

ENGINEERING
TOMORROW



News / 2014

THE CIRCUIT

by Danfoss Power Solutions

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Gremo puts the new PVX
through its paces

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Growing with you – ***Our valued partners***



*Eric Alström – President and CEO
of Danfoss Power Solutions*

It was great to see and visit with many of you at the 2014 IFPE tradeshow earlier this year, and to hear your perspectives on the future of the mobile hydraulics industry. I gain so much insight from my conversations with each of you throughout the year.

As your partner, we are committed to building upon our many strengths, including our new innovative products that differentiate and separate us from others within the industry.

Since becoming a full member of the Danfoss Group last year, we are benefitting from synergies that being part of the larger group entail. Now, as a privately held company, we have an even stronger financial fundament allowing us to really concentrate on our long-term plans of growing with you.

Today, our success in the market is enabling us to find new ways to provide you with innovative, robust products. Our strong global engineering capability enables leading-edge solutions to meet your needs, and you can expect to see us passionately driving toward the improvements and innovations that matter to you the most.

Specifically, we are:

- Increasing our investments in innovation to strengthen our technology and innovation lead within the industry.
- Developing technology that provides you with compelling valued-added benefits. Much of the innovation we are focusing on is an outcome of the technology road-mapping discussions that we have had with many of you, and tailored to each individual customer.
- Continuing to improve our overall operational performance, or what we call our “Engine Room.” This involves getting the basics right in our business and continuing to focus and further excel in areas such as quality and delivery.

Inside this issue of *The Circuit*, you can also read more details about our unique Application Development Centers. At our ADCs, we are testing innovation in real time and applying solutions for your machine right before your eyes. This is our way of anticipating your expectations, and our way of developing technology that meets or exceeds these expectations.

Your feedback from our recently completed Customer Perception Survey (CPS) showed us where your priorities are, and we are holding strong to our commitment to continuous improvement. In addition, the CPS results confirm our industry leadership position, which naturally we are very proud of. But we will continue to push boundaries and work diligently to exceed your expectations. As we strive to continue earning your loyalty and achieving mutual success, we will prove our commitment to being Your Strongest Partner in Mobile Hydraulics.

The Circuit is published by Market Communications, Danfoss Power Solutions, and has a circulation of approximately 13,000 copies in English, German, Chinese, Russian, Brazilian-Portuguese.

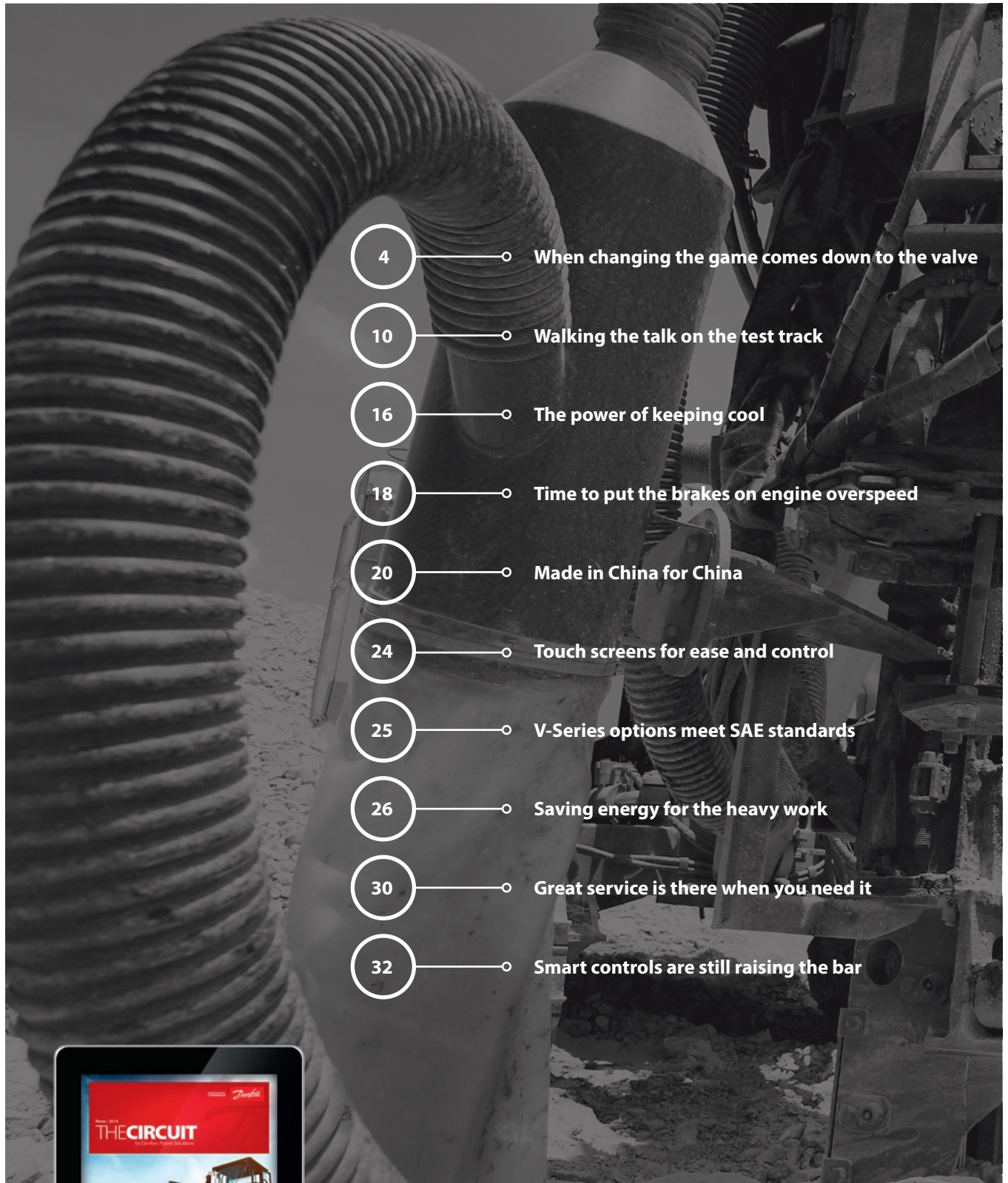
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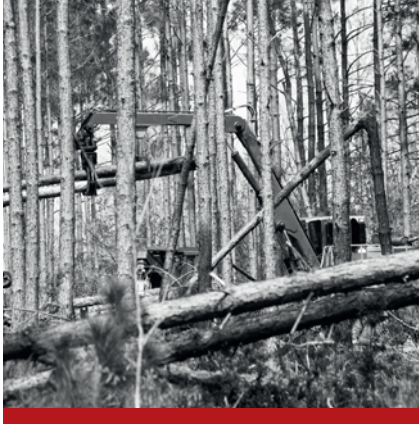


When **changing the game** comes down to the valve

Swedish forestry machine manufacturer Gremo agreed to put the innovative Danfoss PVX proportional valve to the test on its forwarder machine. After a year of field testing, the valve has **proven why it is an industry-changing addition to mobile machine technology.**

Productivity is up, and fuel consumption is down on the Gremo 1050 forwarder as it carves a path through the Swedish forest. Smoother, more accurate crane control means the operator enjoys the comfort of an almost vibration-free cab. Not because the machine has undergone a major redesign – all that Gremo has changed is the hydraulic valve on the crane to the new Danfoss PVX.

Then again, the PVX proportional valve is no ordinary component. Complete with patent-protected integrated sensors and software technology, it offers outstanding precision, a fast reaction time and instantly adjustable settings.



“Because everything is integrated in the PVX, the need for external sensors is eliminated.”

*David Stålgren,
PVX Sales Development Manager,
Danfoss Power Solutions*

Built to withstand

In the management of Sweden's 28 million hectares of forest, such great qualities are only of value if they are also robust. The forwarders used to cut, collect and load trees onto a trailer must be able to withstand the challenges of their tough working environment. Alone in the forest, the operator should be able to rely on the machine to do the job and still make the trip home, even in the event of a technical fault. The robustness question is the reason why forestry is the first application area chosen for the PVX. A full year of field testing on the Gremo 1050 forwarder has exposed the PVX prototype to all the extremes. Based on these results, stepwise testing and introduction of the PVX to other applications will follow.

“As with all new technology, we have to prove that the control technology on the PVX is just as robust as that on conventional valve types. The PVX has been tested on four similar machines, adding up to more than 6,000 hours in the field. The feedback on robustness is very good,” says Danfoss Power Solutions PVX Sales Development Manager David Stålgren. The next step will be to integrate the PVX in the full machine control system.

Integrated versatility

A typical valve block for a forestry crane requires between seven and nine sections to manage individual work functions from the head lift to the grabber. Because the functions have varying needs for hydraulic flow, machine manufacturers are accustomed to customizing the design of the valve block to suit.

One of the major advantages of the PVX is that time-consuming mechanical customization is no longer necessary. Designed as a sectional, two-spool valve, it has the capability to support up to 12 different functions with a maximum pressure of 420 bar [6,092 psi] and 180 l/min

[47.5 gpm] work port flow. All it takes is a swift adjustment of the electronic settings to adapt the valve characteristics to work function needs.

“We can make parameter changes on the fly and have a complete diagnostic overview. It is even possible to download new parameters during operation, for example if there is a need to lift a higher load,” Stålgren remarks. “Because everything is integrated in the PVX, the need for external sensors is eliminated.”

Cooling efficiently

A long-time Gremo customer in northern Sweden, Kapah Forest AB has run one of the forwarders used for the field test. One of Kapah Forest's experienced drivers, Stefan Jusslin, notes the fuel efficiency and the array of useful data conveyed from the integrated pressure and temperature sensors via the CAN bus to the display.

“The on-board computer registers everything so we have data on how much fuel we use per cubic meter of timber. I noticed our machine running cooler and saving a lot on fuel,” he says.

“The crane is also more precise and runs more smoothly. As a result, cabin vibration is reduced so the operator is sharper and more effective. That's a big win.”

Better than conventional

Comparative tests of the PVX and conventional valves have actually measured a 16% increase in productivity and fuel savings of 25% on the crane duty cycle.

Several PVX features are behind these efficiency improvements. Smart metering, minimized back-pressure and variable load-sensing margin control go hand-in-hand with the automatic system adaptation functionality, which responds to actual working conditions. An adaptive energy regeneration function is also available to



Gremo measured
fuel savings of

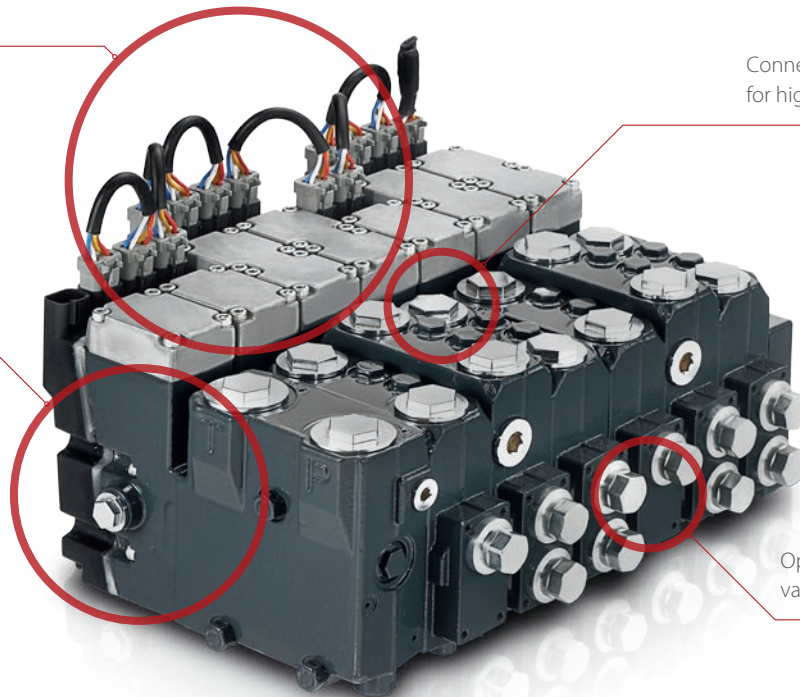
25%

CAN bus enables direct communication, diagnostics and remote connectivity

Inlet with integrated electronics supports up to 12 functions

Connection ports designed for high pressure and flow rate

Optional one or two-spool valve functionality



Introducing the **PVX – intelligent valve technology** for machines in motion

optimize system efficiency by detecting opportunities for flow and energy regeneration.

Data in detail

From the spool position data, and the pressure and temperature data registered by the integrated sensors, machine design engineers can gain an overview of the relationship between work functions, oil flow demand and load size. Based on that information, the valve can be programmed to perform the same task again and again.

“This is a great operator comfort benefit,” Stålgren says. “At the same time, the high precision of the valve enables the crane to work very smoothly even at low speed.”

As you would expect from an intelligent machine control system, the performance data enables accurate diagnostics when a system fault occurs – the valve’s internal functional safety control ensures that the machine comes to a safe halt.

Smarter, simpler system

As the load on the crane shifts during lifting and transferral of cut trees to the trailer, an active dampening feature maintains performance stability without need of accumulators and associated hosing – just

as the integrated pressure sensor eliminates the need for a compensator. Overall, the reduction in parts provides a simplified system that is both easier and more economical to service.

During the field tests, Danfoss has monitored PVX performance on the Gremo forwarders via a remote connection. Stålgren in Sweden and the development team in Denmark have also supported Gremo’s customer directly.

“We’ve worked with Kapah for a year on this project. Even though we stopped the machine from time to time to update the PVX as part of its development, they have still produced as much this year as the year before,” he states.

Stefan Jusslin nods “Danfoss has supported us all the way. They have taken care of everything,” he says.

Ongoing fine-tuning has taken the PVX prototype to an even higher rate of efficiency and robustness during the testing phase. Serial production of this game-changing valve is expected to commence in 2015.



PVX increased
productivity by

16%





Walking the talk on the **test track**

Danfoss has long called itself the **strongest partner in mobile hydraulics**. At the three global Danfoss Application Development Centers, customers can see it for themselves.

They call it the Ames crawler. Painted white with the red Danfoss logo on the sides, it demonstrates the latest mobile hydraulic technology designed by Danfoss engineers – the propel function, fan drive, steering, work functions and the controls that tie it all together in one integrated system.

Right now, the newest innovation on the machine is the PLUS+1® Generic Dual Path subsystem, a smart piece of software for applications with left and right propel systems.

Designed to convert input from the joystick and CAN into differential output commands, the dual path subsystem solves the challenges of coordinating two independent systems that are always unequal. Operators gain a smooth drive and steering performance that eliminates the shortcomings of manual control. Programmable using the PLUS+1® GUIDE tool, the subsystem is easily adaptable to differing machine needs.



“Noise control is an important factor in increasing operator comfort, which in turn reduces fatigue during working hours.”

*Svend Erik Thomsen,
ADC Manager,
Danfoss Power Solutions, Europe*

Five-year roadmap

The crawler is one of eight demonstration machines at the US facility in Ames, Iowa, where a bare field has been transformed into an advanced Application Development Center (ADC).

“Work on the ADC started in 2011,” says Danfoss Power Solutions Propel Systems Engineering Manager Russ Peters. “We looked at 18 off-road platforms, the functions required and the features of each function. Based on this, we drew up a five-year roadmap for building the ADC.”

In addition to the ADC in Ames, which serves the Americas, Danfoss has a similar well-established facility in Nordborg, Denmark, that has been covering European markets for several years. A third ADC is two years into a five-year development program in Haiyan, China to meet the needs of the Asia Pacific region.

Global knowledge sharing

With global locations and development, the ADCs are part of the Danfoss strategy to provide customers with a uniform, responsive service all over the world. At the same time, each one accommodates specific regional needs and has special knowledge of particular application areas – wheel loaders at the ADC in Denmark, concrete pumps in China and sprayers in the US. Knowledge-sharing is an important part of the dialogue between the centers.

“We may have a customer in Poland, who wants to develop a control system for a crawler, while our software person is located in the US. Because of our global knowledge-sharing, our software engineer can optimize the software algorithms using the Ames crawler, integrate them into a customer-specific application and then send it for upload onto a microcontroller on the customer's machine across the ocean. That speeds up the entire development process,” Peters explains.

Global centers with regional expertise

The global ADCs solve and optimize machine challenges internationally at all locations year round. Among the challenges that European customers are currently bringing to the ADC in Denmark is the matter of noise control in machine cabs. To support customer development projects, Danfoss has invested in advanced sound and vibration-measuring equipment.

“Noise control is an important factor in increasing operator comfort, which in turn reduces fatigue during working hours.

“Apart from identifying ways to cut noise from existing systems, we use sound and vibration measurements to ensure we meet performance goals when developing and validating new system solutions,” says Svend Erik Thomsen, Danfoss Power Solutions ADC Manager, Europe.



3

Global Application
Development
Centers engineering
innovative solutions



"At Danfoss, we have always said we are a system supplier and developer. The ADCs are our proof – it's not just something we say, it's also what we do. And customers experience that."

*Russ Peters,
Propel Systems Engineering Manager,
Danfoss Power Solutions*

"Noise control, however, is just one of the ways the ADC in Europe allows us to partner with our customers to develop, tune and validate an entire solution specific to the customer's needs."

The ADC in China continues to evolve as it expands its capabilities within its focus area: concrete pump applications.

With the use of our ADC facility, we are now able to partner with our customers and give them a value-added experience that proves the performance they are seeking. They are truly able to see the value before they buy it, says Charles Tebbutt, Danfoss Power Solutions ADC Manager, China.

Fine-tuning on the spot

Danfoss is the largest manufacturer of hydraulic systems for sprayers in the Americas. So naturally, a large sprayer machine is another of the demo machines in Ames, featuring H1 closed circuit pumps and motors for the propel function, which needs to reach speeds of 65km/h in transport mode and 10-40km/h in the field.

"One of the challenges of a vehicle with such a high center of gravity is traction control when working in fields with many gradients and soil types," Peters says.

"At the ADC, we can change and fine-tune the control system on the spot. Customers can touch, feel and interact with the machine and validate our systems' performance."

Realistic, repeatable tests

With its 11-meter hill, gravel track and dirt area, the US ADC is prepared for testing traction and anti-slip functionality on varying gradients and ground types. Low friction areas simulate ice, and a long concrete track enables high-speed braking tests under repeatable conditions, creating an accurate dataset for system optimization purposes.

A maneuvering area for ISO standard steering tests was completed in spring 2014. In the final phase, scheduled for 2015, the ADC will gain a frost-free four-season yard and garage, equipped for year-round driving tests.

Customers are delighted. According to Russ Peters, barely a week goes by without at least one customer visit. Within Danfoss, the ADC also has many internal customers – whether they are product engineers, who need a hands-on feel for a machine in order to develop a new pump or motor, or sales and application engineers, who come for training.

Faster development with less risk

"Our customers have three main focus areas – productivity, fuel savings and precise control. What we do at the ADC is take the technology development out of their projects because we have already done that. That reduces the risks to our customers' success and cuts their development time."

Rapid deployment of customized systems, full documentation and support, and machine-level validation – the ADCs make a value-adding contribution to customer relations. For Russ Peters and the rest of the global Danfoss team, it's a great feeling to walk the talk.

"At Danfoss, we have always said we are a system supplier and developer. The ADCs are our proof – it's not just something we say, it's also what we do. And customers experience that."



Ames, Iowa

Nordborg, Denmark

Haiyan, China

The power of **keeping cool**



It's no secret that the higher cooling needs of today's emissions-compliant engines are a drain on valuable power. Since Tier 4 became a convincing argument for downsizing engines, power has become a scarce resource, where every kilowatt counts to **maintain and optimize machine performance.**



Over the course of a year – or **1,000 hours** of operation time – every kilowatt of lost power is estimated to cost 250 liters of fuel.

“The RDM has the advantage that it can force the fan to slow down very quickly before reversing takes place. Faster reversing means the impact on the cooling system is reduced. That’s important if the machine is working very hard, as there is little or no cooling when the fan is in reverse mode.”

Steve Frantz, Engineer, Danfoss Power Solutions

Emissions compliance has made closed circuit hydrostatic fan drive systems a more accepted option when it comes to engine cooling. A key reason for that is their ability to provide a fan reversing function without power loss.

Users now gain key optimizing advantages with the launch of the new Danfoss Reverse Displacement Motor (RDM) for open circuit fan drive systems. Supporting efficient power management, the RDM makes open circuit reversing fan drives a real alternative to closed circuit systems.

The need to reverse

The reversing function is particularly critical to avoiding production downtime. But unlike closed circuit pumps, pumps for open circuits have no built-in capability to change the flow direction and put the fan drive motor in reverse.

“A common solution is to add a directional control valve (DCV), which changes the motor direction by feeding the oil flow into the outlet port. Although this solution enables reversibility,” says Danfoss Power Solutions Engineer Steve Frantz

“The problem with the directional control valve is that it restricts flow, causing power loss and increasing fuel consumption. The power loss generates more heat, which also has to be dealt with, potentially by installing a larger cooling system.”

Over the course of a year – or 1,000 hours of operation time – every kilowatt of lost power is estimated to cost 250 liters of fuel.

Cancelling out power loss

It was the desire to eliminate the DCV and find an innovative solution for the changing

needs of fan drive systems that led to the development of the Danfoss Reverse Displacement Motor (RDM) – the first axial piston motor capable of reversing without need of a DCV.

For the first time since the arrival of Tier 4-compliant engines, the RDM eliminates the power loss issue that has caused open circuit reversing systems to become a less favorable option.

Speeding up reversal

Machine OEMs have revealed that their interest in the RDM goes beyond avoiding power loss. The ability of the RDM motor to speed up fan reversal has also proven to be of great value. While large metal fans may take as long as 20 seconds to reverse with a typical DCV system, Frantz explains how the RDM can cut that time to a couple of seconds.

“In a closed circuit system, we do fast reversals often – it’s normal to change direction very quickly. But, in an open circuit system with a DCV, you have to slow down the fan before reversing it. Otherwise, you get high pressure spikes that can cause damage in the system. It is much like a typical light switch that is on or off but nothing in between.

“The RDM has the advantage that it can force the fan to slow down very quickly before reversing takes place. The OEM can determine the speed of the reversal, and even when it is very fast, the transition is smooth compared to a DCV system.

“Faster reversing means the impact on the cooling system is reduced. That’s important if the machine is working very hard, as there is little or no cooling when the fan is in reverse mode.”

More available power

The improved efficiency of the cooling system means less heat generation and increased power savings – making more power available for other functions on the machine.

“For customers who just want to prevent power loss from a DCV, the RDM can be introduced to an open circuit system without any further changes. When faster fan reversing is a requirement, system adaptations may be necessary depending on the type of fan the customer is using. We can help with that too,” Frantz states.

Independent fan control

As off-highway machines become bigger and more sophisticated, more will require multiple fan systems to meet their cooling needs. Here, an open circuit system has the advantage over a closed circuit system by enabling independent fan control.

That’s where the RDM fits right in. In a series of Tier 4 cooling system analyses, independent control of multiple fans was found to provide significant savings in power, fuel and noise.

With its integrated reverse functionality, the RDM has taken open circuit fan drives to a new level of performance. At a time when power optimization, energy conservation, reliability and total cost of ownership are top of mind, it creates an innovative solution to today’s fan drive system performance demands.

Time to put the brakes **on engine overspeed**

Bigger machines are stretching **engine braking capability** to the limits.

Integrated Speed Limitation takes the heat off engines under pressure.

A general trend in the mobile machine industry is that machines are getting bigger, heavier and faster – and they are often driven by smaller diesel engines. As many of these machines rely on the engine for their braking performance, manufacturers are talking more and more about ways to protect against engine overspeeding.

It's a valid discussion. Engine downsizing is a response to Tier 4 emission requirements. Optimization of the machine's hydrostatic transmission enables the same or better drive performance with less engine power. But that raises another point for consideration: the reduced braking

capability of these smaller engines when bringing bigger machines to a halt from higher speeds.

The pressing issue is that the lower braking capability – or drag torque – of the downsized engine makes it more vulnerable to overspeeding, risking damage or failure.

"OEMs may try a variety of things to overcome engine overspeed, including performance reductions, the addition of components to dissipate braking energy, or more intelligent control of existing components," says Chad Daniel, Danfoss Power Solutions Sales Manager, America.

"Typically these options turn out to be too expensive, limited in their effect or, in the case of performance reductions, unacceptable."

Ensuring efficient and safe braking

Danfoss Power Solutions Propel Systems Development Engineer Simon Nielsen is part of the Danfoss team that works on solutions to ensure an efficient and safe braking capability.

"This is something we talk to customers about a lot, particularly in the agricultural sprayer and harvester market where we today have machines capable of speeds over 60km/h [37mph].

"OEM braking performance requirements are often determined by regulations or standards. Even though a traditional braking system is installed, the hydrostatic transmission is often used as the primary braking system.

"If the braking requirements of the hydrostatic system exceed the inherent braking capability of the engine, then the only way to meet these requirements without causing engine overspeed is to have an additional method to reduce the kinetic and potential energy of the vehicle."

Versatile, proven technology

Today, optimized hydrostatic transmissions from Danfoss typically include axial piston pumps and bent axis motors based on H1 technology. The high output speeds of H1 pumps support the higher braking capacity needs of heavier, faster machines.

With this in mind, Danfoss developed Integrated Speed Limitation (ISL) technology for integration in H1 pumps. ISL consists of a pilot-operated, pressure-reducing valve and bypass orifice and, being integrated in the pump end-cap, requires no extra space in the overall system or changes in system line connections.



“... the only way to meet these “braking” requirements without causing engine overspeed is to have an additional method to reduce the kinetic and potential energy of the vehicle.”

*Simon Nielsen, Propel Systems Development Engineer,
Danfoss Power Solutions*

Adapted from its initial application in Series 90 pumps, ISL is purely hydro-mechanical. This makes it well suited to high power closed circuit pumps that are electrically, hydraulically or mechanically controlled, and used in combination with fixed or variable displacement motors. It is also simple to retrofit in existing machines. Nielsen explains how it works.

“ISL limits torque input into the engine from the pump. This means that, of the power that enters the pump, about a third goes to provide braking power in the engine, staying within the engine speed limit, and the remaining two-thirds are dissipated via the transmission.

“This makes it possible to have high hydrostatic braking performance without overspeeding the engine.”

Half the braking distance

In an emergency braking test at the Danfoss Application Development Center in Iowa, USA, a large, fully-loaded agricultural sprayer was brought to a stop in 5.6 seconds from a speed of 58km/h [36mph]. Due to ISL, engine speed remained at or below the 3100rpm limit.

“Because sprayers need to pass certain tests with the sprayer tank full of liquid, the performance requirements are very high. What we can see is that ISL often increases a vehicle’s maximum hydrostatic braking power by a factor of two or three. In most cases, the braking distance is at least cut in half,” Nielsen says.

Machine operators, too, can feel the benefits that ISL provides. Without engine overspeed protection, it is up to their skill and judgment to ensure the machine remains within its braking performance limits. ISL takes over that responsibility so operators can focus all their attention on the job.

Among the engine overspeed protection solutions on today’s market, ISL still stands out as one of a kind more than a decade after it was originally developed for the Series 90 pumps in the Danfoss range. An efficient, automatic and highly versatile opportunity to meet the braking requirements of large, Tier 4-compliant vehicles – and free from the shortcomings of previous alternatives.



Made in China for China

A new Danfoss plant in China has begun local production of the mobile hydraulics that are helping to build China's modern cities and **bring new farm technology to the fields.**

6%

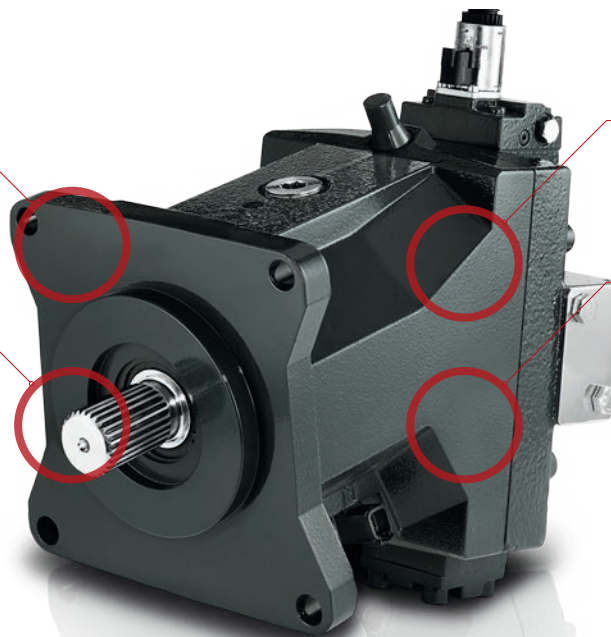
increase in
efficiency makes
H1 your best choice

Greater overall efficiency

Proven operating performance
and increased productivity

Optimized for modern
control systems

Improved fuel economy
and reduced heat load



“Our strategy is to build a facility to produce in China for China. With our localized product lines, we can support needs for work functions, propel and high power open circuit.”

*Martin Nordborg,
Work Function Division Director,
Danfoss Power Solutions, China*

China's fast-developing infrastructure and agricultural mechanization have kept the mobile machine industry on its toes while much of the world has been in recession. Since 2008, half a million kilometers of roads and nearly 18,000 kilometers of railroad have been added to the transport network. In 2013, a market survey put government subsidies for agricultural machinery and tools at RMB 25 billion (USD 4 billion).

Danfoss has opened a brand new production facility in Haiyan, near Shanghai, to provide efficient hydraulic power for Chinese development needs. Covering 21,000 square meters, the plant will have five fully operational production lines by the end of 2014, along with an Application Development Center and Engineering Test Center (see article on page 10). Two more lines producing Series 90 pumps and motors have been in operation since 1995.

“The Chinese government has invested a lot of money in infrastructure, which has led to major growth of 20-30% a year in some areas through the financial crisis. Now the annual growth rate is around 7%, which is still much higher than in Europe and North America,” says Martin Nordborg, Work Function Division Director, Danfoss Power Solutions, China.

Localized support

Two of the new Haiyan lines will produce high power open circuit pumps and V-series

orbital motors, both designed with China in mind. The other three will serve the large local market with PVG proportional valves, H1 bent axis motors and Series 45 axial piston open circuit pumps from the global product portfolio.

“Our strategy is to build a facility to produce in China for China. With our localized product lines, we can support needs for work functions, propel and high power open circuit,” Nordborg explains.

Urban construction

In view of the government's commitment to infrastructure improvement, it is no surprise to learn that the construction and road-building industries account for the biggest share of hydraulic sales.

Urbanization plays a big role in this high demand. More than 86 million Chinese have moved from the country to the cities since 2008, raising the number of urban residents to 731 million by the end of 2013 – close to 54% of the total population. By 2018, approximately 60% of China's population is expected to live in the cities. Consequently, the demand for housing has gone through the roof.

“Wheel loaders, building cranes, concrete pumps and transit mixers are classic building machines. We are developing our Chinese portfolio and footprint in line with the development of the market,” says Nordborg.



At the Application Development Center, customers can participate in the customization and testing of advanced hydraulic solutions for their machines.

Growth in housing demand increases the need for all the other facilities necessary for big city communities. This opens an opportunity for the Danfoss climate and energy experts to support municipal energy, heating and cooling needs.

New farm technology

Agriculture is a relatively new focus area for Danfoss in China. Until recently, most agricultural tasks were performed by manual labor. This is now changing, supported by the government's 12th five-year plan from 2011, which aims for 60% farm mechanization. Under the plan, which covers social and economic development initiatives, farmers can obtain subsidies covering up to 30% of the purchase price of new machinery. Subsidies of 50% are available in specific areas, including those hit by natural disasters.

"Subsidies for farm mechanization are part of the government effort to make China more self-sufficient in food," Nordborg states.

"For us as a supplier of hydraulic solutions for heavy agricultural machinery, the task ahead has got a lot to do with building

trust with local machine manufacturers who are not as familiar with our brand as the international players who are also present in the market."

Closer to customers

The new facilities in Haiyan are made to support these strong local ties. At the Application Development Center, customers can participate in the customization and testing of advanced hydraulic solutions for their machines. The Engineering Test Center is responsible for new product development, product validation and supplier evaluations that ensure Danfoss quality standards are met. In time, all components for the Chinese product lines will be locally sourced.

Located on the same site as an existing Danfoss facility, the new plant will bring the total number of Danfoss employees in China up to 4,000 – approximately 500 of them working with hydraulic solutions for mobile machinery. With an operation of that size, the Danfoss Group has grown to see China as a second home market. The latest investment brings the hydraulic experts even closer to customers.



21,000 m²

of facility dedicated
to manufacturing
hydraulic power

"4,000 Danfoss employees are dedicated
to supporting China's industrial and
development needs."

*Martin Nordborg, Work Function Division Director,
Danfoss Power Solutions, China*

Touch screens for **ease and control**

Easily program your own software and layout using PLUS+1 GUIDE. A graphic library is also available to support faster time-to-market.

All buttons have white backlight design for low light and night use.

Fully integrated connectors and silicone keypad provide water and dust protection from all sides.



Responsive displays push productivity **to maximum.**

Time-to-market is speeding up for OEMs who choose a DP700 Series PLUS+1® mobile machine display. Designed for swift customization, the series gives machines a competitive difference with much less effort by development engineers.

Danfoss has focused on making the interactive, 7-inch screens easy to read and sufficiently robust to survive the toughest work environments. Operators can count on the real-time performance data to help them take machines to the highest level of productivity.

Options include a projective capacity touch screen ideal for outdoor use and operator gloves.

V-Series options meet **SAE** **standards**

The V-Series is your quality benchmark in the medium duty market. Based on proven technology, these reliable motors will reduce your overall system costs while adding value to your machine.



Orbital motors made for a **clear-cut performance** – no more, no less.

Danfoss has expanded the opportunities to select an orbital motor with the right size, performance and durability for a specific task. Designed for medium-duty functions, the V-Series orbital motor program now offers three additional options designed to SAE standards – a compact C-style mounting flange and two shafts: a 6B spline and Woodruff key.

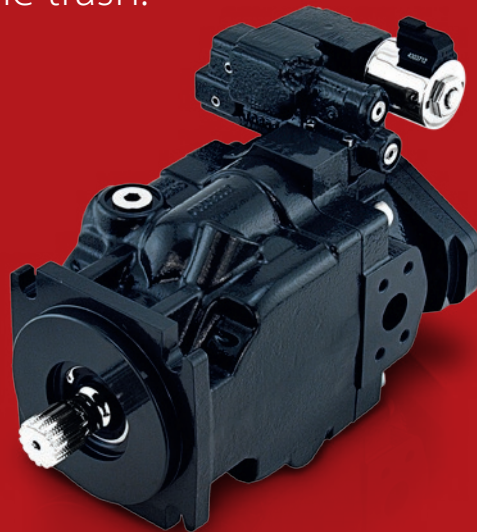
The V-Series is a strong option for reduced total system costs. Among the standard features is the high-pressure shaft steel, which often eliminates the need to connect a drain line from the tank, cutting the cost of installation.

Suitable applications include seasonal machines, such as harvesters, and medium-duty work functions, such as agricultural conveyors and sweeper brushes.



Saving energy for the heavy work

Use the **Series 45 axial piston pump** to replace the traditional gear pump on refuse trucks and other truck-mounted machines – and no power will go out with the trash.



Fuel savings and ever-better efficiency are still at the top of the agenda for mobile machine manufacturers around the world. As the deadline approaches for implementing the final phase of Tier 4, they are likely to remain the priorities for some time yet.

For on-highway machines such as refuse trucks, power management solutions that minimize energy consumption in transport mode are particularly important. With their frequent yet intermittent use of work functions for lifting and emptying garbage cans, a hydraulic set-up based on traditional fixed displacement gear pumps leads to power waste and reduced system efficiency. A Tier 4-compliant system can afford neither.

SAE standards are internationally recognized for their role **in helping ensure the safety, quality, and effectiveness of products and services** across the mobility engineering industry. SAE International coordinates the development of technical standards **based on best practices**.

“When a refuse truck is being driven in transport mode between sites or garbage bins, the pump will come out of stroke and minimize energy consumption.”

*Jerry Rosenberger,
Series 45 Product Marketing Manager,
Danfoss Power Solutions*

It was this issue that led to a growing demand from Danfoss customers in the USA for an advanced hydraulic system that could maintain a high level of performance with less engine horsepower while improving work function controllability.

Variable flow on demand

Drawing on experience from European customers, Danfoss identified Series 45 open circuit axial piston pumps as the solution, in combination with PVG 32 proportional valves.

“Compared to gear pumps, axial piston pumps operate at a constant speed, but with variable flow, so they only pump oil when the demand is there. That means, when a refuse truck is being driven in transport mode between sites or garbage bins, the pump will come out of stroke and minimize energy consumption,” says Series 45 Product Marketing Manager at Danfoss Power Solutions, Jerry Rosenberger.

When running a vehicle from dawn to dusk up to seven days a week, the ability to match hydraulic flow to actual work not only maximizes the use of available power. It also has a direct impact on the end-user’s bottom line. Each 1kW of power saved per 1,000 operating hours translates into an annual fuel saving of 245 liters (65 gallons) – with a corresponding reduction in emissions.

Modifications to work function needs

The Danfoss design team introduced a series of options designed to prepare Series 45 pumps for supplying work function flow on truck-mounted machines in the 250-500hp range. Fundamental is the introduction of PTO-mount compatibility, which enables the Series 45 pump to act as a seal for the wet-mounted power take-off (PTO) shaft that transfers power from the transmission to the pump. The pump’s compliance with SAE standards ensures the safety and quality of the flange design.

Integrated pump control

One new innovation is exclusive to Danfoss: the optional electric on/off control valve with load sense and pressure compensation – affectionately known in-house as the ‘dump valve’. Integration of this smart device in the pump control facilitates an easier engine start-up with reduced wear and tear by unloading the hydraulic system while maintaining load-sensing functionality. An ability to override the PC control allows on-demand commanding to a low pressure standby – contributing to maximum performance efficiency at extremes of temperature ranging from -40°C to 140°C (-40°F to 284°F).

“The dump valve is a great innovation that saves a lot of complexity for the customer,” Rosenberger remarks.

In addition to refuse trucks, Danfoss has successfully applied the modified Series 45 pump solution to truck-mounted cranes. With lifting capacities of 50 to 100 tons, these cranes are no lightweights, typically being used for building construction – an application where the emission requirements of Tier 4 place even higher demands on power optimization. Operators of on-highway machines will find the Series 45 pump more than fulfills the power needs of work functions. The sophisticated control takes performance to the next level, improving efficiency, increasing hydraulic lifetime and bringing greater comfort to the working day.

Improved

efficiency and
increased hydraulic
lifetime



Great service is **there when you need it**

Never have so many of the world's mobile machines been powered by Danfoss Power Solutions. Responding to the high growth in installed product base over the past five years, Danfoss is building **a new global Parts & Service organization** to give customers the best possible support after the initial sale.

"The key to it all is making it easy."

*John Carnall, Parts & Service Vice-President,
Danfoss Power Solutions*



Service kits are a great idea when worn parts in a hydraulic system need a routine replacement. What would make them even better is if they were packaged or painted in the OEM's own brand colors, ready for delivery directly to the warehouse.

After many years of working on the OEM side of the table, Danfoss Power Solutions Parts & Service Vice-President John Carnall knows what it means to have a supplier that continues to add value to the business.

He also knows that it is often the simple things that are most important. The right paint and packaging, for example, are one way to make a big difference to mobile machine manufacturers in their own after-sales customer service.

"A great parts and service organization is flexible to customer needs. If you are going to put replacement components on your machine, then you want them in your own brand colors. If they are not, you will need to send them off to be repainted – and, if they are needed to repair a breakdown, that only creates more of a delay," Carnall says.

"You also want them to be in your own brand packaging before sending them out to your customers. However, if you are a distributor, it's very important that components are delivered in Danfoss packaging, because that shows they are genuine parts."

Once the new Parts & Service organization opens fully for business later in 2014, these will be among the service offerings that Danfoss customers can take advantage of. Based on input from international customers, the overall focus will be on taking technical support to a new level, easing the ordering process and supplying better inventory.

"The key to it all is making it easy," Carnall adds.

Three regions, one global offer

A global business needs a global structure, so this has been the first priority for Carnall and his team. Two Parts & Service regions are now in place in the Americas and EMEA (Europe, Middle East & Africa), with a third on the way in China. In addition to developing further understanding of local customer needs, Carnall points out the regions' important role in supporting large multinational customers. Here, the Parts & Service staff will work closely with Danfoss account managers and sales teams.

"A big part of the whole thing is to standardize our global offering because many of our customers are global now," he says.

"The first step in that is to rationalize our service kits so it is easier for customers to know if they are ordering the right one. Through simpler ordering, we make our parts more available."

A more long-term goal is to establish an e-sales channel in conjunction with distributors to complement existing online services. The capability to identify parts through their serial number will be one of the benefits. Work to develop a platform for this purpose is already underway.

Ambitious goals

In the new Parts & Service organization, ambitions are high. As a result, customers should experience a responsive aftersales service that adds even more value to their business.

"I always tell the sales guys that they have already done the hard work by making the sale," Carnall states. "Our job is to make sure customers keep on getting good service so they want to do business with us again."





Smart controls are still **raising the bar**

PLUS+1® control systems have led an era of intelligent machine management by **enabling complex functionality to be programmed quickly** without advanced programming experience. We talked to two distributors who have used PLUS+1 technology since its release ten years ago.



Chad Crowley is Vice-President of Engineering at SunSource, which he joined in 1996. He started up the SunSource mobile electronic team in 2002 and currently supports all mobile engineering resources.



Paul Skrant, application engineer at Kraft Fluid Systems, has developed PLUS+1 systems since the launch of PLUS+1 in 2004. He is a certified mobile hydraulic and electronic controls specialist.

Danfoss was not short on ambition at the launch of its PLUS+1® system for customized machine control at the Bauma trade fair in 2004. Integrating modular hardware, advanced software and the user-friendly PLUS+1 GUIDE programming environment, the mobile electronics concept was billed as the new industry standard.

The goal was to make it easier for design engineers to integrate control functions for specific applications – making machines smarter and more responsive, while also improving time-to-market.

So how did it go?

The black box

Kraft Fluid Systems was one of the North American distributors that started working with PLUS+1 from day one. Application Engineer Paul Skrant recalls how it was received.

“PLUS+1 was kind of the black box when it came out. We quickly found that it allows us to do a lot more.

“You can take a Word document with the customer’s specifications, turn it into code, and hook it all up in one control system. This means we can have the software ready even before the start of the machine assembly process.”

Many new opportunities

Compared to the previous electronic control functionalities, PLUS+1 opened the door to many new opportunities. Prior to the launch, a number of distributors had helped Danfoss define which needs the new control package should fulfill. SunSource was among them.

“We needed flexible hardware, and we needed the ability to program it ourselves,” says Chad Crowley, Engineering Vice-President at SunSource.

“Danfoss has accomplished that. They have developed an innovative product with lots of modules we can choose from. So we can develop the software and respond to our customers much faster.”

Continuous expansion

When introduced, PLUS+1 mobile electronics consisted of stackable microcontrollers, I/O modules and PLUS+1 GUIDE, along with compatible joysticks and graphical displays.

Since then, many PLUS+1 compliant components have been added, along with new application software and regular upgrades of PLUS+1 GUIDE – version 7.0 was launched earlier this year. Danfoss holds regular training sessions to help distributors and OEMs understand how and where PLUS+1 can be applied.

“Today, ten years after its arrival, PLUS+1 is used by hundreds of OEMs in more than 60 countries. Among them, they have developed thousands of applications,” says Danfoss Power Solutions Product Line Manager Mike Hallet.

“Our ready-to-use platform reduces the cost and development time normally associated with programming. The idea is that customers can quickly and effectively put their ideas into motion and add value to their entire machine system,” he adds.

Emissions and safety compliance

Many OEMs have used PLUS+1 to overcome the machine performance challenges that arose as a result of emissions regulations such as Tier 4 and the functional safety requirements of the EU machine directive, for example.

One of the latest additions to the toolbox, the PLUS+1 Work Function Control (WFC) subsystem application software illustrates how Danfoss continues to improve the platform and support Tier 4 compliance.

"The opportunity PLUS+1 provides to be involved from a very early stage of mobile machine development has made SunSource a more competitive distributor."

*Chad Crowley, Vice-President
of Engineering, SunSource*

Offering three core functionalities – anti-stall, flow sharing and intelligent engine speed control, WFC is designed for machines where the diesel engine has been downsized, taking it below the 56 kW threshold relevant to Tier 4.

The objective is to maintain machine productivity at this lower power rating. Following validation testing of the WFC software on a backhoe loader, Danfoss has documented the potential for an 18% reduction in engine size and fuel savings of 19%.

80% less manual work

Version 7.0 of PLUS+1 GUIDE has gained several new features and options that reduce the programming workload even further.

At Kraft Fluid Systems, Paul Skrant welcomes the capability to export existing electronic display code from one machine to another, eliminating the need to program from scratch. In Danfoss tests, this can reduce manual work by up to 80%.

"Displays are one of the more time-consuming parts of programming. So this migration opportunity is a huge benefit," he says.

Electronic simulation opportunity

Responding to OEMs' increased use of computer simulation models prior to construction of the first machine prototype, Danfoss has introduced GUIDE-to-Simulink® functionality for simulating electronic control behavior. The export of PLUS+1 software code to Matlab® Simulink, using Simulink's S-functions, enables early detection and resolution of design errors.

The new PLUS+1 GUIDE quality assurance tools provide additional design security for developers by comparing the system inputs written into the software code with the

expected outputs – a benefit that becomes really powerful when working with different versions of code.

A business cornerstone

According to Chad Crowley, it is Danfoss' innovative approach to continuous improvement that keeps PLUS+1 the number one choice for mobile equipment. Today, PLUS+1 is a cornerstone of the distributor's business.

"The opportunity PLUS+1 provides to be involved from a very early stage of mobile machine development has made SunSource a more competitive distributor," he states. "For us, PLUS+1 is a critical component when improving machine efficiency."

Responding to complex demands

Both Skrant and Crowley have no doubts that PLUS+1 will continue to provide solutions in response to increasingly complex OEM demands, where precision performance, ease of operation and minimum downtime are priorities.

Crowley points to one of Danfoss' latest moves toward the integration of PLUS+1 microcontrollers into pumps and motors.

"Apart from reducing wiring and installation time, this is a step toward preventive maintenance, where we can use data to predict when a component is nearing the end of its life and prevent downtime."

Improved machine control also presents a means to relieve the back-driving torque that is a problem for many of today's emissions-compliant engines. Skrant recognizes a good opportunity to support OEMs on this point.

"Using PLUS+1, we can find a way to dissipate excess horsepower into another function to stop it going back into the engine," he says.

**Reduce manual
work by up to**

80%

Another area that Danfoss will continue to optimize is operator comfort. New opportunities for intelligent control mean operators can rely on their machine to adjust to varying work conditions and performance demands – leaving them to focus on the task in hand.

PLUS+1 already has a 10-year track record for making machines smarter, safer and more comfortable to drive. It doesn't take a crystal ball to know that Danfoss aims to continue raising the bar in the future.

Danfoss is Engineering **Tomorrow**

Danfoss has captured core messages in a new brand identity launched this fall. Under the slogan *Engineering Tomorrow*, the corporate aim is to communicate the heritage, primary competencies and forward-thinking attitude that make Danfoss a strong global business. During the brand development process, customers and employees were invited to provide input about how they perceive the Danfoss group and their expectations moving forward. Their feedback has helped sharpen the focus on three key values: quality, reliability and innovation.

The new brand look builds on something that has always been at the heart of Danfoss – the color red. The red of the Danfoss logo combined with a new deep-red shade and corporate watermark boldly emphasize the Danfoss commitment to engineering the world of tomorrow. Using its strong engineering expertise, Danfoss works to make significant innovative improvements to the food, energy, infrastructure and climate industries. With a strong new tagline, and a striking corporate brand design to support it, Danfoss can now show the world how it is *Engineering Tomorrow*.