greatly enhanced durability.



Field-proven by thousands of military vehicles in operation today, and originally developed for logging, mining, and military applications, Dana's Spicer CTIS (central tyre inflation system) is now available to enhance manoeuvrability and reduce the fuel consumption of agricultural tractors, and combine and forage harvesters.



TRACTION TECHNOLOGY



MAIN IMAGE: Tyre pressure control at the wheel head of the front axle, with ZF's integrated rotary transmission lead-through

INSET: Tyre pressure control at the final drive of the rear axle

Aside from the obvious benefits of optimised traction, leak detection and reduced soil compaction, CTIS also extends tyre life and increases vehicle stability during on-road transport. By enabling greater functionality at extremely low pressures, it also makes it possible to free a stuck vehicle or take on grades and other extreme conditions that previously required assistance.

Operators can now regulate traction based on application, load and terrain by adjusting tyre pressure with the push of a button. When transitioning to on-highway travel, the CTIS inflates tyres to 1.6-1.8 bar (23-26psi) with a 10-13% tread deflection, which reduces contact with the road surface to improve fuel efficiency by up to 3.3% and reduce tyre wear.

For field work, it deflates tyres to 0.6-0.8 bar (9-12psi) and a 20-22% tread deflection, providing extra contact with the soil to improve traction and reduce compaction.

In the event of an air leak or other potential problems, the integrated diagnostics issue an alert and switch the system to emergency mode. This starts a continuous flow of air to the affected tyre to maintain 30% tread deflection until the vehicle can be moved to safety.

This complete system includes the axles and final reductions designed with special seals, ECU and software, a pneumatic control unit, wheel valves, and quick-release valves.

Two leads are better than one

Another system that can provide comfortable adjustment of tyre-pressure on the move is PTG's Airbox/drive 2L. This universal system is suitable for all tractors, heavy load vehicles and trailers, and is controlled from the driver's seat, optionally with the standard console (pneumatic controls) or the new electronic box (digital controls).

With the former, the driver dials in the desired pressure (continuous adjustment) and presses the start button. The control unit then adjusts the pressure in all tyres and switches off automatically. As an option, a second control circuit for selecting separate tyre pressures for rear and front tyres can be added.

With the digital controls option, the electronic box becomes a universal control unit, which enables the user to operate the tyre-inflation systems of both tractor and trailer at the same time. Pre-dialed pressure data can be saved by axle, and called up at the push of a button. When the system is activated, the pressure is adjusted in all tyres and the system shuts off automatically.

In the case of a 120hp tractor with 540/65 R28 and 650/65 R38 tyres, all tyres can be simultaneously deflated from 1.4 bar to 0.8 bar in three minutes, or vice versa in six.

The air and control lines are led through telescopic tubes, whereby the clearance to the mudguards can be adjusted individually. The system

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is connected to the pneumatic brake system with a safety valve, so 6.5 bar pressure for the brake system is always guaranteed.

At the centre of the wheel, a solid dual-line rotary union is fitted, which makes the Airbox/drive suitable for almost all types of vehicles. The dual-line technique was created to remove the pressure from all ducts and rotary unions belonging to the system via pneumatically controlled check valves in the rim of the connected tyres. Two lines are led through the rotary union from the stable axle to the rotating wheel: one large working

1.4 bar to
0.8 bar in
three minutes



Where next for inflation systems?

Paolo Negri, global platform leader for Dana Off-Highway Driveline Technologies, and **Jan Hesselbarth** of ZF's Industrial Technology marketing and communications department answer a few queries about the potential for tyre-inflation systems' crossover into other off-highway applications and possible further developments:

IVT: Do you see any applications for these systems in other off-highway sectors, particularly forestry, construction or mining equipment?

PN: Yes, we have seen interest in CTIS from all those sectors. On the construction side, Dana has seen some interest in rubber-tyre asphalt pavers and telescopic boom handlers in particular. Asphalt pavers are already using a manual system to change tyre pressures according to the type of asphalt they are putting down, and there may be an opportunity for an automatic system.

Telescopic boom handlers are another application that is generating interest, as a CTIS would enable a change in tyre pressures to increase traction in places where they would otherwise get stuck. In this instance, we see the benefit in maintaining the productivity of the equipment more so than any fuel savings or reduction in tyre wear.

JH: Yes, in general, I think it is possible to use this kind of tyre pressure system for some applications in the construction business, such as graders or dumpers. But till now it is just an idea.

IVT: Would a system that automatically adjusts pressure according to the load or terrain be desirable and/or feasible?

PN: Currently, our central tyre inflation system adjusts the pressure automatically when the vehicle accelerates to transportation speed, and the Spicer CTIS is a flexible system that can meet OEM requirements by easily integrating with multiple functions in order to maximise efficiency, productivity, and comfort.

JH: Desirable yes, feasible – I think yes, too – but this is the task of the tractor manufacturer. At ZF, we just deliver the preparation for the tyre pressure system.

IVT: How much extra cost would the system add to a tractor, and how quickly could that be paid back in fuel/tyre savings?

PN: It largely depends on how much the vehicle is in operation, but generally we foresee a payback between two and three years based on fuel savings, decreased tyre wear, and increased productivity.

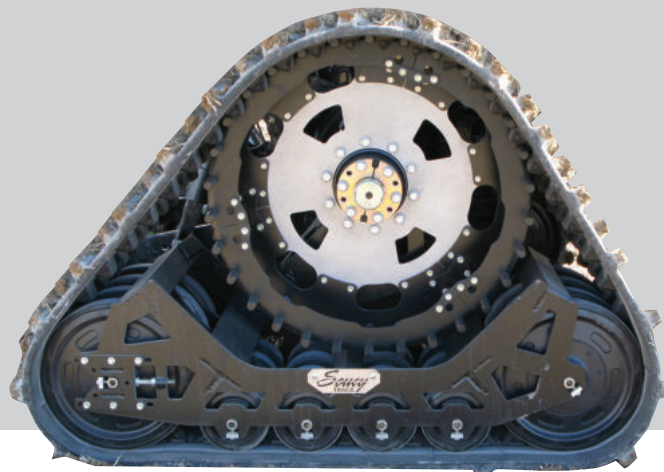
JH: I think this question can only be answered by the tractor manufacturer, as we just provide an integrated rotary transmission lead-through for tyre pressure control, not the whole system.

MYTHBUSTING

Contrary to popular belief, tracks can often create more soil compaction than tyres, claims Avishay Novoplanski, of Galileo Wheel. There are many factors involved, such as the soil type, moisture, weight of the vehicle, number of wheels, tyre pressure and footprint size. But because soil is an aggregate, the compaction is not simply the sum of the weight divided by the footprint area; the density or compaction of the soil can be influenced highly by vibration too.

"Track systems do offer a larger footprint for a given load, but there is more to the footprint than just its size," claims Novoplanski. "A track undercarriage is based on a series of idlers – a series of non-pneumatic stiff wheels. The belt compensates and bridges between the idlers but even so, each part of the soil 'sees' a series of wheels going over it, and each time a wheel passes over, it creates a vibration wave that compacts the soil.

"Moreover, most of the tractor weight is concentrated around the rear axle due to the torque that is developed when pulling so, when using a tracked tractor, the pressure under the rear idler is pretty similar to that of a wheeled tractor, but deployed by steel and hard rubber rather than a pneumatic tyre."



line for supply of large quantities of air, and a small control line to open the PTG valves in the rim. The valve is opened only for the inflation process via the control line. Once the pressure change is completed, the tyre is separated from the system and the rotary unions and the seals run along depressurised.

This offers several advantages over the conventional single-line technique. In the event of leakage in the tyre-inflation system, for example, the valve will protect the tyre from pressure loss. With the single-line technique, however, the driver must stop immediately and close the ball cocks, which are fitted instead of the PTG valves.

As the seals of the unions are under pressure only for the short time that the system is operating, the longevity is far greater than in the single-line systems. So when dealing with high pressures, such as

with truck tyres, dual-line systems are therefore recommended.

This also means that vehicles parked in the evening will be ready to start next morning, unlike single-line systems, which demand the closure or opening of all lines by hand. If the lines are not closed at the end of work, all tyres will likely be flat the next day, as all systems show a continuous loss of pressure.

The air and control lines are connected to the rotary unions via special quick connectors, so can be easily disconnected when not in use and stored in the parking couplings placed on the mudguards. The unions also feature long-life greasing so little maintenance is needed, but feature a built-in thread so they can be dismounted if needed.

In the rim, a switchable valve with anti-kickback attachment is mounted, that shuts off in case of a line tear and protects tyres from pressure loss. **IVT**

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DESIGN

TO COINCIDE WITH CONEXPO, DESIGN A PIECE OF CONSTRUCTION EQUIPMENT THAT COULD BE DESTINED TO BECOME A PIECE OF FUTURE CLASSIC AMERICANA



THE SUPER DOZER

Pope Design

Jon Pope has designed heavy equipment for over 15 years. He has worked for a variety of off-highway OEMs, whether as an independent design consultant or employed by Teague

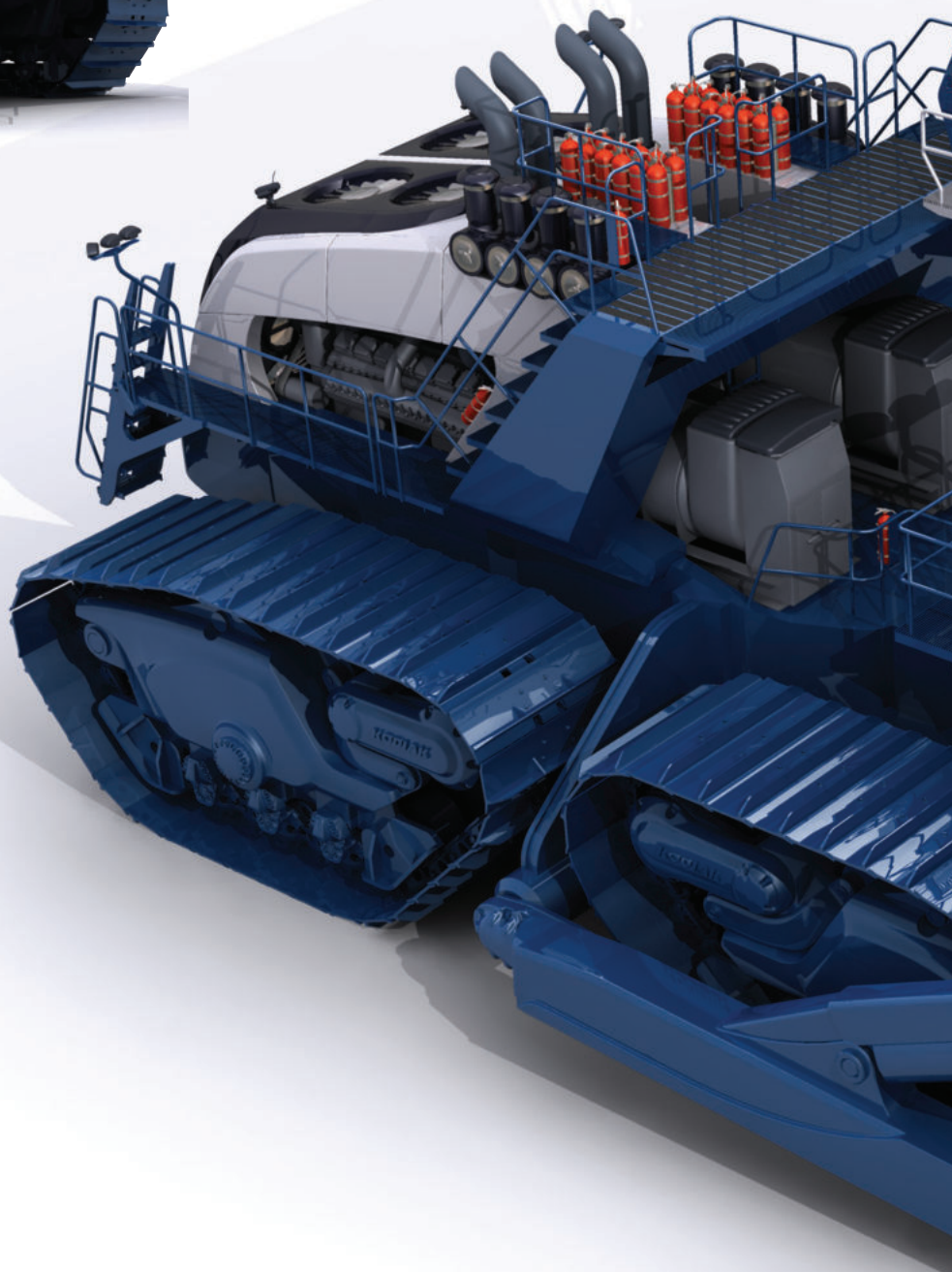
Nothing says Americana as much as supersized vehicles – and the Super Dozer is a machine with a blade that measures 35.17ft wide by 15.35ft tall. The rest of the machine structure is 61.8ft long, 25.78ft wide and 26.1ft tall.

The Super Dozer is modular and can be broken down into 10 components that can be transported from jobsite to jobsite. Its main use would be in the mining sector, but as it can be taken apart and reassembled without the use of a torch, it could be used in very large, long-term infrastructure projects such as new superhighways. It can also be transported to new mine sites instead of being scrapped on-site due to its extreme size.

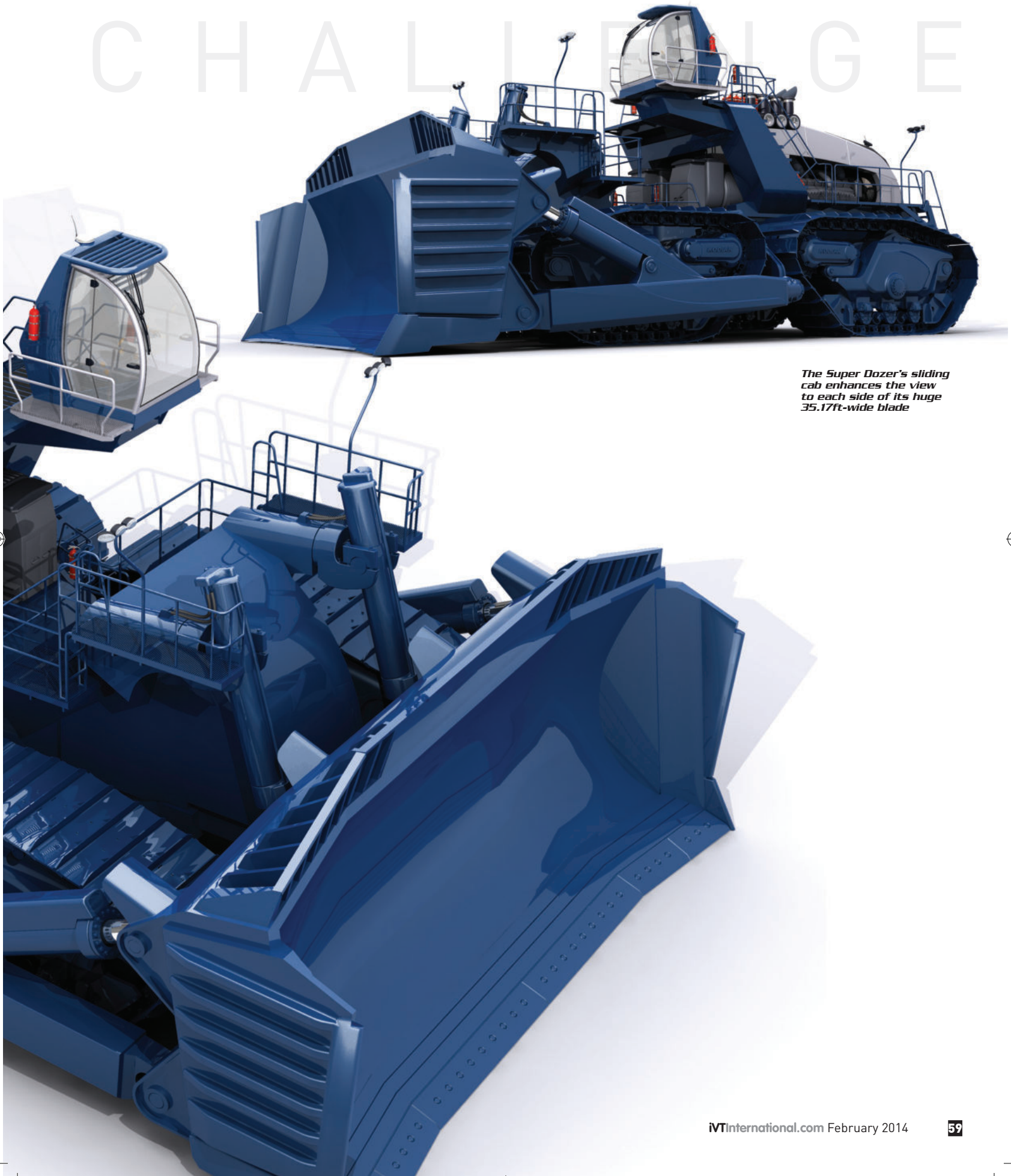
The Super Dozer is powered by two 3,000hp diesel electric power plants, providing 6,000hp in total. Although the machine might look as if it steers by articulating, it is actually a skid-steer, so the centre oscillates instead of articulating. The machine is made up of two chassis, with the centre oscillation point enabling them to twist independently of each other. This gives better ground contract, which translates into better traction, flotation, lower ground pressure and a smoother ride.

The cab is on a bridge in the middle of the machine, and can shift from one side of the dozer to the other. This gives the operator a better view of the edge of the blade on either side of the machine. The cab can be rotated 45° and 90° to reduce stress on the operator when performing a series of back and forth manoeuvres. Because the blade is so large, when it is raised high it becomes almost impossible to see forward, so the cab can rotate a complete 180°, enabling the machine to travel backwards without the blade obstructing the operator's view.

jpope@pope-design.net • www.pope-design.net

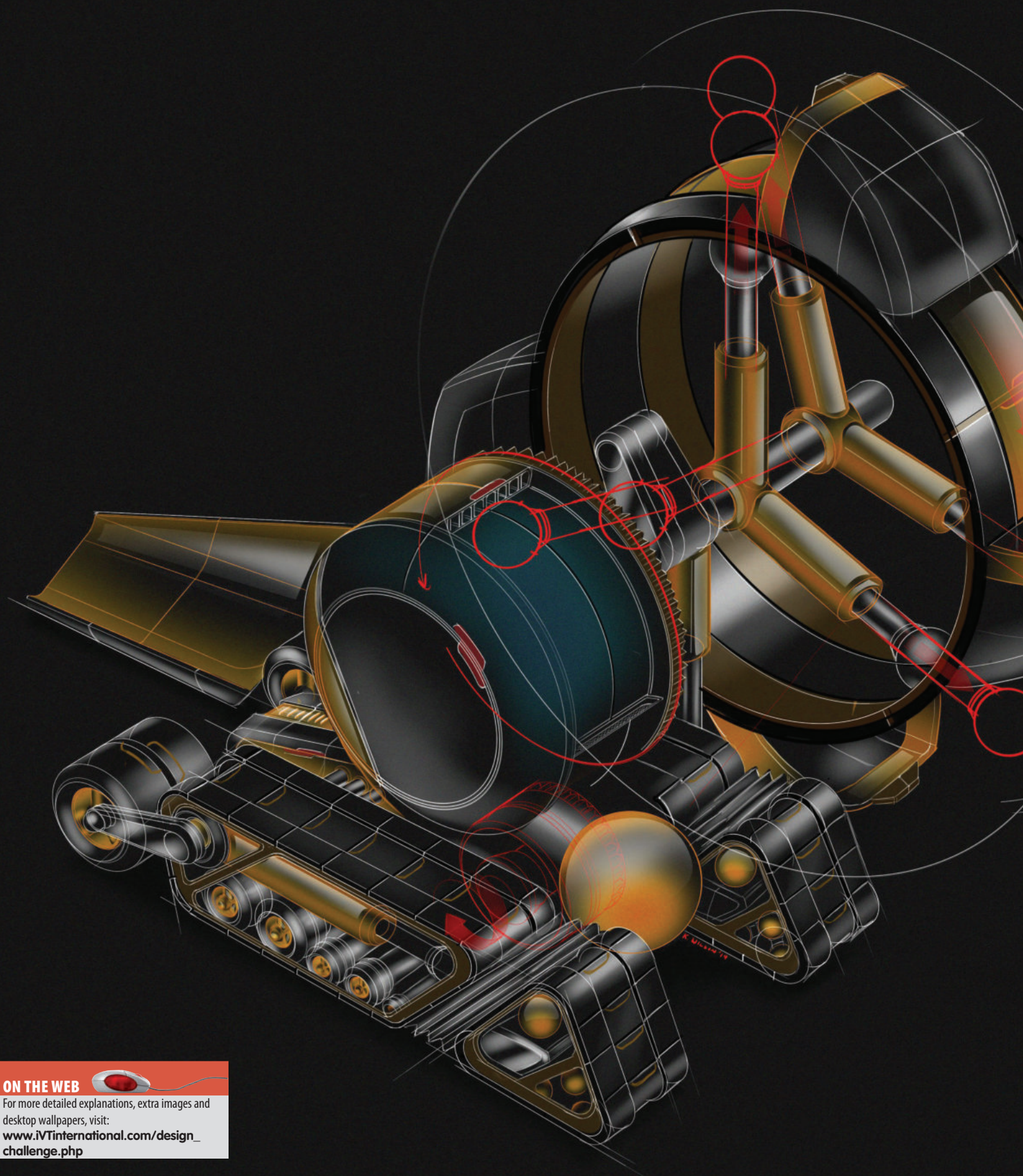


CHALLENGE



The Super Dozer's sliding cab enhances the view to each side of its huge 35.17ft-wide blade

DESIGN CHALLENGE



ON THE WEB



For more detailed explanations, extra images and desktop wallpapers, visit:
www.iVTinternational.com/design_challenge.php

THE WHEELAVATOR



Kevin Wilson

Based in Chicago, and a graduate of Notre Dame, Kevin is a freelance machine designer specialising in the visualisation of mechanisms, vehicles and industrial environments

This concept expands on a design I submitted for the November 2012 DC (the Excaveyor) and draws partial inspiration from the cover of the March 2012 issue of *iVT* (the Earthclaw). With the need for new infrastructure to support our growing energy needs, this machine is purpose built for long-trench excavation. Volvo's recent introduction of a purpose-built excavator for pipelaying/digging alludes to a growing market for these types of machines.

This concept is different in that it does not rely on the traditional hydraulics and arm/boom structure for its operation. A steadily rotating cluster of buckets attached to a flexible belt is directly driven by the forward motion of the machine. A cleated drive pinion engages the ground and causes a master gear affixed to the side of the cab to rotate freely, driving the spinning motion of the flexible belt/bucket cluster. A continuously variable transmission mounted on the driveshaft enables infinite adjustment of rpm.

Two rotating sets of piston cylinders inside the wheel cluster have high-inertia weights at the ends of their rods. As the rpm of the axle increases, inertia drives the piston rods outwards, varying the wheel belt's diameter. This enables the operator to control the material removal rate, the depth of the trench being excavated and, to an extent, the applied force with which the buckets impact the ground. Alternatively, the piston rods can be locked in place once the desired depth has been reached.

A fabricated steel guide ramp feeds the spoil to the side of the trench behind the excavator. This same guide ramp can be attached to the front of the machine to aid backfilling. The position of the cab – central or to the side of the digging action – provides a different vantage point to observe the excavating operation. By doing away with the traditional and heavier excavator working device, this diesel-driven machine offers a novel take on material removal that could improve efficiency in this application considerably.

wilsonme2@gmail.com



PREVIEW



What happens in Vegas...

LOVE IT OR HATE IT, LAS VEGAS IS THE VENUE FOR THIS YEAR'S MAJOR CONSTRUCTION EQUIPMENT AND COMPONENTS SHOW. OUR EXTENSIVE SNEAK PREVIEW OF WHAT'S ON OFFER COULD MEAN THAT YOU END UP STAYING THERE A LOT LONGER THAN YOU ORIGINALLY PLANNED



65



ENGINES

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POWERTRAIN

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FLUID POWER

75



ELECTRONICS AND ERGONOMICS



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www.ifpe.com

▶ ConExpo-Con/Agg 2014 (4-8 March) may be set to cover a record-breaking 2,300,000ft² (net) of indoor and outdoor exhibits – with the co-located IFPE 2014 hitting new heights too, with 165,000ft² (net) of exhibit space – but show management stresses that quality, not size, is the goal.

IFPE 2014, for example, features exhibit pavilions from the Power Transmission Distributors Association (PDTA), and sensor manufacturers and product suppliers. International exhibit pavilions at both shows reinforce the global scope of the events and offer attendees access to a wider range of companies and product options. The shows have eight official country pavilions: IFPE with China, Italy and Taiwan; and ConExpo with China, Ireland, South Korea, Spain and the UK.

Should the products of the expected 2,900 exhibitors at both events fail to grab your attention,

there is also a comprehensive education programme on offer. ConExpo will host more than 110 sessions over 10 subject-matter tracks: aggregates, asphalt, business management best practices, concrete, cranes and rigging, earthmoving and site development, equipment management and maintenance, recycling and preservation, safety and regulations, and workforce development.

IFPE, meanwhile, features its prestigious Technical Conference, with college-level courses also on offer to provide hands-on technical knowledge on fluid power. New for 2014 is a free-to-attend Fluid Power Seminar Series, focused on industry trends and issues affecting the future of fluid power, with real-world solutions for current and future design applications.

Eight sessions will be offered, including best practices in mobile hydraulic maintenance; reducing

leakage and its environment impact; contamination management in hydraulic systems; electronic control of mobile hydraulics; and the troubleshooting of excavators, loader backhoes and aerial lifts.

Some of the potential highlights will appear over the following pages, while the full programme can be downloaded from <http://eee.ifpe.com/Education/General/TechnicalConference/>

It will also be easier than ever to get around the shows – a new show footprint consolidates the outdoor exhibit space into three large areas (a new Platinum lot joins Gold and Silver) to create better attendee flow between outdoor and indoor (including IFPE) exhibits.

Wayfinding upgrades include an enhanced internal shuttle system, better-defined product concentration areas, and knowledgeable on-site guides to answer questions and help attendees navigate the show floor.

ENGINES

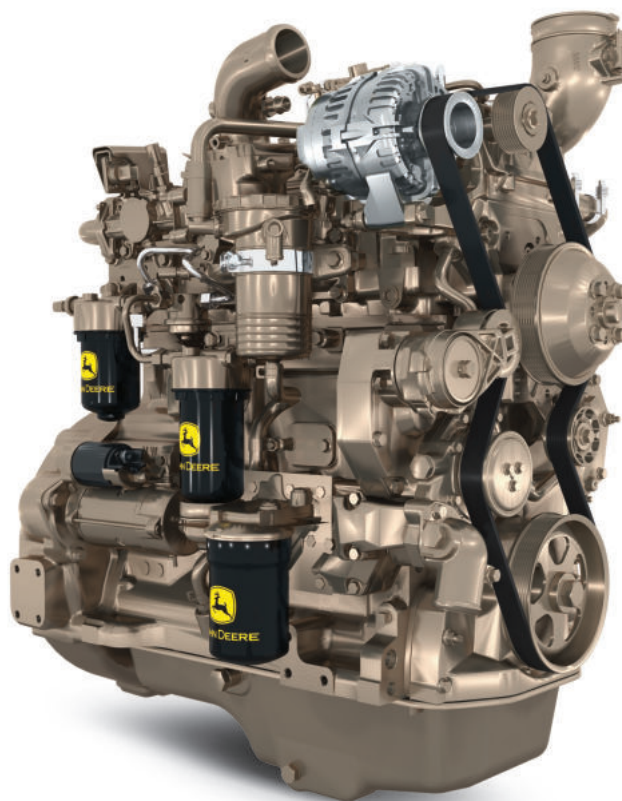
John Deere Power Systems (JDPS)

will display Tier 4 Final off-highway diesel engines at Stand 83718, showcasing 2.9- to 13.5-litre engines that deliver responsive performance, reliable uptime and low cost of operation.

For Tier 4 Final, the company continued with its planned approach by developing the Integrated Emissions Control system, which encompasses a variety of emissions-reduction component and aftertreatment combinations. Integrated Emissions Control system technology configurations have been tailored to meet regulations and customer needs in each power range.

The company is offering three Integrated Emissions Control system configurations for Final Tier 4/Stage IV:

- For the 36-55bkW (48-74bhp) power range, it is offering engine models using an exhaust filter that contains a DOC/DPF without cooled EGR or SCR;
- In the 56-104bkW (75-140bhp) power category, the JDPS PowerTech PWL 4.5L engine (right) is equipped with cooled EGR and an Integrated Emissions Control system configured with SCR and a DOC;
- Engines in the 93bkW (125bhp) and over power range will use an Integrated Emissions Control system consisting of cooled EGR, a DOC/DPF and SCR.



All John Deere Integrated Emissions Control system configurations have been designed to meet the tough demands of off-highway applications. Regardless of power range and Integrated Emissions Control system configuration, its engines offer responsive performance, reliable uptime and a low cost of operation.

JDPS will also display Funk drivetrain components. Funk transmissions, axles, pump drives and planetary drives provide the performance, reliability and durability to meet every customer need.

www.johndeere.com/tier4

For the first time, **Liebherr Components** will present various innovative products in a special pavilion within the Liebherr machinery stand (2155) at ConExpo. The exhibits from the mechanical, hydraulic and electric-drive systems areas have been developed and manufactured at Liebherr's various competence centres.

The display will include the very latest generation of Liebherr diesel engines. The engine on display complies with the Tier 4 Final exhaust emissions limits that came into effect at the beginning of this year. Liebherr uses selective catalytic reduction (SCR) – an innovative technology that makes DPFs unnecessary – exclusively on



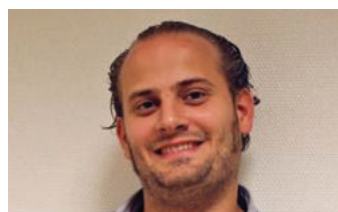
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Establishing an Optimal Work Cycle for an Alternative Wheel Loader Concept (Wednesday, 5 March, 4:00-4:30pm)

Presented by **Bobbie Frank**, alternative drivetrain research engineer, Volvo Construction Equipment and Lund University

LISTEN AND LEARN #1

iVT: So, Bobbie, what exactly is this 'alternative' concept?

It is based on the Gryphon concept, with the simplification that the wheels are propelled by one electrical machine instead of four. This is really more of a mathematical simplification than a conceptual one, and the steering is neglected in this example too.

Is there a part of your presentation that might surprise the audience?

This paper is actually a 'pre-paper' to a journal that I'm currently working on; a complete cycle with gravel pile modelling and where everything is

operational. The IFPE paper concerns a grapple application, which is much easier for calculating optimal control.

So the engineers in the audience will learn that the method works well, while fleet owners will be interested to see that, when operating the loader according to this optimal control concept – in comparison with a very experienced and skilled operator – I could achieve up to 14% lower energy usage. If there would be a possibility to implement this kind of algorithm in an operator-assist system in the future, these savings will really benefit the customer.

these engines. Liebherr's SCR system is particularly notable for its small installation space. A hydraulic driveline demonstrating the proficiency of Liebherr Components consists of a splitter box and several hydraulic pumps, and it is mounted to the V8 engine on display.

The new common-rail fuel-injection system (above) and Liebherr's own engine control unit are other highlights in the Components pavilion. These systems are standard equipment on Liebherr V4-V12 engines and can also be adapted for use on other manufacturers' diesel engines.

Liebherr common-rail systems are notable for their exceptionally low fuel consumption and efficient combustion – both factors that reduce exhaust emissions. www.liebherr.com

Hatz Diesel (Stand 83740) will celebrate the American introduction of the 4H50TIC water-cooled multicylinder turbo engine. Characterised by its compact design, and developed with a consistent downsizing



approach, the engine is especially tailored to customers in the USA and the EU. injection pressures up to 1,800 bar, the particulate emissions can be considerably reduced. Therefore it is possible to achieve the exhaust emissions standards EU 97/68 Stage IIIB and EPA Tier 4 Final without the use of a diesel particulate filter.

Apart from the technical data, the engine also scores high marks with low cost of ownership; firstly because of a low fuel consumption of 205g/kWh (best point), and secondly because of the long service interval of 500 hours.

www.hatz-diesel.com

For OEMs looking for great power, torque and improved fuel economy, the single-turbo **Perkins** 1204F-E44TA (left), is a 4.4-litre, four-cylinder aftercooled engine capable of producing up to 110bkw (147bhp), and was designed to meet EU Stage IV/US EPA Tier 4 Final.

Perkins has minimised the impact of the aftertreatment required to meet Stage IV/Tier 4 Final by integrating the DOC and SCR system into one module, which can be mounted in a variety of remote locations, freeing up valuable space in the engine bay.

For OEMs and end users alike, the 1204F range promises many benefits, from ease of integration and flexibility, to increased productivity and a lifetime of low cost.

By maintaining a high carry-over of components from the previous Stage/Tier, retaining similar cooling packages, and maintaining compact dimensions for the engine envelope, Perkins has reduced the need for vehicle manufacturers to undergo costly machine redesign.

Many of the improvements made at Stage IIIB/Tier 4 Interim have been carried over into the new engine range, including improved power density, better transient response and competitive combined fluid consumption. The 1204F-E44TA will be displayed at the booth of Southwest Products (Silver Lot 4, Stand 6043).

www.tier4air.com



approach, the engine is especially tailored to customers in the USA and the EU.

Sales of the 2-litre diesel engine (left), which is equipped with a Bosch common-rail system, started in January 2014. With 1,952cc, the engine has a maximum power of 75bhp (55bkw) and a maximum torque of 240Nm, which is already available from as low as 1,600rpm.

Including starter and alternator, the engine weighs just 381 lbs (173kg) and therefore saves 198 lbs (90kg) over its nearest competitor. Therefore the engine has by far the lowest power-to-weight ratio in the power class up to 56bkw.

Due to the iHACS combustion process (intelligent Hatz Advanced Combustion Strategy) and an optimised combustion chamber geometry, combined with the sophisticated technology of the Bosch common-rail system, which operates with

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Volvo Penta, the Volvo Group's engine manufacturer and supplier to other OEMs, has long been known in North America for its marine engines. But the company is also now becoming a prominent force in the industrial segment, with a versatile range of engines suited to a variety of applications.

With proven technology from Volvo Trucks adapted for off-highway applications, the company now offers a full range of Tier 4 Final emissions-compliant 143-700bhp engines (above). These come in 5-, 8-, 11-, 13- and 16-litre displacements and are suited to a host of off-highway applications, including materials handling, construction, quarrying, mining and agriculture. For power generation, Volvo Penta also offers a complete line of Tier 3-compliant engines, ranging from 96-568kVA on prime power.

The company is displaying its D8, D11 and D13 off-highway engines at ConExpo – with the 8-litre being shown in the USA for the first time. Stand 83830 will also showcase Volvo Penta's SCR Tier 4 Final technology. The system does not require regeneration or a diesel particulate filter – commonly used aftertreatment systems that require maintenance and, ultimately, replacement – making it a simpler, more versatile and less costly option for OEMs and end users alike.

www.volvopenta.com

FPT Industrial will present its latest solutions for the construction industry, including the latest addition to its range, the R22 (right), at Stand 7646. Furthering its offering into the low-displacement construction equipment sector, the compact and efficient 2.2-litre R22 provides 33-52bhp and up to 250Nm of torque.

The engine meets Tier 4 Final/Stage 4 emission regulations, achieved through the use of a partial flow filter (PFF) and an in-house engine management system to ensure particulate matter is regenerated either passively or actively.

A supplier to the likes of Case and New Holland Construction, Tigercat, Generac and Perkins, FPT will also showcase its Tier 4i N45 Industrial Power Unit (IPU), which features a four-cylinder, 4.5-litre NEF 45 engine that produces 100-167bhp. Its six-cylinder 8.7-litre C87 engine, with a range from 301-408bhp, will also be on show.

To reach the emission levels of Tier 4 Final, the company is one of the few engine manufacturers to offer a maintenance-free aftertreatment solution using only SCR. The patented High Efficiency SCR (HI-eSCR) system cuts nitrogen oxide levels (NOx) by more than 95%, while the PM levels remain naturally low within the engine.

These and other innovations have been developed at FPT's Research & Development Centre in Switzerland and Burr Ridge in Chicago, IL, USA to ensure the lowest emissions and highest productivity.

www.fptindustrial.com



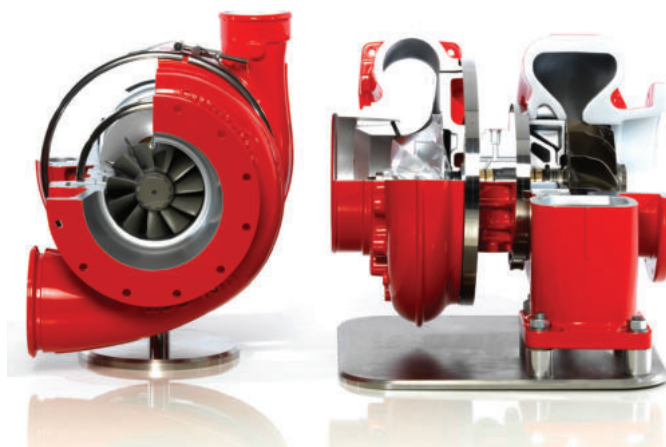
LISTEN AND LEARN #2



Hydraulic Hybrid Excavator – Customers, Diversity Drives Innovation (Thursday, 6 March, 1:00-2:00pm)

Presented by **Ken Gray**, global product manager, large hydraulic excavators, Caterpillar Inc

The fuel-saving Cat 336E H Hybrid was launched in 2013 as the industry's first hydraulic hybrid excavator. With over 300 patents filed, the innovative hydraulic hybrid technology is a significant departure from the typical hybrid approach. To accomplish such a feat required an acute, intense focus on the customer and a diverse, global team empowered to drive an innovative solution. Learn the story behind the development of this game-changing product from Caterpillar.



Cummins Turbo Technologies will reveal a new addition (above) to its existing range of large turbochargers for engines 16 litres and above at Stand 84808. This extensive range provides robust flexible solutions for the off-highway sector.

The launch will enable Cummins Turbo Technologies to bring to market the most efficient turbochargers in this range – its new technologies are capable of improving overall turbocharger efficiency of a typical application by 10%.

The new Series 900, which has been designed to meet the diverse duty cycles of this engine range, draws on the company's 30 years of experience in the development and manufacture of turbochargers for the 16-litre and above market. The robust and durable technologies that the complete range offers are suitable for applications from 400-6,400hp (294-4,707kW).

Cummins Turbo Technologies is also unveiling plans for investment in future technology solutions for the range to improve fuel efficiency. The shift in focus to prioritise fuel economy highlights the company's belief that the industry has now reached the tipping point at which global engine and equipment manufacturers are developing products designed to insulate customers from rising fuel prices.

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POWERTRAIN

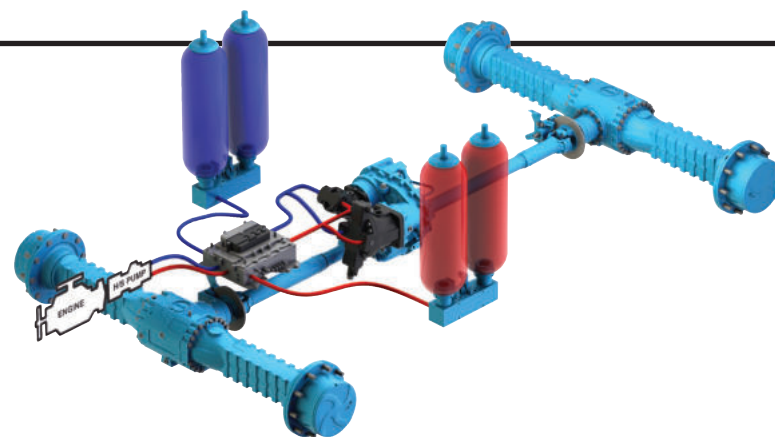
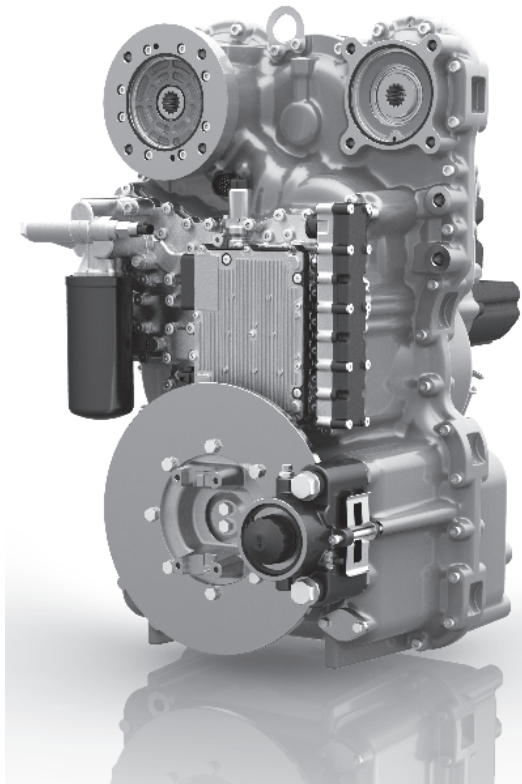
Crushers and screeners require drives with high torque and low speed, but as several components manufacturers do not produce specific models for this equipment, they often supply products designed for other applications, such as excavators, that have different requirements and duty cycles. Customers therefore end up with more expensive solutions and oversized products, especially for motors.

In contrast, **PMP Industries'** technical department designs specific models for each application – and because it manufactures both the gearboxes and the hydraulic transmissions, it is able to provide complete solutions tailored to an application's specific features.

It offers two solutions (right) designed for crushers and screeners: PMC travel drives coupled with PMH MKF hydraulic motors, and PMCI travel drives with integrated motors. Available in torque ranges from 20,000-60,000Nm, and with motors of 55cc and 110cc, the target applications are crushers and screeners from 10-70 tonnes. A mechanical disengagement option is also available. Although the first option, PMC and PMH MKF, is the more standard, with a separate gearbox and motor, the PMCI series is more cost-effective as it includes all the valves for the travelling functions and offers the possibility of providing a two-speed machine. Find out more in South Hall 3/4, Stand 83907.

www.pmp-industries.com

At Stand 85030, **ZF** will present its latest product highlights, including the ErgoPower Efficiency Package and the continuously variable cPower for construction machinery,



(below) giving an insight into the future of industrial vehicles.

The fully powersplit, continuously variable technology benefits from the long-term experience gained in the agricultural machinery sector and offers considerable consumption benefits and productivity increases for the vehicle owner. cPower is a new technological benefit in construction machinery and allows for completely new drive concepts. Up to 25% less consumption, as well as up to 20% more efficiency, underline the advantages of the continuously variable transmission in typical operating cycles that will create new megatrends for industrial vehicles.

For many years, ZF's driveline and chassis systems have proven themselves well capable of meeting the challenges of the off-highway market. With the ErgoPower Efficiency Package, it consolidates its broad competence in development, offering more than the sum of individual advantages. This approach makes it possible to reconcile the frequently conflicting demands for enhanced comfort and increased productivity with reduced consumption and component wear.

Dana Holding Corporation will announce the latest developments for the Spicer PowerBoost System while debuting the Spicer TE18 powershift transmission as part of a 21-tonne front-end loader system (above) at Stand 85114.

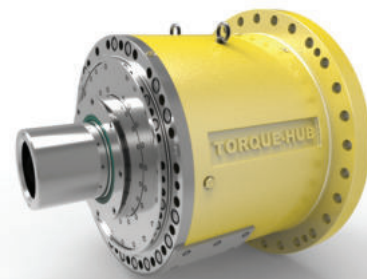
The Spicer PowerBoost System is a line of integrated hydraulic-hybrid powertrain concepts for off-highway vehicles that support the recuperation of working and braking energy. Deployed through series or parallel hybrid configurations that fit into existing vehicle designs with minimal adaptation, the system supplements all types of transmission architectures.

The Spicer PowerBoost System captures kinetic energy that would be otherwise wasted throughout the drivetrain and working hydraulics, and then uses this recuperated energy to help power the

vehicle. This has been shown to reduce fuel consumption by 20-40% compared with conventional drivetrain concepts, depending on vocational application and duty cycle.

Dana's 21-tonne front-end loader system showcases the new Spicer TE18 powershift transmission as well as the hydromechanical variable transmission (HVT) from Dana Rexroth Transmission Systems, the 50:50 joint venture between Dana and Bosch Rexroth. The transmissions are shown with re-engineered Spicer 37R and Spicer 43R axles, and a Spicer Wing series driveshaft, in a system that demonstrates Dana's ability to meet varying market needs, from value-driven solutions up to premium configurations.

www.dana.com/offhighway



Oerlikon Drive Systems, with its two brands Oerlikon Graziano and Oerlikon Fairfield, is exhibiting at Stand 81529. The company is a leading worldwide provider of complete drive systems, gearing solutions and transmission components, providing solutions for all-wheel-drive vehicles and agricultural tractors, Torque Hub planetary drives for industrial machinery (above), off-highway equipment and transmissions for high-performance cars.

This know-how and capability allows for the full deployment of a development programme, from conceptual and simulation phases to mass production, for complete mechatronic driveline systems, as well as for single gearing components.



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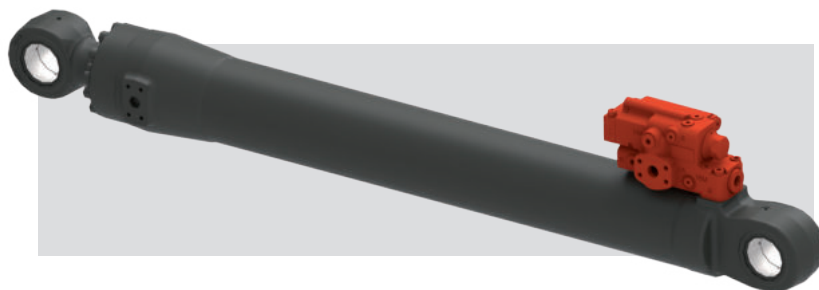
www.marzocchipompe.com • pompe@marzocchigroup.com

The product range on display will include axles for wheeled loaders, Torque Hub and Shifting Solutions for use in all types of demanding construction machinery applications. The axles with wet disc brakes feature patented pump oil circulation integrated into the differential, for highly efficient cooling of the brake disc, and can be combined to support wheeled loaders with machine operating weights from 11 to 24 tons.

Torque Hub is a range of final drive units that deliver the torque output and long service life that is a vital requirement for agricultural, industrial and off-highway mobile equipment applications. Also on show will be examples of gear sets (gears, shafts, crown wheel and pinions, planetary gears) and shifting solutions (synchronisers and powershift units).

www.oerlikon.com/drivesystems

FLUID POWER



With the new Cindy-Reg load-holding and load-control valve, **Bucher Hydraulics** presents an ideal solution for saving an astonishing amount of energy directly at the cylinder. The safety valve with the smart recuperation/regeneration concept makes it possible to reuse a part of the oil flow, which is fed directly into the opposite side of the cylinder, with the unused part going directly to tank with no backpressure.

The pump output flow can therefore be considerably reduced during the lowering operations of industrial vehicles, which is important for saving energy.

Depending on the system, there is the possibility that the pump output flow that has been saved can then be used for other functions. In addition to the main elements, such as the zero-leakage control assembly and the fast-acting, directly operated pressure-relief function, the safety valve (above) includes an integral balance valve for tandem applications.

With the increased flexibility of the Cindy-Reg load-holding valve, the energy savings of up to 25% can result in greatly reduced operating costs, while there are simultaneous increases in efficiency due to the much-enhanced cycle rate.

Find out more in South Hall 3, Stand 82829.

www.bucherhydraulics.com/cindy-reg

LISTEN & LEARN #3

Design, Modelling and Control of Hybrid Powertrain (Tuesday, 4 March, 1:00-4:00pm)

Presented by **Zongxuan Sun**, department of mechanical engineering, University of Minnesota

Powertrain hybridisation has been widely accepted as one of the most promising solutions for addressing rising oil demand and concerns on climate change, improving fuel efficiency and reducing emissions. In a hybrid powertrain, an alternative power source, such as electric power or fluid power, for example, complements the internal combustion engine, to improve fuel efficiency by engine downsizing, load levelling, and regenerative braking.

This short course will cover the background information, the various types of hybrid powertrain systems, different hybrid architectures, and the modelling and control of the hybrid powertrain.

resistance to corrosion, resistance to high temperatures and excellent ductility.

Ideal for compact equipment, the 4BD4FH block coupler is designed for hydraulic quick change within seconds and enables connection under pressure. It has greater flow capability than standard flat-face couplers and leads to an overall reduced pressure drop.

The coupler uses high-pressure FFH flat face couplings, all conforming with ISO 16028 standard. The user can choose between a cartridge of ½in or ¾in.

www.faster.it

Flow Summation, the most significant advance in hydraulic valve technology in the past 40 years, is now available for larger excavators. Initially, FS-series control valves were focused on the mini- and mid-excavator market, combining variable pump efficiency and open-centre valve simplicity to deliver the market's most efficient and controllable valve solution. Now **HUSCO** has taken this market-leading technology (below) into the 20-ton and larger excavator market.



"We haven't just made it bigger," says Joe Pfaff, VP of engineering, "we've taken the best aspects of Flow Summation and engineered these advancements into large-scale spool valves that have been designed specifically for 20 to 30-ton excavators."

Flow Summation control valves provide many advantages for the construction equipment market. The efficiency benefits have been proven on multiple machine platforms, with fuel efficiency improvements ranging from 10-20%. The performance results were achieved using a refined-yet-simple valve architecture that maintains compatibility with load-sense variable-displacement pumps, allowing for easy installation into existing hydraulic systems. The technology provides smoother, more stable control than PCLS systems.

Visit HUSCO at Stand 80916 to discover more innovative hydraulic control solutions, including IMVT – the most advanced mobile hydraulic control system available.

www.huscointl.com

Faster (Stand 83930) continually develops new products to exceed the requirements of the hydraulics market, and one of these is the new flat-face series FFH (below right). FFH provides notably higher performance characteristics than FFI couplings, while the series also exceeds the performance characteristics established by ISO 16028 regulations. Working pressure has been raised to 35MPa and the flow rates have been highly improved.

FFH couplings have undergone severe internal validation tests, such as 1,000,000 cycles impulse tests and burst tests at 140MPa. The coupling is available in sizes ½in, ¾in, 1in, 1½in, 2in and 3in.

As a flat-face screw-on coupling for heavy-duty applications, the FHV Series can bear high working pressures and has exceptional flow capacity. The male coupler is assembled with a double patented valve and can be connected under residual pressure. Connection is easier via a special ball bearing system.

The coupling is also provided with a safety sleeve to prevent accidental disconnection, and can be supplied with female threads, with flanges and with semi-flanges configurations. The range extends from ¾in to 2in sizes.

FFH and FHV couplings feature a zinc-nickel surface treatment for excellent



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motion and progress

ELECTRONICS & ERGONOMICS

Ametek VIS has recently expanded its field-proven line of rugged instrumentation to include colour flat-panel displays. Its display offerings include an 800x480 WVGA colour display with a six-button interface with tactile feedback or a touchscreen interface (below). The displays include a CAN J1939 databus and analogue inputs to provide maximum flexibility to display vehicle data, as well as support for video, USB and Ethernet. The switch-to-ground 500mA output enables control of an external device. The display also features dual-colour (amber or red) dead-fronted warning indicators positioned above the display for critical alarms, as well as the ability to display warning indicators on the display itself. The rugged housing is sealed to IP67 standards and up to 10g vibration levels to ensure a truly rugged instrument.



The displays can be used with standard screens providing vehicle data, warnings and diagnostics, or can be customised easily to a unique application with a powerful OpenGL graphical interface tool. The interface tool facilitates rapid HMI development with advanced performance characteristics.

For more information on these products, visit Stand 61955.

www.ametekvis.com

Autec's Dynamic series of radio remote controls for off-highway mobile applications now includes two new products: the ARX receiver (right) and the SOS system. ARX, a new compact receiver for mid-size to small applications, has two safety outputs that may be used either as a Stop or UMFS (Unintended Movement from Standstill) function, according to machine needs. The wiring system of ARX enables a direct connection to solenoid valves and to other machine controls (horn, engine, etc).



LISTEN & LEARN #4

Energy Consumption in Fluid Power – The Impact and Potential Savings in Mobile Machine Applications

(Wednesday, 5 March, 1:00-2:00pm)

Lonnie Love, PhD, group leader of Oak Ridge National Laboratory's (ORNL) automation, robotics and manufacturing group

Fluid Power is a foundational technology for both the manufacture and operation of mobile machines. However, there are many areas where fluid power can improve. A recent ORNL/NFPA study suggests that between 2-3% of US energy consumption is derived from fluid power components and systems. Furthermore, the average efficiency of fluid power systems is approximately 21% – although typically higher in mobile machines. Therefore, even moderate improvements in efficiency can yield tremendous energy savings.

Emerging trends in advanced manufacturing (including additive processes, lightweight metals, low-cost carbon fibre) can simultaneously increase efficiency as well as improve competitiveness.

The SOS (Supervised Operator System) solution enables safe operation of elevating working platforms in dangerous conditions, such as close to live overhead power lines. Should the operator be endangered, a supervisor may intervene immediately by means of a second transmitting unit that can take control of the machine, disable the operator's unit and bring the operator and the machine back to safe conditions.

The Stop and UMFS safety functions are compatible with requirements of EN ISO 13849-1 and EN IEC 62061. Dynamic series radios are approved in all major international markets and take advantage of Adaptive Frequency Hopping Spread

Spectrum – a two-way communication method that provides a very reliable link for both commands and data.

Don't miss these and other Autec systems at Silver Lot 4, Stand 6773.

www.autecsafety.com

Enovation Controls will display the pick of the technologies offered by FW Murphy and EControls in South Hall, Stand 83911.

The organisation's PowerVision Configuration Studio will highlight their integration capabilities, which provides operators with vital engine and equipment information customised to their exact specifications. This technology makes integration fun, too, by adding Bluetooth capability, video, OpenStreetMap and touchscreen capabilities.

The latest offering in Murphy's pump controller line-up, the MPC-20, will debut at the show. The MPC-20 is a fully sealed, Tier 4-ready pump controller for electronic and mechanical engines offering easy-to-use configuration software.

EControls' engine and fuel control systems showcase the company's expertise in alternative fuel solutions for CNG, LNG and propane, as well as petrol and diesel. EControls is the largest global provider of state-of-the-art, full-authority engine control systems, with more than 150,000 systems on the road.

www.enovationcontrols.com

As a leading manufacturer and supplier of magnetostrictive sensor technology for position measurement, **MTS Sensors** (Stand 80820) offers the Tempsonics MH-Series of successful sensors for cylinder integration in the field of mobile hydraulics.



At ConExpo, the company will present cost-efficient developments in the mobile hydraulics field, which, as a result of their durability, as well as their wear-free and interference-resistant measurement, offer a competitive alternative to angle sensors, potentiometers, wire-actuated encoders or inductive proximity switches.

With an extended stroke length, the new Temposonics MH is suitable for lifting cylinders with a stroke up to 5,000mm (200in), making them ideal for controlling the telescopic arm position of telescopic loaders and working platforms. The device is presently the longest position sensor for displacement measurement integrated in hydraulic cylinders of mobile machines.

Furthermore, Temposonics MH-Series sensors with CANopen safety output will be presented. The devices are approved for use on mobile machinery – in mobile hydraulics, these include steering systems for construction, as well as supporting cylinders on mobile cranes, which ensure overload protection of the crane. The measuring lengths are within 50 and 2,500mm.

www.mtssensor.de

ASM Sensor specialists will launch the WB21 tape extension sensor (right) at Stand 83539, providing up to 20,000mm measuring length in a compact housing. Due to the design of the sensor and the

inherent strength of the stainless steel tape, they can be used in environments and areas where other sensors would struggle to survive, such as hard-to-reach areas where directional changing pulleys are used or where temperature extremes cause problems such as icing.

The life of ASM's range of tape extension sensors is totally unaffected by the use of pulleys, which makes them the perfect choice for safety-critical areas often found in crane operation or the mobile machinery market in general.

This new sensor is made from a quality moulded housing, which enables lower construction costs for a rugged sensor that meets a high sealing level of IP67/69K (operational) making it an affordable choice for today's demanding markets. It is also available with a choice of three analogue and three digital outputs (SSI, CANopen or CAN J1939) a linearity of $\pm 0.10\%$ with the option of redundant outputs. The WB21 is perfectly suited for installation on cranes, excavators, forklift trucks, hoists and access platforms.

Data sheets can be downloaded from: http://www.asm-sensor.com/asm/pdf/pro/wb21_en.pdf

www.asm-sensor.com



Otto's response to customers' challenging applications ignited the creation of the new soft-touch option for its popular Contour Grip (above). This ergonomically styled grip, which offers the selection of a multitude of switch configurations in varying locations, now has a comfortable tactile feel. Tested by experts in the field, the response has been exceptional.

Virtually any Otto switch can be used in the grip, including electromechanical and Hall-effect switches such as Otto's HTW series thumbwheel switches, K series rocker switches, P and HP series pushbutton switches and T series toggle switches.

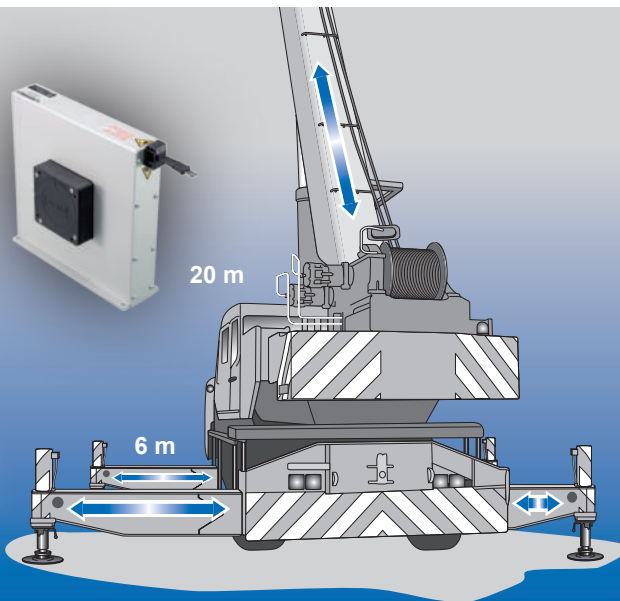
The ergonomic design reduces muscle strain in the arms and wrists, allowing for extended use with minimal fatigue. Both left-handed and right-handed versions are available. The new soft-touch grip is made to withstand harsh environments and works well in construction, industrial and off-road applications. Visit Otto at Stand 85308. **ivt**

www.ottoexcellence.com





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Near-zero heroes

2014 IS THE YEAR THE ENGINE INDUSTRY HAS BEEN WORKING TOWARDS FOR A DECADE. THE RESULTS OF ALL THAT HARD WORK – A RANGE OF ENGINES PRODUCING NEAR-ZERO EMISSIONS – WILL SOON BE SEEN AT CONEXPO

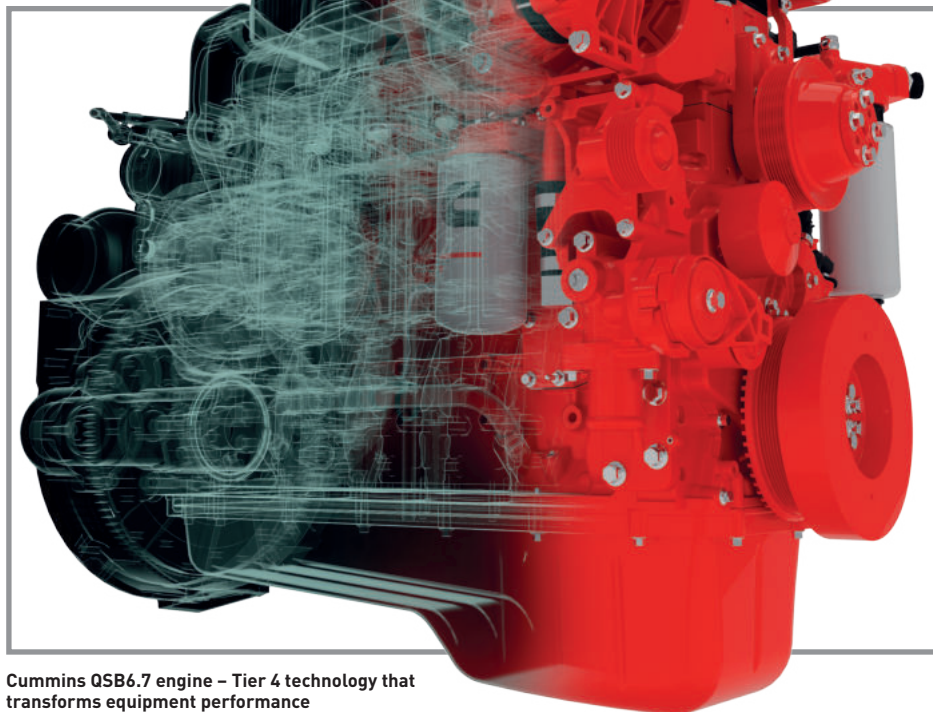
The date 1 January 2014 marked an important milestone for the equipment industry, with the long-anticipated arrival of a new generation of near-zero emissions regulations for diesel engines in North America and Europe – the EPA Tier 4 Final off-highway standards and equivalent EU Stage IV.

Extending all the way from 49-675bhp (36-503kW), the Cummins engine range for Tier 4 Final and Stage IV will be a key focus of engine attention at ConExpo, opening 4 March in Las Vegas, where the world's construction equipment industry will gather to display the latest equipment and new technology. At the show, Cummins, situated in South Hall 4, Stand 84808, will focus on how its latest Tier 4 Final technology not only meets emissions but also transforms equipment to be more productive and fuel efficient than ever before.

New engines on display will include the QSF3.8, ideally suited for compact off-highway equipment, and the QSG12, which provides heavy-duty power capability for higher-output machines. In addition to Tier 4 Final engines, Cummins will also be showcasing some of the first Tier 4 Final-ready power packs in the industry, together with a Tier 4-powered rental trailer. The company's portfolio of key enabling technologies will be highlighted, with Selective Catalytic Reduction (SCR) aftertreatment, new NanoNet fuel filters providing exceptional levels of protection and Variable Geometry Turbocharging (VGT).

Visitors will be able to talk with Tier 4 specialists about the company's successful field test programme, based on over 70 machines accumulating high operational hours. Tier 4 Final field test success is no surprise. Cummins started with a proven design – a diesel platform with a legacy of exceptional reliability and durability. Its Tier 4 Final engines then went into production on 1 January as fully proven platforms, ready to deliver even better performance than customers have experienced before.

While all engine manufacturers collectively offer some variation in the technology approach employed to meet the stringent Tier 4 Final and Stage IV requirements, from Cummins' perspective one thing is for sure: its latest generation of engines being displayed at the forthcoming show are not just the cleanest, but also the smartest and most productive it has ever introduced.



Cummins QSB6.7 engine – Tier 4 technology that transforms equipment performance

Its 2.8-litre to 15-litre engine range is designed to transform all types of construction and materials handling equipment, by enabling them to operate with faster cycle times for increased productivity and with reduced fuel use for lower operating costs, while retaining all the legendary reliability of a Cummins engine. In addition, the 2014 engines are backed by the most capable service and support network in the business. This capability will be highlighted on the Cummins stand, with service support experts available to talk with OEM equipment dealers and operators about the latest tools and resources available.

Visitors to ConExpo will be able to see a wide range of OEM equipment displayed ready to meet Tier 4 Final and Stage IV – with many of those machines featuring Cummins engines and integrated exhaust aftertreatment. The integration of Tier 4 Final power systems into this equipment is made easier by Cummins' single-system approach, which delivers

more compact packaging and reduced installation complexity. The rollout of equipment with Tier 4 Final engines will be gradual, but as the arrival of new equipment ramps up over the course of the next 18 months, the substantial improvements in performance will soon become obvious to operators.

Ready to meet near-zero emissions

Reducing diesel engine emissions has been a long and challenging journey that was initially focused on on-highway vehicles before being followed by the restrictive emissions for off-highway equipment operating in construction, agricultural and materials handling applications which first took effect in 1996. Exhaust emissions of particulate matter (PM) and nitrogen oxides (NOx) are now over 90% lower than specified in the engine regulations in place just over three years ago in the 174-751bhp (130-560kW) output category. Commencing on 1 January 2015,

EXHIBITOR AT



4-8 March 2014

Las Vegas, USA

South Hall 4, Stand 84808

the same stringent emissions reduction will also extend to engines with over 74bhp (55bkW) output.

What does this mean for the environment? The emissions output of a single Tier 4 Final off-highway machine is equivalent to the emissions output of 25 machines meeting Tier 1.

Cummins' clean diesel technology also brings greatly improved conditions for operators working on site. The use of more advanced fuel injection systems featuring higher pressure delivery improves the combustion process so that visible smoke is virtually eliminated and the engine operates far more quietly and with less vibration. This all adds up to a more comfortable and productive working environment.

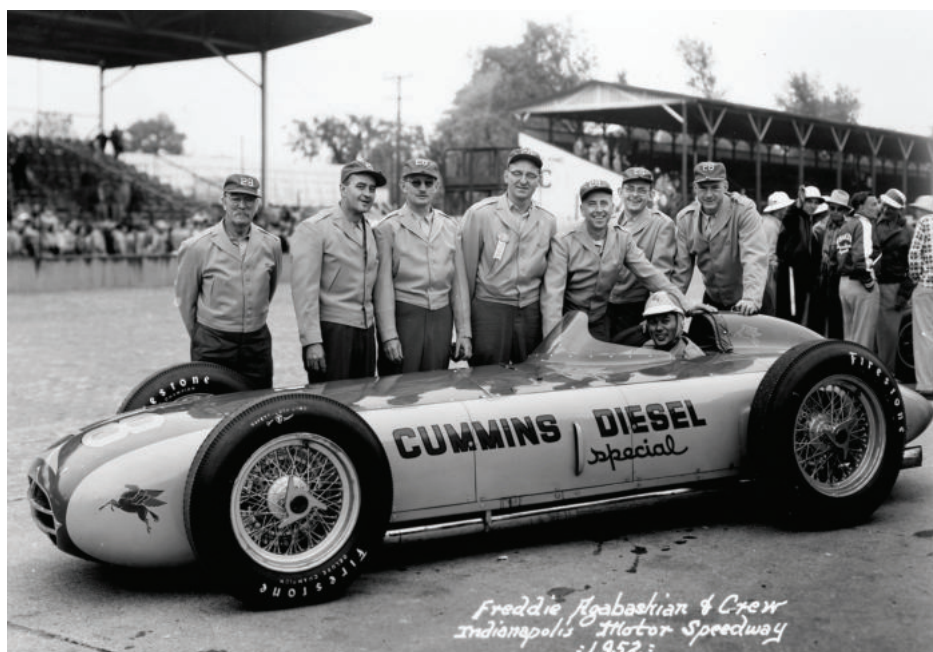
But cleaner diesel engine combustion alone cannot take emissions down to near-zero levels. Engines require exhaust aftertreatment to reach the Tier 4 Final standard. Integrated exhaust aftertreatment for Cummins' popular mid-range QSB4.5, QSB6.7 and QSL9 is made up of a simple, service-free Diesel Oxidation Catalyst (DOC) with Selective Catalytic Reduction (SCR) designed and built by the company itself. This exhaust aftertreatment system is proven technology based on the huge number of Cummins on-highway systems now in service, though specially ruggedised for tough off-highway environments and designed to last the life of the engine.

The smaller QSF engines adopt even simpler aftertreatment systems for their lower outputs, while the heavy-duty QSG12 and QSX15 replace the DOC with a diesel particulate filter (DPF) to help achieve their class-leading power density and the faster engine response required for larger machines. The Cummins DPF operates automatically with active regeneration only occurring during around 1% of the engine run time.

The smarter electronic management that comes with Cummins Tier 4 Final technology keeps the equipment operating at optimum power and fuel efficiency, responding to the differing load and duty-cycle conditions that are usually experienced by off-highway equipment. This electronic control capability additionally enables the exhaust aftertreatment to automatically clean itself when needed, to maintain peak operating condition.

Enhanced engine performance

While cleaner diesel engines are great for the environment, there are also a number of more tangible benefits for Cummins Tier 4 Final users. Increased efficiency within engine combustion means better fuel efficiency. The fuel efficiency comparison between Tier 4 Final and Tier 3 engines is dramatic. For example, Cummins Tier 4 Final engines typically use 8-10% less fuel, enabling a notable reduction in operating costs.



Number 28, the famous 1952 Cummins Diesel Special race car, will also be on show at ConExpo

Cummins Tier 4 Final engines are not only stronger, but also produce more power than ever before. Compared with their Tier 3 predecessors, Cummins Tier 4 Final QSB6.7 and QSL9 engines each produce more torque, with top ratings of 770 lb-ft (1,044Nm) and 1,200 lb-ft (1,627Nm) respectively. Transient response is class-leading, together with excellent power-to-weight ratio. The heavy-duty Cummins QSX15 increases output by 75bhp (56bkW) to a peak rating of 675bhp (503bkW). So while the engine is cleaner, it has also been maximised to deliver the dependability, reliability and durability needed for the rugged environment and duty cycles of the heavy equipment industry.

Selective Catalytic Reduction requires diesel exhaust fluid (DEF) for operation, which functions as a reactant in the catalytic process to lower NOx emissions. Known as AdBlue in Europe, the fluid required for off-highway equipment is the same as that used in on-highway vehicles and is available in a wide variety of packaging sizes.

The larger the packaging size, the lower the cost, though typically the diesel exhaust/AdBlue fluid is always priced below that of diesel fuel. Cummins' ability to design and manufacture both the Tier 4 Final engine and exhaust aftertreatment as a single integrated system means that DEF consumption is minimised and can even be as little as 3% of diesel fuel consumed.

A 'diesel special' on show

Cummins will be bringing one of the most famous diesel-powered race cars to its ConExpo display with the appearance of Number 28. In 1952 the Cummins Diesel Special Number 28 created a sensation at the Indianapolis 500 race by taking pole position with a 139mph (223km/h) track record.

A radically different Kurtis-Kraft roadster style chassis with low, long profile was adapted for the horizontally positioned JB-600 diesel. Built from lightweight aluminium, the race-engineered 6.6-litre was updated to 420bhp (313bkW), boosted by the first turbocharger used at Indy. After 100 miles on pace with the leaders, Number 28 retired because of damage from track debris. Due to entry rule changes, Number 28 became the last diesel to compete in the Indy 500, but still transformed perceptions about what was possible with diesel technology.

The appearance of the famous race car on the Cummins booth provides a fitting testament to how that heritage of innovation is brought right up-to-date at the show with the latest Tier 4 Final technology displayed alongside. Visitors will be able to see how Cummins technology has the power to transform equipment performance – and their business – at ConExpo 2014. **ivt**

Kevan Browne is marketing communications director at Cummins Engines



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The end is nigh...

...BUT IT'S A REASON FOR REJOICING RATHER THAN PANIC. WITH THE DELIVERY OF THE FIRST MACHINE USING AN EPA TIER 4 FINAL-CERTIFIED ENGINE ALREADY HISTORY, THINGS ARE ALREADY LOOKING UP

▷ Back in 1994, when the US Environmental Protection Agency (EPA) announced its tiered approach to drastically reducing emissions from non-road diesel engines, engine manufacturers clearly understood the environmental importance and the global impact of this crucial initiative. They also knew it would take unprecedented effort and major resources to achieve the new emissions standards.

Over the years, Caterpillar leveraged its deep technical expertise and vertical integration to achieve milestones in each tiered step. One particularly notable milestone for the company was reached on 12 September 2013, when the first 988K large wheeled loader, powered by the C18 ACERT engine, was delivered. The 988K is the first Cat machine in the 175-750hp range with US EPA Tier 4 Final/EU Stage IV technology to hit the market, and the C18 ACERT was the industry's first such non-road engine system in that range to be certified by the EPA.

The road – and the destination

The road to Tier 4 Final/Stage IV has resulted in Cat machines and engines that offer considerable value for both the environment and the customer. Reducing engine emissions was just one of the company's goals on this journey. As part of the development process, its dedication to maximise customer value led it to partner with its customers to better understand their specific business needs and equipment requirements. Customers said they required optimised productivity, fuel efficiency, component life and lower operating costs. They also made clear that their success depended on solutions that support their company's bottom line. Caterpillar listened.

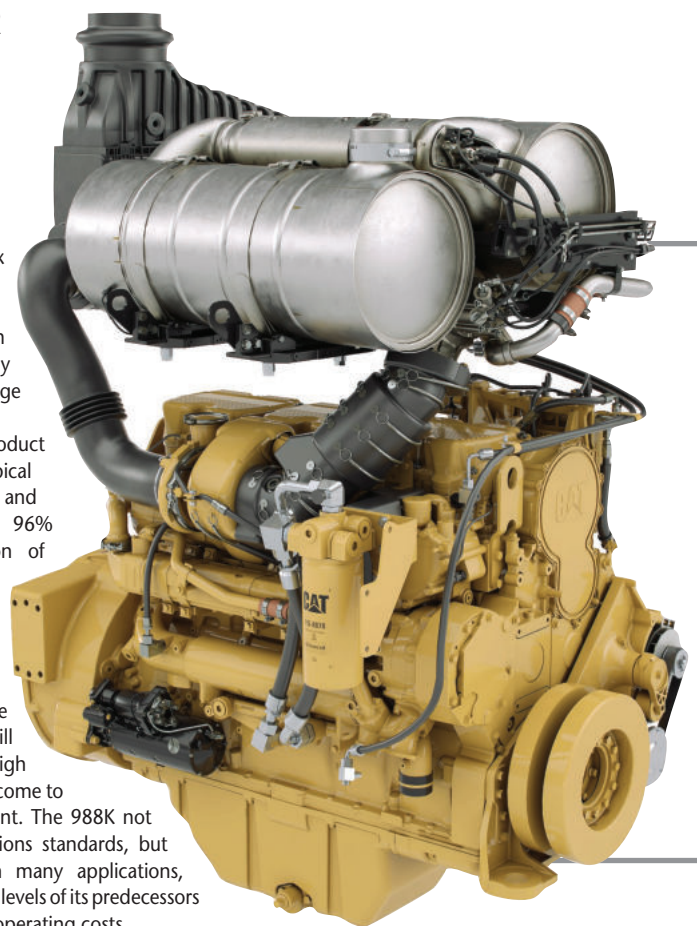
The development and validation of application-specific Tier 4 Interim/Stage IIIB technology solutions ultimately resulted in the most successful New Product Introduction programme in Caterpillar's history to date. With over 50 million hours recorded on more than 100,000 engines powering Cat machines and OEM equipment, these solutions brought the company to its Tier 4 Final/Stage IV destination: meeting emissions standards and the unique needs of each of its customers.

Caterpillar's C18 ACERT engine system dramatically reduces oxides of nitrogen (NOx) from the exhaust by converting them into nitrogen and water,

producing near-zero NOx emissions. This has been accomplished by adding a selective catalytic reduction (SCR) system to the already proven Tier 4 Interim/Stage IIIB suite of technologies.

The end result is a product that has reduced typical engine particulate matter and NOx emission levels by 96% since the implementation of Tier 1 emissions standards in 1996.

As the company's 988K large wheeled loaders with Tier 4 Final/Stage IV technology roll out into the field, operators will still experience the same high product quality they have come to expect from Cat equipment. The 988K not only meets current emissions standards, but also maintains – and in many applications, exceeds – the performance levels of its predecessors while offering lower total operating costs.



TOP: Caterpillar's C18 ACERT Tier 4 Final-certified engine, as used in its 988K large wheeled loaders (above). Despite complying with the latest emissions standards, the 988K boasts higher performance in many applications than its predecessors

Looking ahead

Other Tier 4 Final/Stage IV Cat machines and engines have already been certified and released. More will continue to roll off the assembly lines in coming years. "Tier 4 is a critical and multifaceted initiative at Caterpillar," declares chief technology officer Gwenne Henricks. "As part of our dedication to introduce sustainable solutions into the off-highway industry, we're leveraging the expertise of our global R&D team to ensure that Cat products meet emissions standards and our customers' needs. It's our job to help our customers succeed – today and in the future – with equipment and service backed by the world's best dealer network." **IVT**

An expert on Tier 4 aftertreatment systems, Matthew Delzell is a marketing and sales support supervisor for Caterpillar, while Heather Delabre works as its engine development communications specialist



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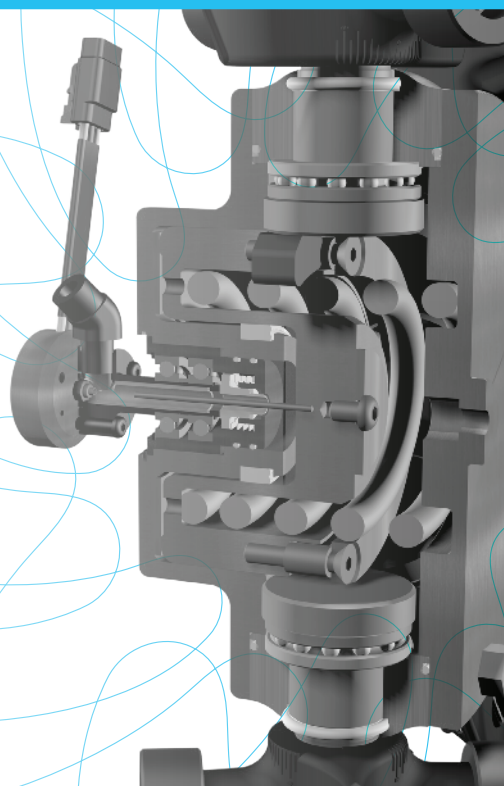
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Winter warmers

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Construction machines are used all year round – even in the depths of winter. Parking heater manufacturer Webasto therefore offers air and water heaters that will ensure these vehicles remain ready for operation – even under cold and icy conditions. The heaters operate independently of the engine, so unnecessary engine idling is avoided. The result is reduced fuel consumption and emissions.

Air heaters are characterised by their ability to heat vehicle cabs quickly and efficiently. In the construction equipment sector they are frequently used in crane cabs, where the air is heated inside the device and fed into the vehicle cabin. These heaters offer continuously thermal regulation, whereby a temperature sensor permanently monitors the interior temperature and automatically adjusts the heating power.

Webasto will be presenting its new Air Top Evo 40 and Air Top Evo 55 models at ConExpo 2014. The heaters score points with numerous new features. An integrated automatic cold-start system delivers 10% greater heat output, enabling the driver's area to be heated even faster. Furthermore, the heaters run much more quietly and are characterised by lower power consumption than their predecessor models. The new Air Top Evo heaters benefit from these new features due to improved heating performance control. Both the fuel pump activation and the regulation of the fan speed have been optimised.

In addition, the models are equipped with an automatic high-altitude mode as standard, which guarantees ideal combustion if the oxygen content of the surrounding air decreases due to lower air pressure at high elevations. In this way, optimal operation is ensured up to 2,200m above sea level.

Depending upon requirements, clients may choose between the Air Top Evo 40, with a maximum heat output of 4kW and the Air Top Evo 55, with a maximum heat output of 5.5kW. The models will be offered as original equipment as well as for retrofitting, with a compact design that facilitates easy fitting. Versions are available for operation with diesel (12/24V) and petrol (12V). The new heaters will be freely available on the retail market from April 2014.

In hot water

Webasto's water heater systems provide a well-known alternative to air heaters. In addition to heating the



Even drivers of snow groomers can sit in a comfortably warm vehicle. The Air Top Evo heaters guarantee optimal operation up to 2,200m above sea level

cab, these systems also warm the engine because they are integrated into the coolant circuit of the vehicle. Using additional components, other systems that are critical for the operation of the vehicle – such as the battery, fuel tank and hydraulic oils – can be brought up to operating temperature.

Particularly suited for use in construction machines are the robust Webasto product models Thermo Pro 50 Eco (24V/diesel) with a heat output of 5kW and Thermo Pro 90 (24V/diesel) with 9.1kW heat output.

End idling with intelligent technology

In order to avoid unnecessary engine idling, Webasto has developed its patented Engine-Off technology especially for construction machinery. This ensures that the vehicle can be maintained at operating temperature – independent of its engine – during operational downtime and breaks. OEMs, owners and lessees of these machines will all profit in equal measure from the benefits. Because the equipment is maintained at the perfect temperature, engine operating hours are reduced, fuel is saved and emissions are reduced. Service intervals are extended,

the overall service life of the machine is greatly increased, and resale value rises.

Engine-Off technology is available for fitting as original equipment – but can also easily be retrofitted as only a small number of additional components need to be integrated into the heating system. Control is easy: the driver only needs to activate the system and the temperature in the cab is then automatically maintained at the desired level.

And that's how the Engine-Off technology works. For as long as the vehicle's engine is running, it generates heat – which is distributed via the cab heat exchanger. When the engine is turned off, the Engine-Off system takes over and the parking heater's circulation pump ensures that the coolant continues to circulate through the system. This enables the continued use of the residual engine heat to keep the cabin warm. If the temperature in the driver's cabin drops below a predefined value, the parking heater is automatically switched on. **IVT**

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Bigger and better

WITH THE ADDITION OF TWO LARGER FRAME SIZES TO THE H1 AXIAL PISTON PUMP RANGE, PLUS A BUNCH OF NEW INNOVATIONS, MOBILE MACHINE EFFICIENCY IS REACHING ENTIRELY NEW LEVELS

Size is inevitably an important consideration whenever Danfoss designs electrohydraulic transmission solutions for construction machinery, and OEMs will certainly appreciate the addition of the 210/250cm³ frame sizes to the H1 axial piston pump series. Completing the H1 range, these new arrivals and several other bright spots of innovation should catch OEM attention at IFPE 2014 in Las Vegas.

Bringing a dynamic extra dimension to intelligent power management, Danfoss will launch its advanced PLUS+1 Best Point Control software – a powerful step-up for the seamless human machine interface. Another highlight is the H1 Automotive Control (AC) system, which now includes Eco Mode and Cruise Control options for improved fuel economy and operator comfort.

Along with Danfoss's smart PLUS+1 Anti Spin and Generic Dual Path software, the latest innovations support the trend towards highly integrated electronic controls and increased use of system data in tailored solutions that optimise a vehicle's available power.

H1 motors provide OEMs with improvements not only in reliability and flexibility, but also in overall efficiency, resulting in lower fuel consumption and reduced lifecycle costs



H1 AC brings intelligent electronics to machines such as telehandlers, wheeled loaders, dumpers and sweepers, which need to maintain a constant speed when moving up and downhill

A new hydrostatic generation

H1 was the new generation of hydrostatics for the high-power mobile machinery markets, introduced at a time when everyone was talking about the US Tier 3 emissions requirements. The move towards larger, emissions-compliant engines had reduced the space available to hydraulic systems.

Danfoss's response was to launch the first compact H1 axial piston pumps, shorter in length for optimised system design flexibility and with a high operating efficiency to compensate for the lower engine rpm. The first H1 bent-axis motor followed. Standing out for its relatively small size and 0° capability, it promises a safe, precise performance and a seamless shift from four- to two-wheel drive solutions, giving operators the smoothest possible ride. The motor is also up to 6% more efficient than competitor products.

Over the past decade, Danfoss has regularly added new pumps and motors to the H1 family. The newest arrivals – the 210/250cm³ pump frame sizes – fill the last gaps in the range, which now comprises 14 pumps with displacements of 45-250cm³, five bent-axis motors spanning 60-250cm³ and five control options. A patented Integrated Speed Limitation (ISL) circuit enables improved vehicle braking with no risk

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of engine overspeed. For the construction industry and others reliant on heavy-duty mobile machinery, that adds up to a comprehensive choice of solutions when customising complete H1 transmission systems with optimised electric control.

Today, of course, the talk is no longer about Tier 3 but about the even tougher Tier 4 standards, which will be phased in from 2014. Designed with the future in mind, the original members of the H1 family are still well equipped to meet the latest market demands.

"All H1 software solutions are pretested, so OEMs can count on them to improve productivity and efficiency within the confines of today's emissions and safety regulations," says Markus Plassmann, high-power closed-circuit product marketing manager at Danfoss. "As a result, the time-to-market for new electrohydraulic transmission systems is much shorter."

The latest innovations raise the efficiency level an additional few notches.

Best Point Control: Plassmann describes the new PLUS+1 Best Point Control software for H1 pumps and motors as the next evolution in intelligent power management for off-highway transmissions. Using operational data to secure maximum performance, the software achieves up to 25% savings on fuel consumption and emissions.

"This electronic concept uses the operator's power requirements to determine the optimum engine speed," he explains. "The engine operation point is permanently calculated as a function of power demand. All the driver has to do is focus on the job in hand – and enjoy the comforts of smooth, responsive controllability and less noise."

Adjustable driving characteristics: To enable automatic adjustment of vehicle driving behaviour, Danfoss has developed H1 Automotive Control (AC) – a strong combination of advanced H1 technology and decades of experience with electronic automotive control development. Pre-certified according to the SIL 2 functional safety standard, H1 AC adjusts driving characteristics to specific operating requirements whether driving on- or off-highway.

"H1 AC brings intelligent electronics to machines such as telehandlers, wheeled loaders, dumpers and sweepers, which need to maintain a constant speed when moving up and downhill," Plassmann explains. "In transport mode, H1 AC switches to automotive driving characteristics for the best operator comfort."

An especially innovative feature of the electronic H1 AC controller is that it is embedded in the H1 pump. The electrical connections are positioned to enable easy installation on OEM vehicles. Additional watchdog circuitry provides real-time fault monitoring of electronic hardware – an attribute that helps industrial vehicle manufacturers satisfy functional safety legislation faster and at reduced cost.



Options for more comfort and economy: At IFPE, Danfoss will present its newest H1 AC options – Eco Mode and Cruise Control. Functioning in much the same fashion as in cars, Cruise Control steps up the focus on operator comfort, enabling operators to maintain a constant cruising speed until deactivation by braking. Eco Mode is responsible for automatic engine speed reduction in transport mode.

"Depending on the machine type, configuration and duty cycle, Eco Mode represents another possibility for improving vehicle fuel economy, cutting consumption by up to 20%," says Plassmann.

Intelligent Anti Spin: The commitment to flexibility is a recurring theme in all H1 transmission solutions. PLUS+1 control software therefore plays an indispensable role in the efficient customisation of intelligent machine management systems.

Two of the subsystem applications relevant to construction machinery are PLUS+1 Anti Spin and Generic Dual Path. Designed for systems where a single pump delivers hydraulic flow to multiple motors, PLUS+1 Anti Spin eliminates the slippage that occurs when a wheel loses ground contact on uneven terrain. Detecting the lack of traction, the anti-spin function reduces flow to the wheel in question until traction is restored. Anti-braking system functionality is another feature.

Dual Path Alignment: Dozers, crawlers and pavers are among the applications that can benefit from PLUS+1 Generic Dual Path, which overcomes the shortcomings of manual control on machines with independent left and right propel systems. Adept at converting input from the joystick and the controller area network (CAN) into differential output

LEFT: The new H1 210/250cm³ axial piston pump completes the H1 range, which now comprises 14 pumps with displacements of 45-250cm³ and five bent-axis motors spanning 60-250cm³

BELOW: Pre-certified according to the SIL 2 functional safety standard, H1 AC adjusts driving characteristics to specific operating requirements, whether on- or off-highway



commands, the subsystem ensures both sides of the machine are accurately aligned. The result is infinitely variable steering, allowing operators to choose between straight tracking, pivot steer and full counter rotation in either direction.

Plassmann comments on the adaptability of the dual-path subsystem to differing machine needs: "OEMs can choose, for example, differential steering for pavers and non-differential for crawlers. The requirements of other dual-path applications are also easily fulfilled," he says.

Market demands for customisable transmissions are unlikely to stop with these Danfoss innovations. Characterised by their simple, compact design, H1 pumps and motors will need to provide increasingly complex functionality in the years ahead – supported as ever by smart PLUS+1 control software.

The Danfoss advantage is that intelligent machine management is already firmly embedded in its innovation culture, and once the potential of advanced electrohydraulic controls is understood, each evolution inspires the next. On that basis, keeping up with future market demands is unlikely to be a problem. **IVT**

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Compact without compromise

WITH SPACE FOR COMPONENTS AT AN INCREASING PREMIUM, THE CONSOLIDATION OF MULTIPLE FUNCTIONS INTO A SINGLE CARTRIDGE IS AN IDEAL SOLUTION – AND IT CAN BE ACHIEVED WITHOUT ANY DECLINE IN POWER AND PERFORMANCE

▶ With the recent introduction of Tier 4 engine emissions standards, the conventional wisdom of bigger meaning better has been jettisoned. As OEMs find themselves having to make more efficient use of their available horsepower, demand has grown for compact and tunable control options.

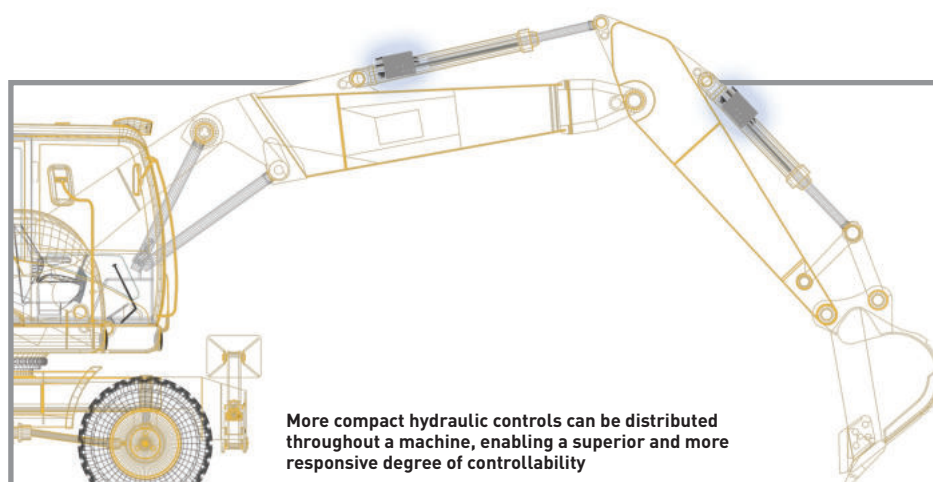
To give system designers a superior level of control with less pump flow and pressure drop, HydraForce has introduced an innovative line of multifunction cartridge valves that enable more compact circuit designs without compromising on performance and power. By consolidating multiple control system functions into a single cartridge, the company has created many clever and compact valve solutions, including electrohydraulic valves with integral load-sensing and load-holding capabilities, combined system relief and on/off control, and system bypass and flow regulation.

"By pushing the boundaries of computational fluid dynamics and other modelling software, we've been able to optimise the internal pressure dynamics and flow capacity of our valves while minimising their actual size," states Ron Morgenson, VP of Worldwide Technology at HydraForce. The line-up now includes more than two dozen unique valve choices, encompassing electrohydraulic and mechanical flow, direction and pressure controls that can handle flow rates up to 303 l/min (80 US gal/min) and continuous operating pressures up to 350 bar (5,075psi).

The latest in the series of HydraForce multifunction valves are the HSPEC valves which combine an electrohydraulic flow control valve with integral pressure compensation. There are two variations; one model features a post-pressure compensating element that enables flow sharing, while the other features a load-holding compensator that is ideal for stable lifting and lowering operations. Both models are available in three flow ranges that can satisfy flow demands from 0-32 l/min (9 gal/min), 0-70 l/min (18 gal/min) and 0-132 l/min (35 gal/min) respectively.

Applications for HSPEC technology

The HSPEC-30 valve provides the functionality that would otherwise require three separate cartridges. In a single cavity, it combines an electroproportional flow control valve, a post-pressure compensated logic element, and a load-sense check valve. This new



More compact hydraulic controls can be distributed throughout a machine, enabling a superior and more responsive degree of controllability

breed of multifunction valves is driving down the size of manifolds, giving engineers the freedom to locate the manifold where it makes the most sense. Whether the hydraulic circuit is packaged in a single centralised manifold, or is distributed and directly mounted to a hydraulic actuator, HSPEC technology offers the engineer uncompromising flexibility and ensures a more robust, responsive solution for machine control.

The HSPEC-30 valve enables tunable directional control circuits in a way that cannot be accomplished with traditional options. With three sizes to choose from, the optimal cartridge size can be selected to meet exact flow requirements. With the freedom to mix and match cartridges with different flow ratings, directional control circuits can yield some major improvements in system response, flow control and metering resolution.

The serviceability aspect of cartridge valve-based circuits is often overlooked. While it may take hours to repair or service a conventional stack-type directional control valve, it takes only minutes to remove and replace a cartridge valve. When servicing a cartridge valve-based circuit, the loss of hydraulic fluid and introduction of contaminants are greatly reduced. Pairing a function with an optimally sized control valve and avoiding depot-level maintenance on a directional control valve can be a boon to productivity.

Flow-sharing with finesse

An ideal application for the HSPEC-30 valve is a flow-sharing directional control circuit. A cartridge valve-

based directional control circuit provides independent control of meter-in and meter-out flow logic. This circuitry produces a higher level of performance and is a superior hydraulic architecture for applications that require more finesse.

By using the HSPEC-30 for the meter-in side of flow control, the flow-sharing benefits associated with post-pressure compensation enable precise motion control of a hydraulic motor or cylinder. Cartridge valve-based directional control circuits also have the added advantage in how they can be packaged. Although a single centralised manifold is most common, a cartridge valve-based directional control circuit can be distributed and directly flanged to each hydraulic actuator; a feat that is not possible using conventional spool valve technology.

The HSPEC-34 replaces three valves as it combines the functionality of an electroproportional flow control valve, a pressure-compensating logic element and a load-holding valve. This new family of multifunction valves was designed to provide superior load-holding characteristics, while giving precise and stable flow control with little or no leakage. An ideal application is boom control circuits that benefit from the ability to selectively choose between power-down and gravity-assisted lowering. By using the boom's structurally induced load pressure, the HSPEC-34 harnesses the natural force of gravity and provides smooth and stable lowering. With an emphasis towards increased efficiency, the HSPEC-34 has the potential to convert gravity-assist lowering into considerable fuel savings.

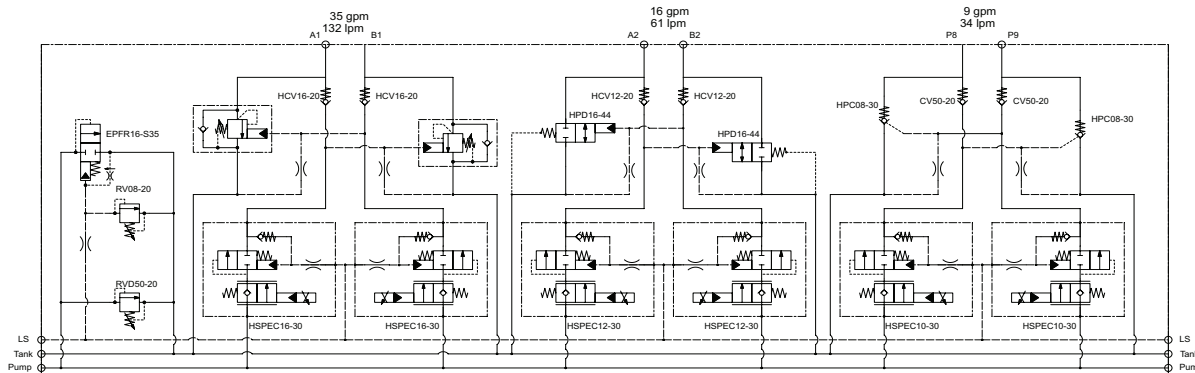
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LEFT: Hydraulic schematic shows how multiple hydraulic functions can be structured to share flow with the application of multifunction HSPEC valves

As a result of extensive machine testing in the field, HydraForce has documented a 22% fuel efficiency improvement when using a gravity-lower circuit over a conventional power-down/counterbalance valve-equipped boom control circuit. This equates to a fuel saving of 4 litres (1 gallon) of fuel per hour when operating a typical boom up/down work cycle.

Laying the groundwork for innovation

HydraForce's commitment to the use of simulation, prototyping and testing of its cartridge valves and

manifolds has been solidified with the opening of a new Innovation and Technology Center in Vernon Hills, Illinois that has nearly doubled the company's engineering and product development capabilities. A new higher-pressure hydraulic test stand will enable the testing of hydraulic valves and circuits at up to 448 bar (6,500psi) with flow rates of up to 454 l/min (120 gal/min). The applications lab has grown 2.5 times its original size and is scheduled to expand even more with the addition of field-testing capabilities, including a vehicle proving ground.

By consolidating its product development in Vernon Hills, HydraForce has increased manufacturing capacity in Lincolnshire by 1,393m² (15,000ft²). The Innovation and Technology Center has over 13,192m² (142,000ft²) of space devoted to bringing prototypes and production parts to market faster, now and in the future. **IT**

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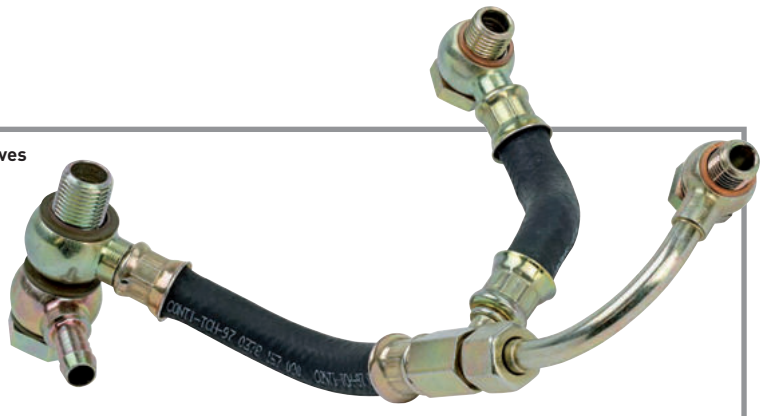
A tall story

LIEBHERR'S LR 13000 CRAWLER CRANE OFFERS IMPRESSIVE STATISTICS. AT ITS HEART IS A COMBINATION OF HYDRAULIC COMPONENTS THAT ACHIEVES THE UNACHIEVABLE: FAULT-FREE OPERATION, IN ANY CONDITIONS

▶ Liebherr's LR 13000 is not only the most powerful crawler crane of conventional design in the world, but also the tallest. By using hydraulic hoses, valves and couplings from ContiTech, the crane manufacturer is wisely putting its faith in safe and reliable components. These have repeatedly proved their mettle in the decades of development co-operation between the two companies – even under the toughest load conditions.

ContiTech Fluid Technology has enjoyed a long, trusting business relationship with Liebherr. In the manufacturer's heavy-duty cranes, hydraulic hoses and hose assemblies made using steel, plus those using synthetic fibres, special hoses incorporating Teflon, brake hoses, hydraulic couplings and high-pressure connector systems from ContiTech, ensure that these construction machines can perform even the most difficult tasks reliably. In the process, the hose assemblies and couplings have to withstand not only high pressures, but also extreme mechanical stresses: they are in constant motion when the crane

Hydraulic hoses, valves and couplings from ContiTech play a crucial role in the safe operation of hydraulically operated construction machinery



is in use. Abrasion can easily occur in operation on construction sites.

If you also factor in the aggressive action of hydraulic oil, great demands are placed on the hose assemblies. All these requirements are taken into account during production.

Hitting new heights

The record-breaking crane's particular areas of operation are in the construction of nuclear power stations and refineries and in the pre-assembly of offshore steel structures, such as oil platforms, where the lifting of evermore extreme unit weights is required. The high-quality hydraulic components from ContiTech ensure reliable power transmission.

"Extreme precision and maximum quality are called for here," emphasises account manager Dieter Klüschen. "And that includes both the structural design of the hose itself and the perfect rubber compound." Impeccable quality assurance systems at ContiTech ensure that nothing will go wrong, even under extreme operating conditions.

After all, without hydraulics almost nothing on the LR 13000 will work. Two 500kW V8 diesel engines operating in parallel drive its hydraulic units; these, in turn, move the crawler tracks, the stabiliser and auxiliary cylinders, the slewing cylinder and the cables and winches, to raise the lattice jib and hoist the loads, the slewing gear and the hydraulic cylinders for a whole range of functions.

The crane was first assembled in its maximum lattice boom configuration at Liebherr's manufacturing plant in Ehingen, Germany: the combination of the 120m main mast with the 126m luffing jib produces a lattice boom system with an overall length of 246m

and a weight of 700 tonnes. Mounted on the solid crawler chassis, the crane reaches a height of 248m. That means that this giant crawler crane, which outstrips all dimensions seen until now, towers over the 162m spire of Ulm Minster, the tallest in the world, by no less than 86m. The LR 13000 could lift a load of 624 tonnes, which corresponds to around 600 small cars, onto Ulm Minster in a single hoist.

The first load hoisted into the air was a twin-axle mobile crane, an LTM 1030-2.1, with a weight of 24 tonnes – as if it were nothing. To achieve the world record, an enormous amount of ballast was needed: the crawler crane was therefore fitted in Ehingen with 400 tonnes of slewing platform ballast and 1,500 tonnes of derrick ballast on the counter-jib on a special foundation.

The LR 13000 reaches its maximum boom length of 246m using a single main boom and luffing jib. At its steepest setting, the crane has a load capacity of 68 tonnes. According to the manufacturer, the stability of the jib system was successfully tested on the acceptance inspection site with a test load of 103 tonnes. Using the Liebherr power boom – a double boom in the lower section – the LR 13000 can lift 330 tonnes to a hoist height of 202m.

The first model of the record-breaking crane went to Chicago, USA. The shipping process itself turned into something of a logistical challenge: 147 transport vehicles were needed to move the LR 13000 from Ehingen to the customer.

Impeccable quality assurance

Impeccable quality assurance systems at ContiTech ensure consistently high quality: all the company's hoses meet DIN standard specifications. However,



Hair-raising heights or enormous loads – neither is a problem for the Liebherr LR 13000 crawler crane

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ContiTech Fluid Technology takes the very loosely drafted standards and tightens them substantially. For instance, the company specifies absolutely precisely the materials from which the outer and inner rubber plies have to be composed and how many threads are to be used for reinforcement.

Trials are conducted in ContiTech's labs and test facilities to determine whether the hose meets the specified requirements, has the desired impulse resistance and passes the burst tests. UV resistance, abrasion strength and media resistance to hydraulic oil and gasoline, for instance, are also tested. Here, too, the testers apply considerably more stringent benchmarks than the DIN standard would require. With reference to the impulse resistance, for example, these benchmarks are up to a third higher than the specifications of DIN 6803. Depending on the customer's requirement, resistances of up to three million impulses are possible.

But the hydraulic hose assemblies are not the only components that have to keep pace with the constant rise in requirements; this same demand is made of the connections between the assemblies and the central hydraulic unit. Depending on the application, both

RIGHT: Hose and industrial hose assembly production at ContiTech are based on the TS 16949 quality management system and the ISO 14001 environmental management system



snap-on and screw couplings are used as connectors. It is absolutely vital that nothing goes wrong at this crucial junction between the hose and the fitting, so ContiTech has rigorous specifications for these rubber/metal connections. After all, a hydraulic system is only as strong as its weakest point. How the hose has to slide between the nipple and the sleeve of

the fitting and then be firmly pressed into place with a hydraulic press is therefore clearly regulated. This ensures that the connection is absolutely leakproof and that precise functioning of the hydraulic application is guaranteed. **IVT**

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Multi-Wing is really Mixing it Up

The new MxFlo Fan: the pressure's never been greater

Multi-Wing introduces its first mixed flow fan designed specifically for engine-cooling applications. The MxFlo delivers up to 50% greater static pressure than standard axial fans, and it hits peak efficiency at high pressure. Built to solve the stringent emission requirements from Tier 4 in the U.S. and Stage III B Standards for Nonroad Engines in Europe, the MxFlo delivers its peak performance under the most challenging conditions. Designed to fit clutches as well, the MxFlo uses a combination of axial and radial airflow to cool the engine.

The MxFlo has an available diameter range of 550 to 735 millimeters and is molded in glass-reinforced polyamide (blades) and long-fiber glass-reinforced polyamide (hub).

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DARREN MAGNER

EXHIBITOR AT



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A huge relief

USING LOGIC ELEMENT TECHNOLOGY TO BOOST THE FLOW (AND PRESSURE) CAPABILITY OF ELECTROPROPORTIONAL RELIEF VALVE CIRCUITS IS A CRUCIAL PART OF DESIGNING COST-EFFECTIVE HYDRAULIC CIRCUITS

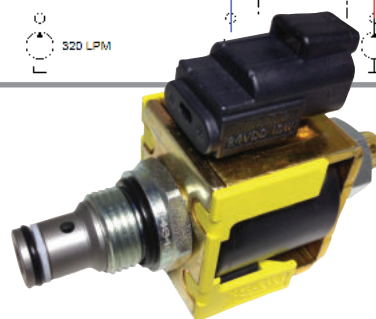
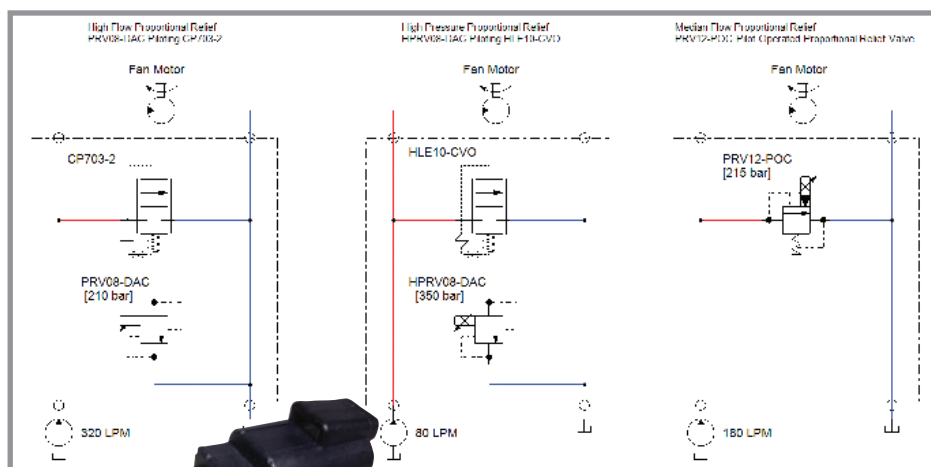
The efficient use of logic elements is key to the design of cost-effective circuits, and is perhaps only limited by the imagination of the designer. Most experienced hydraulic circuit designers know and understand the many ways to apply logic elements. Those who are less familiar with logic elements, but are always looking for the next best solution, will benefit from looking at normally closed, vent-to-open type of logic elements, such as Comatrol's new HLE10-CVO and its family, and proportional relief valves, such as the new HPRV08-DAC and its family.

Logic elements – often called differential sensing valves – are pressure control devices. Like directional control valves, a spring bias holds the spool in open or closed position, and it is shifted by hydraulic pressure. Unlike directional control valves, they are modulating devices (rather than on/off), and maintain a pressure differential. By themselves, logic elements perform no function but are building blocks for many circuits.

Creating a big relief

Proportional pressure-relief valves (PRVs) are two-way valves that provide a relief pressure as a function of electric current. Both normally open (increasing pressure with increasing current), and normally closed (decreasing pressure with increasing current) are available. With the growing market for proportional fan systems, this article will focus on the normally closed design for fan speed control.

The normally closed proportional relief valves are available in direct-acting and pilot-operated designs. A direct-acting, normally closed proportional relief valve, such as PRV08-DAC and HPRV08-DAC, is used for low-flow applications, such as piloting a logic



TOP: Fan speed control examples using direct-acting proportional relief valves (PRVs) piloting a logic element: high flow (left), high pressure (middle). The example (right) shows a pilot-operated PRV

LEFT: Combining a logic element with a direct-acting proportional relief valve (above) provides high-flow and high-pressure solutions

element. For high-flow applications up to 180 l/min, internally pilot-operated cartridges, such as PRV10-POC or PRV12-POC, are available. Should the flow requirements (or even pressure requirements) exceed that of the internally pilot-operated valves, then combining the direct-acting PRV with the proper logic element is the next logical step.

Some common applications for normally closed proportional relief valves are the electroproportional control of system relief pressure or a remote pressure compensator control for open-circuit piston pumps, but where system requirements dictate full pressure with no electrical signal. Most fan drive systems

require the fail-safe mode (no electrical current) to provide full fan speed, which makes normally closed PRVs ideal.

The example schematics above highlight three different solutions to provide proportional fan speed control to a fan motor. The first two are combining a spool type, normally closed, vent-to-open logic element with a direct-acting electroproportional relief valve to create a proportional relief function – selecting the logic element size and pressure to match the system requirements. The third schematic shows the single valve advantage of the pilot-operated type (smaller size and less space needed), but has flow (180 l/min) and pressure (210 bar) limitations.

The first schematic is the high flow example. If the system requires up to 380 l/min and 210 bar max pressure, then select the proper logic element to match the capacity, such as CP703-2 in combination with a PRV08-DAC. For higher pressure requirements (middle schematic), select the HLE10-CVO with the HPRV08-DAC – both capable of 350 bar and providing flow up to 100 l/min. The third schematic is for flows up to 180 l/min and when pressures of 210 bar or less are needed, in which case, a single cartridge valve such as pilot-operated proportional relief valves PRV10-POC or PRV12-POC should be used. **IVT**

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Look before you leak

THE EO-3 COUPLING SYSTEM ENSURES THE INSTALLATION OF HYDRAULIC LINES IS MADE EVEN MORE QUICKLY AND SECURELY, WHILE PROVIDING A VISUAL CONFIRMATION OF A LEAKPROOF CONNECTION

For more than 80 years, Parker Hannifin, one of the world's leading manufacturers of drive and control technology, has been developing high-pressure hydraulic couplings and setting standards globally. Over those eight decades, new geometries and materials have hugely improved the performance, reliability and ease of installation of the original Ermeto couplings. As a result, any leakages in piping systems today cannot be ascribed to material defects, as they could be previously, but rather to improper installation. Assistance is provided in this regard by the new, quick-to-install EO-3 coupling system. Its innovative form and technology raise pipe installation to a high level of quality, security and economy.

The correct installation of couplings is essential, because the results of leakages are far from pleasant, and can include cost-intensive downtimes, customer complaints, reworking, environmental damage and even accidents. With this firmly in mind, Parker has developed a coupling concept in the EO-3 system that sets new standards.

EO-3 couplings enable simpler, quicker and more secure installation, due to a new thread technology. In contrast with all prior (DIN-standard) couplings, the system is based around a 24° inner cone with integrated soft seal and a cone-shaped connecting thread. The first system of its kind in the world is said to be unique, and enables the control of installation results from the outside. Using a yellow signal ring, the installer can immediately tell whether or not the coupling has been made correctly.

In addition, EO-3 couplings can be installed much more quickly than conventional coupling systems. The EO-3 installation requires neither a torque wrench nor a wrench extension; a common open-ended spanner will suffice. With pipe sizes from 25mm, an octagonal screw nut – instead of a standard hexagonal screw nut – eases installation. The octagonal screw nut makes access easier with the open-ended spanner in tight construction spaces. The spanner does not need to be lifted off and replaced so frequently, meaning the installation speed increases.

Machine pipe forming

For the new bolt connections, Parker uses the EO metal-forming machine tool that is already on the market. With the machines users have been using up



As a fitting series for tube and hose assemblies, the EO-3's indicator ring ensures unambiguous assembly and peace of mind to the assembler. Leakage due to over- or under-tightening is prevented

until now to produce, for example, the EO-2-shaped pipe couplings, they can also create EO-3 couplings – an important contribution to cost reduction. This merely requires the respective EO-3 forming dies.

EO-3 can also be used in applications that demand flexible hose connections, while linking to existing EO-2 connections is also made possible without any problems via an adaptor. This means 'old' couplings can be converted or upgraded to the EO-3 system at virtually no additional cost. The new coupling system offers four times the safety of its predecessor and does away with the standard LL, L and S series classifications that have previously been customary. Except for a few exceptions, a single pressure stage of 420 bar applies to all pipe sizes. Elastomeric materials can be selected specifically for applications and, therefore, media.

There are many benefits of Parker's new EO-3 concept, including:

- Immediately detectable thread intake;
- Quick manual pre-installation;
- Safer installation due to reduced effort;
- Compact design means space-saving constructions, with less space needed for difficult installations;
- Shorter installation time;
- Signal ring as a control option for the installer;
- A soft seal integrated in the cone improves sealing behaviour – even with high system dynamics;
- Additional increased safety is provided by elastomers pre-installed in the fitting body.

Parker's EO-3 coupling system can be used across all external pipe diameters from 6-42mm and is effective in temperatures from -40° to +120°C. **IVT**

Andreas Kock is business development manager of off-highway mobile (DIN) at Parker Hannifin Corporation, Tube Fittings Division Europe



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States evidence

JUST BECAUSE A COMPANY IS HEADQUARTERED IN EUROPE DOESN'T MEAN IT CAN'T SERVE THE NORTH AMERICAN MARKET PROPERLY AS WELL. TAKE A LOOK AT WHAT'S AVAILABLE HERE, FOR EXAMPLE

▶ Marzocchi Pompe, a leader in the design and production of high-performance external gear pumps and gear motors, can count on more than 50 years of worldwide sales experience since it was established back in 1961 in Bologna, Italy.

The company has also been extremely active in North America since the late 1970s, with several accounts both in the industrial and mobile business. To be as close as possible to its American customers, in 2001 it established its own US branch in Valencia, California, before moving to Schaumburg, Illinois in 2008. The US branch is committed to supporting and servicing Marzocchi's customers with fast responses and deliveries. Inside and outside sales resources, customer service representatives, skilled technical support, in addition to quick product availability as a result of good levels of important stock, make that possible. The result today is a healthy customer base covering mobile and industrial OEMs, with several distributors and integrators spread in the US territory. And the company's already huge product range of reliable and high-performance products has recently seen some important additions.

Welcome to the family

Marzocchi's priority valve pumps now cover a range of displacements from 4.5-87cc/rev. The components of the priority valve, the priority port, the secondary



New and improved hydraulic products can be sourced from Marzocchi Pumps USA, in Schaumburg, Illinois



The low-noise Erika pump family reduces noise levels by an average of 15dB(A)

ports and the load-sensing connection are placed on a cast iron block. The cast iron block in the pump group 2 is assembled like the cover in the family pump group 3 and can be fitted either on the cover or directly on the outlet port in accordance with customer requirements. The pumps with priority valve are available in various versions: with and without a load-sense signal (both static and dynamic); and if the VP cast iron block is mounted on the cover, it is also possible to integrate a relief valve with inner drain.

T-System pumps and motors with integrated support are special motors that can also work with radial and axial forces applied to the motor shaft, thereby making possible the transmission of motion by means of pulleys, belts, chains, sprockets, or the direct fitting of large and heavy fans. The use of the bearing support is essential for these applications because it supports external stresses, leaving the internal bushings free to move, and following the movement of the gear without other constraints. The bearing is permanently lubricated by the hydraulic oil circuit, ensuring optimal lubrication and a good heat exchange. The cast iron flange guarantees a secure and robust load transmission to the support structure, while the compact design allows it to be used in conditions where space-saving solutions are needed.

T-system is available for all versions of pumps and motors in AL and GH groups 2 and 3, in a range of

displacements from 4.5-87cc/rev. All these products can be equipped with integrated valves: cavitation valves, relief or electroproportional valves can be integrated in the cover.

A new proposal for the gear pumps market, the low-noise Erika pump is a perfect fit for all those applications that are expected to produce low noise levels. Erika reduces the noise level by an average of 15dB(A) compared with a conventional external gear pump. The range includes pumps with displacement from 7-87cc/rev, and is perfectly interchangeable with the standard gear pumps in families 2 and 3.

At the heart of the design is the particular shape of the Erika profile, which eliminates the phenomenon of encapsulation typical of normal gear pumps, deleting the source of the main cause of noise and vibrations. The helical toothing ensures the continuity of motion despite the low number of teeth. The low number of teeth greatly reduces the fundamental frequencies of the pump noise, making the sound more agreeable. In this way it is possible to minimise both the pressure oscillations and their frequency. Erika is a registered trademark that will complement that of Marzocchi Pompe in the identification of new products. **ivt**

Daniilo Persici leads test, FEA and CFD analysis in Marzocchi Pompe's R&D department



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Beyond the brake pedal...

ELECTROHYDRAULICALLY ENHANCED BRAKING CAN ENABLE HIGHLY ADJUSTABLE AND VARIABLE BRAKE PRESSURES, MEANING SLOWING DOWN OR STOPPING IS NO LONGER JUST A CASE OF STAMPING ON THE PEDAL AND HOPING

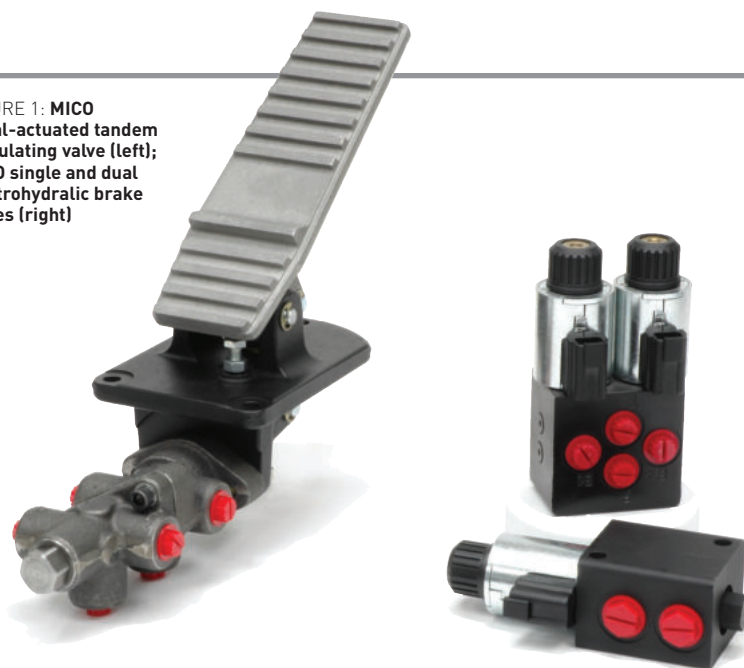
▷ MICO has a long history of working closely with its customers' engineers to optimise the brake valve that is attached to the brake pedal. This provides the crisp, precise, response customers have come to expect from hydraulic full-power braking systems when they step on the pedal. In the last decade in particular, customers are finding more situations where they want the brake pressure to vary with other inputs, including computer control. The result is that MICO is still working closely with its customers' engineers to optimise the response of their brake systems using both pedal valves and electrohydraulic brake valves. It therefore develops a wide variety of electrohydraulic brake valves and accessories, each optimised for specific full-power braking applications, including retarding, ABS, electronic traction control and stability control.

A full-power hydraulic brake system is one that uses a pumped hydraulic fluid, like a fluid power system, to control the brakes. These systems are common on off-highway mobile equipment, and even some on-road vehicles. In the event of loss of pump pressure, back-up braking is typically provided by hydraulic energy stored in accumulators. The brake pressure on these systems is typically controlled by a specialised pressure-reducing and relieving valve, which is modulated by the brake pedal.

Due to the desire to modulate brake pressure based on conditions beyond the position of the brake pedal, MICO developed the EBV electrohydraulic brake valve. It started with the proven construction of the MICO pedal-operated, full-power brake valves, which have been optimised for full-power braking applications and include a patented auto-relieving feature. As always, it was important to minimise part count for minimum cost and maximum reliability. The first prototypes were cartridge valve designs, but the reliability analysis revealed that each static seal added potential fault points and cost. It was determined that end-of-line testing could not reliably distinguish a non-conforming internal static seal, so current designs, such as the latest pedal valves, are sleeveless with no internal seals. A design that was readily customisable to fit packaging requirements was also required.

The most obvious difference between manual and electrically actuated valves is the force and travel available. MICO pedal valves typically have around

FIGURE 1: MICO pedal-actuated tandem modulating valve (left); MICO single and dual electrohydraulic brake valves (right)



500N available at the valve from the operators' foot through a lever multiplier to apply the brake valve. These manual brake valves use 4.5mm or more travel at the valve. Commercially available solenoids used on EBV valves have limited force and travel available.

Use the force

The first question was: how much force is required? The valve must always turn on to apply the brakes when the solenoid is energised, even in the most adverse operating conditions. The loads required to overcome a return spring (ensuring a controlled neutral location) could also be readily quantified. Brake pressure acts to return the spool to the off position in a modulating valve, with the force due to brake pressure being balanced against the applied force to maintain constant brake pressure for a given applied force. Considerable force is also needed to make sure the valves are contaminant resistant.

Because large contaminants can plug small orifices, the EBV valves have no small orifices. Really large contaminants could potentially interfere with flow or movement, so effective system filtering as well as

MICO accumulator charge valves with pressure filters, or screens, can help catch these particles entering the full-power brake system.

Small particles, however, cannot be eliminated entirely – all fluids have them to some extent. To provide the same high performance as its manual modulating valves, MICO adopted the same spool fits and mating surfaces. To control leakage, 5µm radial spool clearances are used. In full-power brake systems, valves can sit under a high-pressure differential for long periods without actuation, meaning considerable force can be required to break the spool free after sitting for a long time in contaminated fluid. This silting force became a primary determinant of the solenoid force required.

The next question concerned how much travel would be required. This could be traded off with force in commercially available proportional solenoids. For a given package size, longer proportional travel provided less force and vice versa. MICO's manual full-power modulating valves were spring returned, with travel that includes three components, as shown in Figure 2.

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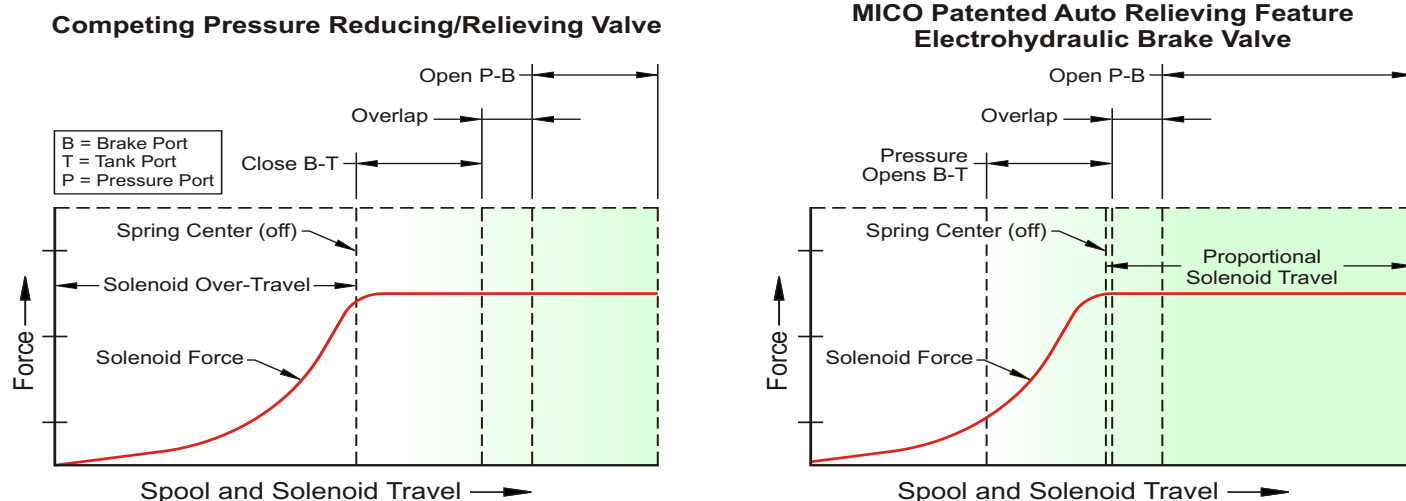


FIGURE 2: MICO Electrohydraulic Brake Valves (EBV) allow for use of solenoid over-travel

The brake port is connected to tank when not applied. The flow area determined by this travel needs to be large enough to allow the brake to decompress, venting brake pressure and releasing a hydraulic-apply, spring-release brake, or applying a spring-apply, hydraulic-release brake. The latter can require a large volume of fluid to be dumped before they build brake torque.

Spool diameter also had to be kept low to minimise quiescent leakage and silting force, so considerable travel is required to provide large valve areas. Once the spring-apply, hydraulic-release brake is empty the load is a dead-headed load, and very little fluid transfer is required to modulate the brake pressure.

Then comes overlap, where the spool overlaps both the pressure port to brake port and brake port to tank lands. This is the operating range of the valve whenever a steady brake pressure is desired. Overlap is required to minimise the oil consumed by internal leakage, while leakage must be low to run off accumulators for a long time.

In full flow

The next component of spool travel is the travel required to provide enough open flow area to fill the brake. With large multiple-disc brakes, often used in off-highway equipment, very high flows are required for fractions of a second to fill the brakes before brake pressures and brake torque are achieved. Once the hydraulic-apply, spring-release brake is full, the load is a dead-headed load, and very little fluid transfer is required to modulate the brake pressure. The successful brake modulating valve must be able to modulate pressure in this blocked load without instability or noise.

Commercially available proportional solenoid valves have a proportional zone, where force varies little with travel for given amperage, and a similarly sized 'over-travel' where the force drops off with travel. Commercial solenoids also have over-travel available, with a 3x3 solenoid typically providing around 6mm of total travel.

Actuating a valve and filling a brake with oil requires high forces, though dumping a full brake to tank requires no solenoid force. If spring centred, brake pressure is available to push the spool out of the way and open brake-to-tank as far as required. By changing the spring-return mechanism to a spring-centring mechanism, MICO set the neutral position of its brake valve at the start of the proportional solenoid travel, and used this non-proportional part of the solenoid travel for the spool travel required to dump the brake to tank. This became the basis of its patent on the EBV valves.

Timing is crucial

Brake cylinders are single-acting cylinders possessing substantial stick-slip characteristics. They require rapid acceleration to avoid delays and dead band and, once up to speed, they are difficult to slow down. Too slow and there will be a delay; too fast and there will be abrupt or touchy application of the brakes. But by controlling the current fed to EBV valves during the fill cycle, the speed of the cylinder can be controlled to optimise response.

The same select-fit hardened steel spools in iron housings that have provided such long successful history in MICO's pedal valves in full-power braking applications have been used. The development process includes extensive lab and field testing. The

former includes multiple endurance tests; some of them with contaminated oil and some exceeding eight million cycles. Performance testing under adverse conditions includes temperature chamber testing from -46° to 122°C. Initial field testing included applications notorious for adverse working environments, such as underground mining.

MICO EBV valves have been in serial production for over 10 years. Subsequent developments include coils that are IP67- and IP6K9K-rated and hot-dunk resistant. MICO now makes custom configurations with one to four EBV valves per package, along with a variety of auxiliary valves, many of which have relatively low annual production volumes.

Some applications – remote controlled machines, for example – went straight to brake-by-wire, but most others added electrohydraulically enhanced braking by adding EBV valves to existing pedal valve systems as new features were desired. This soon led to systems with up to 10 valves to control four brakes. The latest trend is towards brake-by-wire, often with a manual valve as a redundant back-up. Requiring only one EBV valve per brake to provide all desired electrohydraulic braking features, software can be used to optimise all normal braking functions, and the manual back-up kicks in only in the event of a system fault.

MICO has a long history of working with off-highway OEMs to develop solutions for brake systems that meet or exceed expectations in real applications and can readily prototype custom EBV packages or designs in short order. Lab testing uses actual brakes, simulating a full power brake system, rather than just fluid power test stands. **IVT**

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From Germany with love

USING GERMAN KNOW-HOW, CUSTOM BRAKE SOLUTIONS MADE IN THE USA ARE NOW BEING ADOPTED BY SOME BLUE-CHIP OEMs. EXTENSIVE IN-HOUSE TESTING WILL ENSURE CUSTOMER SATISFACTION

▷ A recognised specialist for customised brake solutions in Europe, Knott GmbH is a company with strong tradition and a good reputation among European axle and vehicle manufacturers. The German company is also renowned in other continents, such as in North America, where it has a production facility in Lodi, Ohio.

"Wherever specialised brake solutions are needed, Knott has the right answer," says Knott USA president and CEO Joe Kott. "Our engineers are committed to demonstrating this on a regular basis."

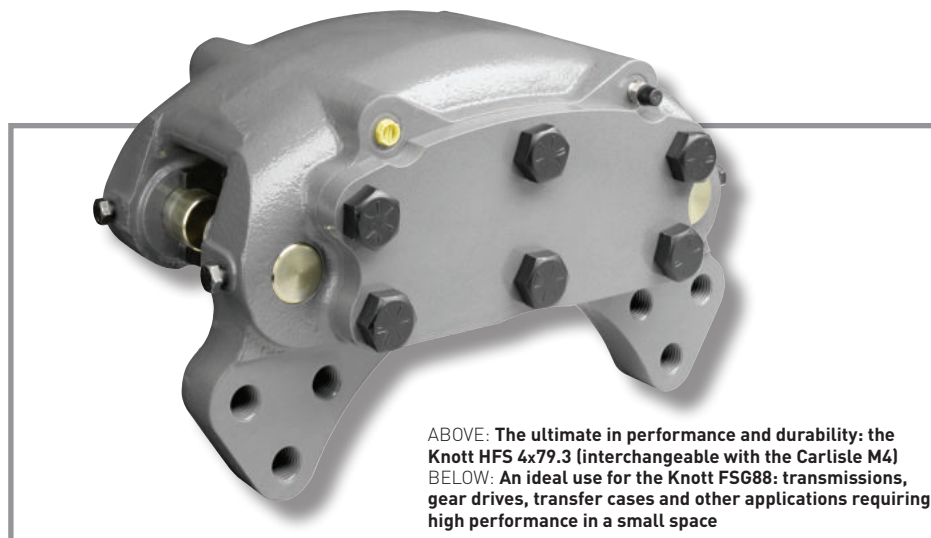
And it's true: there is hardly a branch of the off-highway and materials handling industry in which Knott brakes are not implemented. The company has gained enormous experience in the outfitting of construction machinery, agricultural utility vehicles, airport ground support vehicles and floor conveyors, and the increasingly important heavy and light dump trucks in the open-cast mining industry.

"In association with our headquarters in Germany, we continue to create innovative solutions based on the optimum use of braking energy, the greatest possible service life and the simplest possible handling," states Kott.

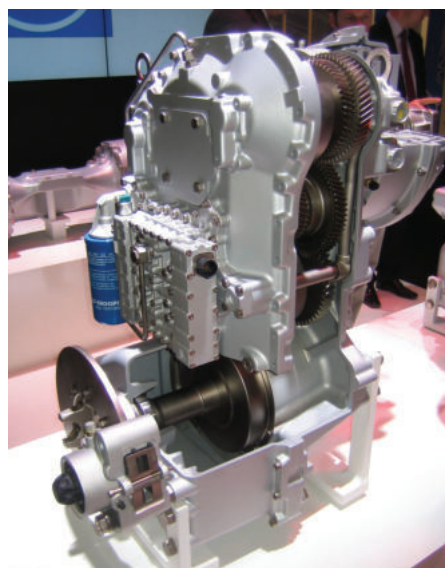
These are anything but empty words, and a glance at Knott's customer list shows a host of well-known manufacturers putting their trust in the company. Many leading construction machinery and axle manufacturers, including AxleTech International, Sisu Axles, Kessler + Co, and market leader ZF, have staked their reputation on Knott for many decades. Liebherr, Volvo CE, JCB and Hitachi also use Knott products to meet their needs.

Direct contact is of prime importance. "Our ability to customise and deal with special demands requires direct, personal exchange on projects," assures Kott. "This starts at the development stage, carries on through to testing, and continues right up to the final brake solution."

In order to ensure that these special solutions function properly, the company makes use of its own extensive state-of-the-art testing facilities. "At Knott, we are already in a position to test our own developments and products in-house for all eventualities – up to 65,000Nm," states Kott with pride. "We also simulate climatic conditions and how they affect construction and mining machinery



ABOVE: The ultimate in performance and durability: the Knott HFS 4x79.3 (interchangeable with the Carlisle M4)
BELOW: An ideal use for the Knott FSG88: transmissions, gear drives, transfer cases and other applications requiring high performance in a small space



permanently working in tough environments. With our climatic chamber, which can simulate -70° to +180°C, and with our special salt spray chamber in which all parts can be tested for corrosion resistance, we are industry leaders."

Kott assures customers that only those products that have successfully passed through all these rigorous processes will be released for installation.

Best for test

Knott has plans to expand upon its testing abilities at its German HQ. By 2015, some notable improvements to its testing capabilities will be completed, making the company one of the few in the world capable of testing brakes up to 200,000Nm in-house. This will be of great importance for the mining industry.

One can rest assured that Knott USA relies on the art of the engineer and will meet all customer needs. In an era in which these demands are constantly growing, it will always find time to meet and discuss solutions. Why not visit Knott's booth at ConExpo and discover the range of solutions it has available? One of the highlights in terms of disc brakes will be the 4x85 fixed calliper with an active piston-return system which minimises lining wear. There will also be examples of spring-applied, hydraulic-released (SAHR) brakes, including the FSG 88, and the company's biggest drum brake, the 200x500 S-cam brake, which reaches 38,000Nm.

A prime example of its wet multidisc brake range (ball-and-ramp principle) will also be on show – a 10in version with the usual strong points of this kind of brake, such as a sealed closed system that makes the brake insensitive to dirt. It also provides a unique multiservo effect that provides a braking force greater than that attained using annular wet disc brakes. **ivT**

Winfried Sauer has been head of sales and marketing at Knott GmbH for 25 years



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American beauties

THESE RANGES OF AXLES AND PLANETARY WHEEL AND TRACK DRIVES ARE ALREADY IN USE IN A WIDE RANGE OF CONSTRUCTION EQUIPMENT WORLDWIDE – AND IN SOME CLASSIC AMERICAN VEHICLES TOO

▶ As a leading designer and manufacturer of a variety of advanced engineering systems and mechatronic solutions for power transmissions, Comer Industries supplies many major manufacturers of construction equipment, agricultural machinery, industrial and renewable energy applications across the world.

Through Comer Industries Inc, its North American subsidiary located in Charlotte, North Carolina, the company is also able to boast a long-lasting collaboration with the most important OEMs of the USA's road construction and mobile crane markets.

Partnerships in these sectors started several years ago and continues to improve with the implementation of new products and new models year after year, confirming the company's position as a leading supplier of off-highway components in the United States.

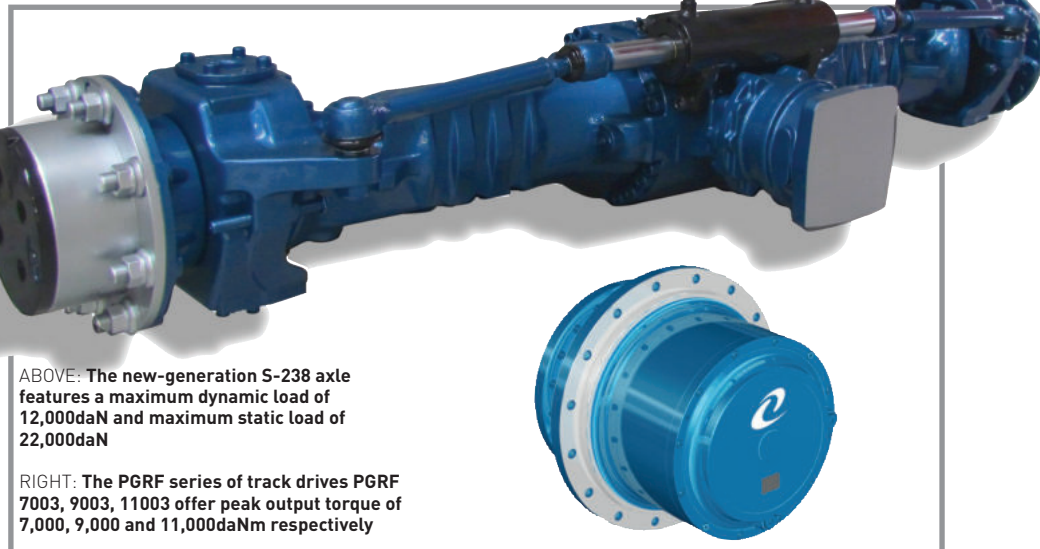
Dedicated to the construction market

As a result of the great deal of experience gained from development and production of special components with a high content of customisation, together with its strong relationships, Comer Industries has recently introduced two new ranges of products dedicated to the construction sector.

Its new drive axle line, type S-228 and S-238, was designed and built for application on several vehicles, including earthmovers and agricultural machinery, as well as telescopic boom handlers with up to 8,000 lb of lifting capacity. The technical and design choices made during the development of this new range of axles, as well as the competence gained in this specific sector over 25 years, are making these products the new state-of-the-art for the off-highway market.

The enhanced static and dynamic load capacity, together with a superior braking capability and the possibility to include a locking differential that can be activated on the go, are making this axle the most desirable product for the development of new ranges of off-highway vehicles. Those results were achieved by optimising the design and selecting materials, using advanced CAD simulation programs.

The S-228 model is available with a dynamic load capacity of 10,000daN and a static load capacity of 18,000daN, while the S-238 version, which will be on display at ConExpo 2014 in Las Vegas, has a dynamic load capacity of 12,000daN and a static load capacity of 22,000daN, making it suitable for equipping



ABOVE: The new-generation S-238 axle features a maximum dynamic load of 12,000daN and maximum static load of 22,000daN

RIGHT: The PGRF series of track drives PGRF 7003, 9003, 11003 offer peak output torque of 7,000, 9,000 and 11,000daNm respectively

machines with an overall weight up to 24 tons and with up to 100kW of installed power.

An extension of the product range to provide compatibility with bigger vehicles is also currently being actively pursued by the Comer Industries engineering team.

Market confirmation is offered by the success of the earlier S-128 drive axle, which features the highest torque, braking and efficiency performance in its category. Its modularity and versatility make this axle suitable for installation into a variety of off-highway machinery that weigh up to 11 tons and have up to 66kW of installed power.

Squeezing more into planetary drives

Additionally, the company has recently launched a new range of planetary wheel/track drives from 7,000 to 11,000daNm (PGRF 7003, 9003 and 11003). These are the result of a redesign of existing products into more compact, flexible, interchangeable and robust solutions. These can equip many applications, such as forestry excavators, vertical and directional drills, and crawler cranes.

Extensive tests and special technical solutions obtained by the company's R&D team through careful analysis of target markets enable this product to be used in the most severe applications.

The optimised design, which includes three stages of reduction, ratios from about 70 to more than 250,

several configurations for motor input (from 90-160cc), integrated SAHR brake, disconnection option and top-of-the-class torque rating are some of the key points of the planetary gearboxes.

New customers for new vehicles

Highly focused on service, reliability and proximity, Comer Industries continues to consolidate its presence in the North American market, serving new customers and adding new vehicles to its portfolio.

For instance, Xtreme's model XR5919 telescopic boom handler will make its market debut at ConExpo, equipped with Comer Industries' S-128 axle model – a clear acknowledgement that this highly demanding customer found the answer to its need for high reliability and service for tough applications. Leeboy has recently redesigned its famous range of brooms, using F-068 axles that, with their double reduction configuration and enhanced load capacity, met the OEM's expectation of robustness and functionality at the right cost. It has also begun production of a redesigned line of pavers using Comer Industries' planetary track drives. Terex, which delivers reliable, customer-driven solutions for many applications, has also begun to supply its all-terrain mobile cranes with Comer Industries' swing drives. **IVT**

Marco Zanon is application sales manager at Comer Industries, where he has worked since 2007



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OPERATORS EXPECT THE SAME SIMPLE AND EFFICIENT USER EXPERIENCE FROM VEHICLE DISPLAY SYSTEMS AS THEY GET WITH A SMARTPHONE. SOFTWARE, AND APPS IN PARTICULAR, ARE NOW PLAYING A GREATER ROLE IN ACHIEVING THIS

▶ At ConExpo 2014, maximatecc will present the CCpilot VC display product platform. With its efficient ARM core, a powerful software platform and high-readability 5in display with optional touchscreen, this new display product makes it possible to offer a premium user experience and enhanced operator support functions in a variety of cost-sensitive construction and agricultural vehicle applications.

The merger of CrossControl, a 220-employee company specialised in advanced control solutions for industrial vehicles, and Maxima Technologies, a 440-employee provider of instrumentation solutions, was completed in January 2013. The new company – known as maximatecc – offers a range of display and instrumentation solutions to OEMs globally. Now the strengths of CrossControl and Maxima are combined in a new line of displays – the CCpilot V-line.

Work the phone

Operators of most industrial vehicles are increasingly coming to expect the same user experience in their work equipment as they get with their smartphone or in their car. This is partly a question of generation, but the trend is definitely there and it will prompt off-highway equipment suppliers to react in order to keep their machines attractive.

The maximatecc response to this trend is to adapt the technologies commonly used in the smartphone and automotive markets into a product for the industrial vehicle domain. In the CCpilot V-line, Maxima Technologies' experience has been leveraged to realise instrumentation products for cost-sensitive equipment as well as the advanced computing and software competence of CrossControl.

As has been the case in the automotive industry, it is expected that in the industrial vehicle market most innovations will be in software, through soft products and apps that help improve the user experience, human-machine interaction, equipment use and lifetime profit. For advanced industrial machinery this is already the case, illustrated by developments in, for example, advanced forestry machines, tractors and mining equipment. What will follow is the same development in less advanced/costly equipment, requiring product suitable for those markets.

The CCpilot VC is based on a powerful and efficient ARM Cortex A8 core with Linux operating system.



ABOVE: CCpilot VC – a new display product from maximatecc with 5in TFT display and efficient ARM computing core

One can choose to run applications on the Linux system or use the LinX Software Suite, an open software application platform where applications are developed in Qt and CoDeSys. The LinX Software Suite features a range of ready-made software components, meaning that premium user interfaces can be realised with a very limited spend of programming resources. As a complement, maximatecc offers software development services that can be deployed either on an advisory basis or for development of a complete system.

With its 5in TFT display with WVGA form factor and resolution, CCpilot VC offers high readability and enables design of attractive and user-friendly GUIs. The standard version uses eight configurable push buttons for user interaction. A touchscreen is optional and there is also the option to have push buttons and a touchscreen. The enclosure is designed for flush mounting in a panel/dashboard/armrest but it can also be fitted to a bracket.

The CCpilot VC features two CAN interfaces, supporting CANopen and SAE J1939. Besides managing information from two separate CAN networks, the unit can also be used as a gateway between these networks. Other serial interfaces are Ethernet and USB, used for loading software, connecting peripherals, etc. The analogue video input (PAL/NTSC) makes it possible to use the CCpilot VC as a video monitor.

The development of the CCpilot VC platform was initiated in 2012 and serial production of OEM versions was begun in December 2013 after successful field testing, certifying tests and pre-series production. Standard product variants will be released throughout 2014. **IVT**

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