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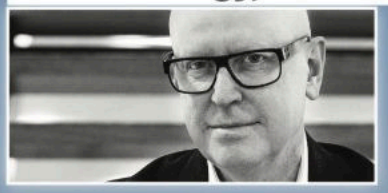
iVT INTERNATIONAL
INDUSTRIAL VEHICLE TECHNOLOGY

November 2014

Interview
Anders Larsson
VP Technology, Volvo CE



Ergonomics
Cold comfort for operators

Going to extremes
Cat & Finning's Coldest Journey vs the 1939 Snow Cruiser

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Winter Special: Ensuring off-highway vehicles don't catch their death of cold

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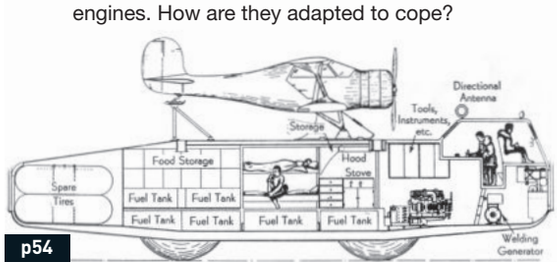

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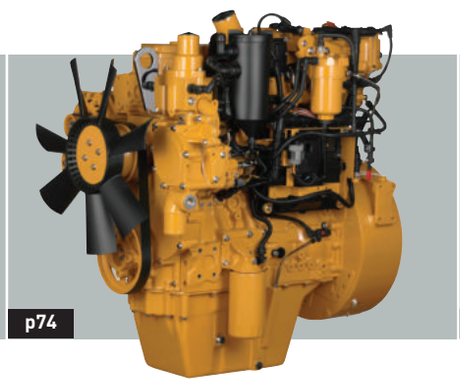

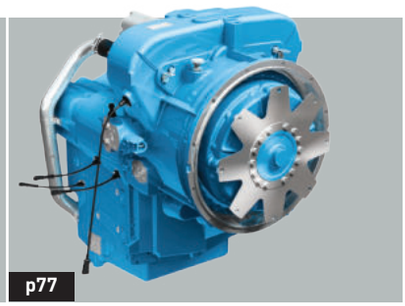

FOREWORD

Having indulged in one of my favorite pastimes/addictions last night – that of buying assorted clothing, components and accessories for my small fleet of bicycles (okay, perhaps there might've been another bike acquired too) – I now feel ready to tackle virtually anything that this time of year has to throw at me. And just in time too, as if it hadn't been for my new Northwave Artic (sic) insulated commuter boots, the first frost of the season would have made this morning's ride to the office quite an ordeal.

That said, I'd take being too cold over being too hot any day of the week. I may have once flippantly written that Volvo CE should try building machines in – and inviting journalists to – places like Tahiti rather than the sub-Arctic – but then I'll clutch at any straw when I'm struggling to get an article off to a catchy start. The fact is, according to the girlfriend, I'm a 'winter bear' – and if offered the choice of spending a fortnight in a seven-star Dubai hotel or an Inuit igloo, I'd take the latter every time.

And that's why this Winter Special is without doubt the issue I've most looked forward to compiling in all my 13 years at *iVT*. Somehow the machines designed expressly for working in snow seem to have that extra, almost undefinable, touch of glamour; perhaps even a touch of romanticism as their components battle heroically against the extremes.

So given that producing a winter issue has been in my mind for at least a decade, perhaps I really shouldn't have been surprised to finally discover that, as far as most construction machines are concerned, there's not really any such thing as a 'winter model'. That's not a criticism – far from it. One of the features I'd initially considered for inclusion was provisionally titled 'Building the Perfect Cold Weather Machine', but further digging soon revealed that the vast majority of off-the-shelf engines, hydraulics and HVAC systems, etc, are already perfectly well-equipped to deal with virtually any climatic condition. It seems you will rarely be forced to buy an upgraded pump for your cold-store truck, for example.

Nowhere was this illustrated more perfectly than in my interview with Richmond Dykes concerning The Coldest Journey (p42 – and the reason this long-awaited Winter Special finally came to fruition), which revealed that surprisingly few component upgrades were required to make Cat's D6N dozers suitable for -70°C operation in Antarctica. They're already tested down to -40°C and that's more than enough for 99.9% of applications.

I also recall, years ago, interviewing Camoplast's Jan Kral, who told me that the Trooper tracked carrier we were set to feature in *iVT* May/June 2008 – the one that could start up at the drop of a hat in -40°F conditions – would soon be heading to Utah's Great Salt Lake to work at +100°F, with no modifications needed.

Of course, this is only the case because so much care and forethought has gone into them at the design stage, even if some of them may never see a snowflake in their entire life – as Steve Casey's article on designing with the operator in mind makes abundantly clear. So whatever you component suppliers and OEMs are doing, you're doing it very well – and for the extremely rare occasions when that's not good enough, companies such as Volvo offer a useful work-around. Its 'Siberian Kit' for example, enables its articulated haulers to operate efficiently at -40°C, via modifications to electrical equipment, batteries, hood, fuel supply and radiator.

As for me, shivering on my bike saddle, I can only look on enviously at those operators sitting in warm, comfortable cabs perfect for any season. There's nothing else for it – I'll just have to continue buying new thermal base layers, jackets and waterproofs. And perhaps just one more bike…

Richard Carr, editor, iVT International

Coming up in the March issue of iVT

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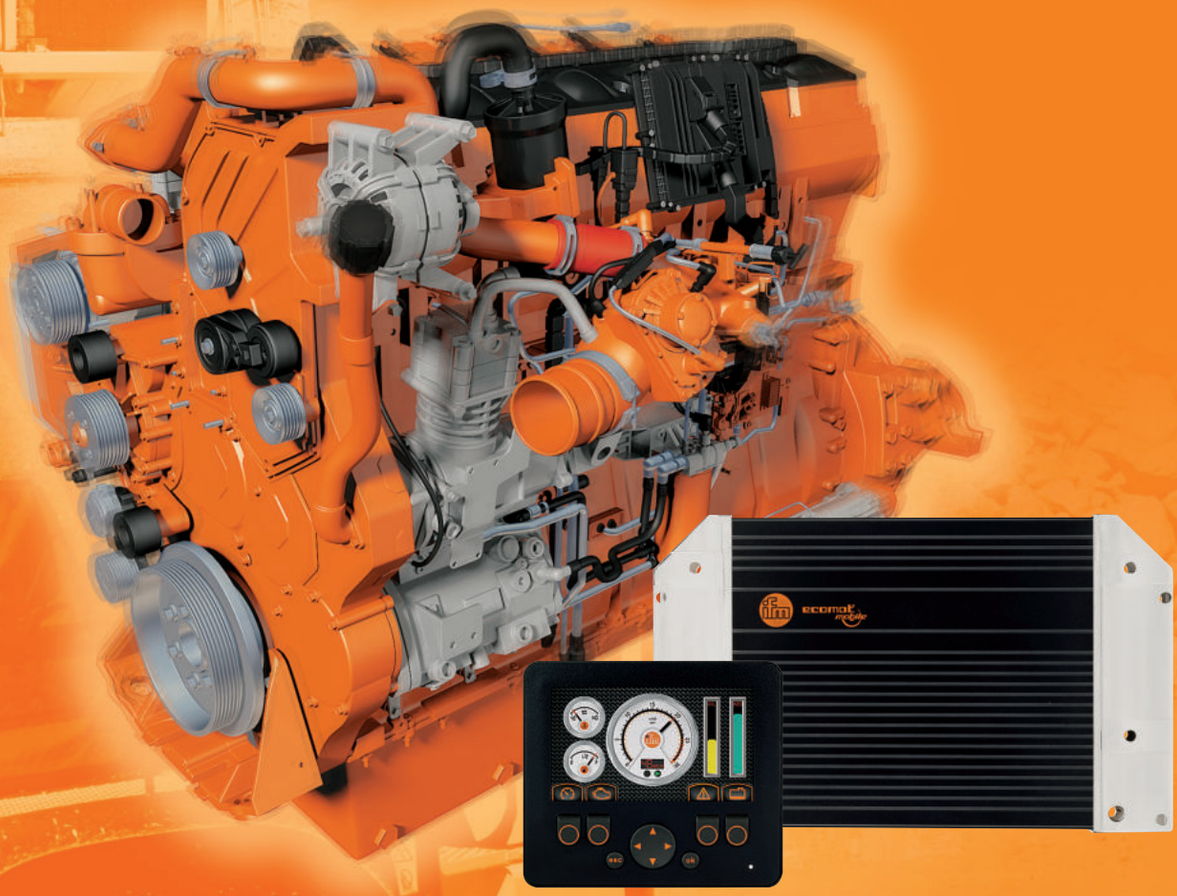

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Cementing reputations

SENAGO, ITALY – Cifa may be more well known for its road-going concrete mixers, but it now boasts a full range of machinery for work in tunnels and confined spaces too, with one of its latest – and most stylish – models being the Coguaro4 mixer.

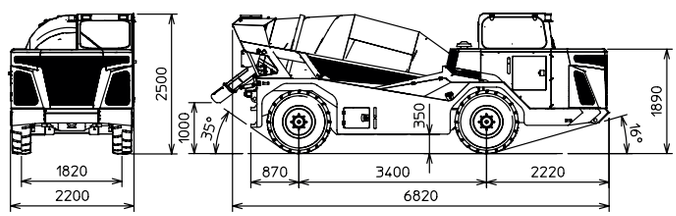
Despite the unusual design for this type of machine – which often suffer from a Spartan appearance – the Coguaro4 creates a strong sense of Italian styling, according to Massimo Galimberti, Cifa's product manager for underground products: "It's the first project completely developed from scratch by our in-house styling center, blending aesthetics, technology, functionality, ergonomics and quality. Traditionally, design for this type of machine is less accurate, with little attention to detail. They are used in very difficult work conditions and the 'look' is really the last detail that manufacturers and customers pay attention to."

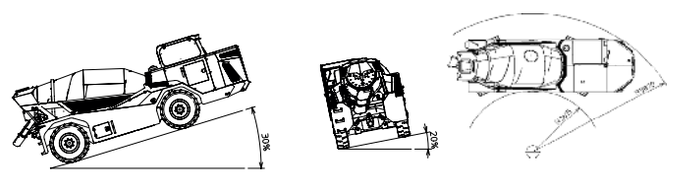
Designed for the special transportation of concrete in tunnels and mines, the machine had to fulfill two conflicting demands – that of providing an efficient transportation capacity within a small footprint, while enabling it to maneuver in the tight spaces common to these applications.

As a result, the Coguaro4 features a 4m^3 capacity drum of 1,750mm diameter, which rotates at 17rpm with two 250mm-diameter rollers. The constant speed drive (CSD) ensures its revolutions remain consistent by varying the speed of the motor. Set low in the chassis, the drum contributes to the overall height of just 2.5m, while its four steerable and driven wheels combine with the 3.4m wheelbase and 2,200mm width to provide a turning circle of 2,615mm.

The machine is driven by an innovative electrically operated hydraulic transmission, with a hydraulic pump and two hydraulic motors – one mounted directly on each axle – supplied by Linde Hydraulics. "In this way we know the working data of each motor and can adjust working parameters and traction in accordance with the terrain, as well as reducing noise and pollution," says Galimberti.

The first Cifa machine to be fully designed in-house, the Coguaro4 boasts styling unusual to this class of vehicle





COGUARO 4

The absence of moving mechanical parts is also claimed to provide maximum reliability and driving performance, while minimizing fuel consumption.

The turbocharged Perkins 1106D-E66TA Stage IIIA engine delivers 121kW @ 2,220rpm, while the 195-liter fuel tank should enable long workshifts before refueling is necessary. Cold climate oils are optionally available.

Its 10,000kg net weight more than doubles to 21,000kg when used at maximum capacity, when top speed is reduced from 25km/h to 15km/h on the flat, or from 15km/h to 5km/h when tackling a 30% grade. Multidisc wet brakes on each axle and SAHR internal discs ensure safe stopping.

Safety first

Safety, of course, was high on the agenda, with all machine functions being constantly under control. The closed cab is ROPS/FOPS compliant, with visibility enhanced through the use of electronic sensors for obstacle detection and an infrared rearview camera for maneuvers in tunnels. A fire suppression system is available as an option.

The mixer itself is safe too, as Galimberti explains: "We transferred to this machine the checks that we currently use on our most advanced truck mixers, such as the drum rotation check during vehicle movement and safety systems to block the drum when carrying out maintenance inside it."

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WORK LIKE A **TROJAN**

HIXON, UK – Claimed as a breakthrough in the heavylift industry, ALE's Trojan truck features the ability to link an unlimited number of tractor units in a command and drone convoy. The command vehicle controls all following tractors through mechanical, air and CANbus links.

Braking, electrics, engine compression braking and transmission retardation are all synchronized by computer to ensure each unit's gearing, RPM and torque is matched.

With 700hp supplied from the Volvo Penta TAD1662VE Euro 5 engine, each 72,000kg unit provides a maximum geared road speed of 48mph, and can pull a gross combined weight of 300 metric tons at its maximum gradient of 14%. The main transmission is an Allison M6620AR 6-speed fully automatic model with integral torque converter, while the auxiliary Kessler VG2500 transmission with a two-speed transfer case delivers one-third of its torque to the two front axles (Dana twin-steer, each with 12,000kg capacity) and two-thirds to the two Kessler rear axles (each with 24,000kg capacity).

The bespoke engine and transmission performance provides a claimed fuel saving of 40% compared with that achieved by previous models.

TAILGATE **PARTY**

ÖREBRO, SWEDEN – A range of new improvements has given Atlas Copco's Minetruck MT42 the means to beat its own productivity record.

The most striking upgrade is the redesigned box, which shares the same physical envelope size as the previous models, but with a reduced dump height. Produced from high-strength steel, its new geometry features optimized internal plate angles that will shed material easier – aided by the innovative tailgate, which acts as a spill guard.

The tailgate automatically folds down behind the box before dumping, without affecting ground clearance or the rear-view camera's line of sight. Hydraulically operated, its status can be seen on an in-cab display, as is the status of the DPF and DEF tank level associated with the new engine option – the Cummins QSX15.

The truck is also ready for an optional electromagnetic retarder braking system, which creates resistance during downhill hauls to provide wear-free braking. This can also enable higher speeds to be achieved, further boosting productivity.

THE NAMES HAVE BEEN **CHANGED...**

PFULLENDORF, GERMANY – Under the slogan 'Oktoberfest of Innovations', Kramer-Werke has launched its first Stage IIIB wheeled and tele-wheeled loaders, while revising both brand and nomenclature. The Kramer brand will now stand alone, without the addition of 'all-wheel' while new machine names will enable potential customers to better understand capacities.

Products will therefore now be differentiated according to Economy (the 5 Series) and Premium (8 Series) models, making Kramer's 8095T, for instance, clearly identifiable as a premium tele model with a bucket capacity of 0.95m³.

The 5 Series comprises seven models with bucket sizes from 0.35-0.95m³, with all models from the 5075 up providing three steering options: all-wheel, front-wheel or crab.

An optional long loading system for all models from the 5055 upward is ideal for loading de-icing salt and grit for winter maintenance applications.

The Premium Series features seven models and three engine variants, with the smallest (the 8075) being equipped with a 35kW Yanmar model and the rest with a 55kW Deutz TCD 2.9 – although the largest models – i.e. 8105, 8115 and 8095T – can benefit from a 74kW version.

The optional Powerflow high-performance hydraulic system provides attachments such as rotary snowplows with up to 120 l/min of flow.

A new innovation on the telescopic models is the final position dampening that supports safe movement of the load and reduces stress on both machine and driver.

GEHL FORCE WIN

WEST BEND, WI, USA – With three models, Gehl's R Series radial-lift skid-steer loaders fall into the large-frame category and can be quickly fitted with optional counterweights to increase rated operating capacity to 957kg on the smallest model (R190) and to 1,261kg on the largest (R260).

Yanmar engines provide either 68.4hp or 70.7hp, to drive the high-powered auxiliary hydraulics that deliver 119 l/min on the R190, or 132.5 l/min on the R220 and R260 models in high-flow configuration.

This is controlled from the joystick which, just like the armrests and hand/foot control options, is fully adjustable. The cab-forward design and its lowered rear towers deliver optimum visibility to the bucket edge and rear of the machine.

FROM TOP TO **TOW**

CHÂTELLERAULT, FRANCE – With the launch of its P60/P80 towing tractors and W08 load transporter with 800kg capacity and towing capacity of 7 metric tons, Linde has extended its range of hauling products.

With a capacity of 6-8 metric tons, the P60/P80 tractors can easily tow over hills or loading ramps, via a maintenance-free enclosed 4.5kW rotary current motor that gives a top speed of 20km/h. An integrated hill-approach assistant prevents rollback at the bottom of inclines, while an automatic parking brake – activated whenever the pedals are released – means the driver can jump straight off and leave the machine absolutely motionless until the accelerator is pressed again.

The high ground clearance effortlessly overcomes common obstacles, using the decoupled and sprung wheel attachment to absorb vibrations. Sprung elements are also reinforced on the rear axle of the W08.

The 6mm steel chassis offers the same turning radius as the previous version, despite being 150mm longer – the extra space expanding the footwell for more legroom. The driver's seat can be easily accessed from either side, and is surrounded by intuitive control elements arranged in the same way as in a car.

Lateral battery change can be quickly carried out using roller conveyors or a pallet truck rather than a crane system.

READY, MILLING AND **ABLE**

WINDHAGEN, GERMANY – Three years in the making, Wirtgen's new generation of compact cold milling machines are said to be able to speed up completion of a project by as much as 20%.

The half-meter W 50 Ri and W 60 Ri models feature a slimline chassis specifically designed for an unobstructed view of the milling edge to the front, as well as of the left and right side plates. The new, completely round milling drum assembly, coupled with innovations in the drum, side plates, scraper blades and gradation control beam, make milling simpler, faster and of higher quality.

The extra-wide front wheels minimize the surface load exerted by the machine, reducing wear. The driving dynamics package enables speeds of up to 12km/h in the four-wheel versions.

Maneuverability has been enhanced through generous locking angles to either side, resulting in extremely small turning radii. In the four-wheeled version, the front wheels are offset by 15cm, so as to travel in-line when the steering wheel is turned to the right, while the rear inner wheel also features an automatic tracking function.

The hydraulically operated folding discharge conveyor, with a maximum length of 5.60m and maximum width of 350mm, can be quickly folded up on cramped job sites or for transport. Its large slewing angles of up to 30% to left or right enable the discharge of material even under difficult jobsite conditions.

A multifunctional armrest offers high user-friendliness, with all the main operating functions and information being displayed in color on the control screen.

A GOOD **i-DEERE**

DES MOINES, IA, USA – Replacing the 5430i model, John Deere's R4040i self-propelled sprayer promises greater performance and reduced cost of operation.

Powered by a 6.8-liter JDPS PowerTech PSS engine that produces 235 rated hp (boosted to 255hp with IPM), it meets Tier 4 Final with the use of SCR technology. Combined with hydrostatic final drives and planetary gears that provide constant four-wheel traction in both transport and spraying modes, it enables top speeds of 40km/h and 20km/h respectively. With two-wheel, four-wheel and crab steering available to suit different crop and field conditions, it enables a 4.5m turning radius.

The chassis features XtraFlex dual-strut independent wheel suspension for a faster, smoother ride, while hydraulic track width adjustment comes as standard.

The centrally located cab is now easier to access, provides a more comfortable operating position, and ensures good visibility. Its restyled interior features a new cornerpost display, while John Deere's GreenStar 3 2630 touchscreen display with full FieldDoc spray documentation and ISObus compatibility is fitted as standard.

The 4,000-liter PE spray tank's rounded shape and smooth internal surfaces enable efficient mixing and cleaning, sending up to 380 l/min to the steel spray booms. To minimize overlaps or skips, automatic Section Control switches individual boom sections on and off when the sprayer enters or leaves predefined areas, such as headlands, while LED boom lights help maintain high productivity at night.

The pendulum boom suspension system's PU dampers add stability, with the BoomTrac automatic boom leveling system adding even more accuracy. The BoomTrac Pro option further increases accuracy by automatically adjusting the height of the boom wings to match the contours of the terrain.

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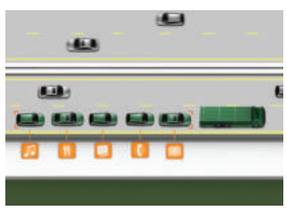
RICHARD CARR, iVT INTERNATIONAL

AS EXECUTIVE VP OF VOLVO CE'S TECHNOLOGY FUNCTION, ANDERS LARSSON HAS A LOT ON HIS PLATE IF THE COMPANY IS TO REACH THE GOALS IT OUTLINED IN LAST YEAR'S INNOVATION FORUM

MAN ON A MISSION

Way back in 1978, Anders P Larsson would often ride his bicycle in temperatures as low as -20°C to his first job, machining castings on a turning machine at Volvo CE's Eskilstuna plant.

And that's about all there is to tie this article in with the winter theme running throughout the rest of this issue – but given Volvo's Swedish origins, and Anders' later role as head of its motor grader division in chilly Goderich, Canada from 2000-2004, it nevertheless still seems a rather appropriate fit. Perhaps I should really have interviewed him in a cold chamber, but instead, we meet in the pleasantly warm office he now occupies as executive vice president of Volvo CE's Technology function at its Brussels, Belgium HQ.

Clearly then, he boasts an enviable knowledge of the company's history, operations and aims, and also has a lot to say on the topic of product development efficiency (which will appear in a future issue, along with thoughts on designing for emerging markets). But, given our last meeting had been at Volvo's Innovation Forum (*iVT* Sept 2013), it seemed natural to kick off by touching on a few of the topics that had been covered there.

For instance, 'zero accidents' is a surprisingly ambitious goal – one that was restated when I visited the AstaZero active safety test area in Sweden in August, where Volvo CE showed its autonomous wheeled loader and Volvo Trucks is testing a whole range of onboard technologies. So just how viable is that aim?

"It's a vision that drives a lot of things, but to be honest, it will be extremely tough to reach absolute zero," he admits. "But we could certainly get closer."

Would any of the on-highway technologies I'd seen being trialed by Volvo Trucks have any application in construction equipment then, I ask? "You're thinking about automatic braking?" he responds. "On-highway trucks and articulated haulers are a variant on the same theme, so that could certainly work. [See a video of this in action on our website.]

"The truck industry is also working on 'road trains', where you hook up three or four trucks electronically. Once there's a short distance between them, all the drivers of the following trucks just push a button to lock in, and then they can relax without fear of collision while the truck drives itself. By reducing headwinds, that saves a lot of fuel – but there's a lot of legislative challenges to overcome!"

Easy does it

That may soon mean an easy life for truck drivers, but there's no such luck for their off-highway counterparts. The typical operator may be getting older, but that doesn't mean they are all able to control motor graders: "We need to look at how we can make it easier for a newcomer to quickly learn how to operate even the simpler machines, in terms of both HMI and greater automization of functions."

By 'quickly', could that even mean that a complete novice could jump into a machine and instinctively operate it, I inquire? Is the ultimate aim to build an 'idiot-proof' digger?

"That leads back to one of the themes from the Innovation Forum – zero downtime. Over time, you add in the kinds of things that simplify and protect the machine, and make it increasingly bulletproof and intuitive – it's not quantum leaps but step by step, and we will gradually get closer and closer to it. So we could really have an impact on the more complex machines, such as excavators, which comprise about half the total market."

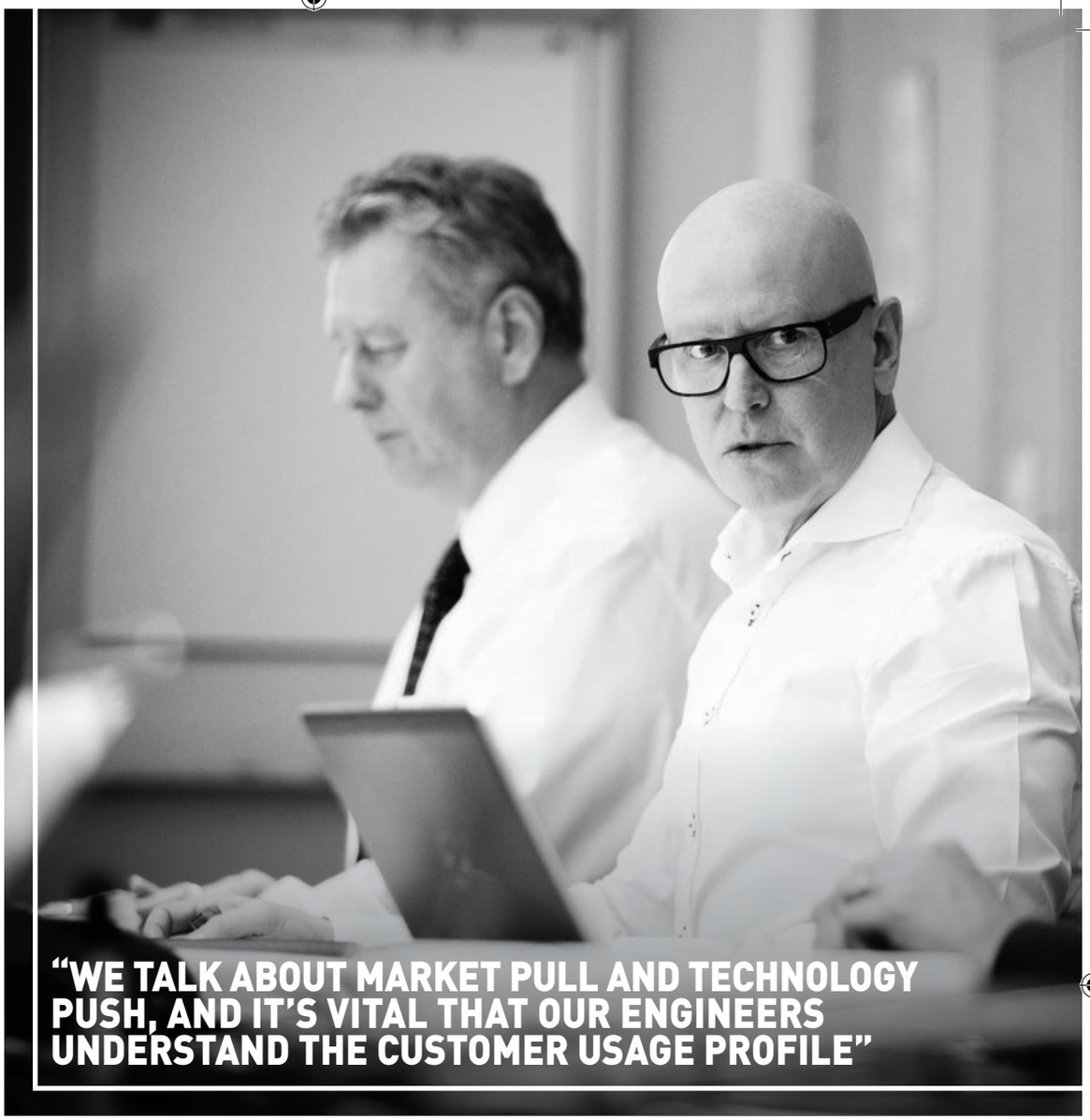

"WE NEED TO LOOK AT HOW WE CAN MAKE IT EASIER FOR A NEWCOMER TO QUICKLY LEARN HOW TO OPERATE EVEN THE SIMPLER MACHINES"

This is the machine that, when pressed, he suggests could be the first to feature head-up displays as standard, although he doesn't see the technology as being economically viable just yet. "Technologically, it's quite feasible – it's already used in some high-end applications. But once you can ramp up the volume, it will become more available.

"People talk about these fancy technologies a lot, but it's crucial to be inventive in the commodity type of things as well. You can't just add in a lot of fancy stuff; you need to come up with cost-effective solutions.

"I think there is much more that can be done, over time, to improve the operability of machinery. That can lead you into adopting semi- or fully automized functions; it also can protect integrity, and the quality, of the machine. By restricting use of some functions, you can protect the equipment and ensure longer life, so it's not only about providing support for the operator.

"We talk about market pull and technology push, and it's vital that our engineers understand the CUP [customer usage profile]. It's not just sitting at your computer and trying to develop new stuff to push out; you need to be out there to see how



"WE TALK ABOUT MARKET PULL AND TECHNOLOGY PUSH, AND IT'S VITAL THAT OUR ENGINEERS UNDERSTAND THE CUSTOMER USAGE PROFILE"

"NOW IT'S ABOUT HOW DO YOU GO FROM BEING GOOD TO BEING THE LEADER?"

STOP PRESS!

As *iVT* went to press, Volvo announced that the branding and manufacture of backhoe loaders and motor graders would be transferred to SDLG

ACQUIRED TASTES

Anders had rather cruelly put me on the spot at dinner the previous evening, asking my opinion on which OEMs led the way in terms of excavators, articulated trucks, wheeled loaders, and so on. So now it was time to get my own back. Which Volvo machines would he claim are the market leaders, I probe?

"Of course, the political statement is they're all good – which I genuinely think they are – but with our heritage, I think the articulated trucks are really strong, as are the wheeled loaders, especially in the upper end, and we have really good excavators. When you compare the 'me-too' design of the Samsung excavators that we acquired in 1998, we've moved the goal posts – now it's about how do you go from being good to being the leader?"

They certainly are the machines that are synonymous with Volvo, I agree – probably more so than the backhoe loader it launched just over a decade ago, anyway. Is that all down to lack of a brand history in that sector, or is it a technological thing?

"That's an excellent product," he counters, "but it's tough to really get the volume and market share. The biggest market is India, so you need to have a good backhoe, but when you design it yourself the challenging thing is you don't already have a population out there – unlike when you acquire something. It takes time to recoup that investment, and build up the population – and the aftermarket is very important too."

Volvo CE has a long history of OEM acquisitions, of course, but there are still several potentially attractive gaps in its portfolio, such as the dozer alluded to by president Martin Weissburg in *iVT* June 2014. That would certainly provide a perfect fit with the road construction equipment the company acquired from Ingersoll Rand in 2007, but would it be financially rewarding enough to produce a clean-sheet design for what is a relatively small market? And what could Volvo do differently to make it stand out from the crowd?

"There aren't that many players in the sector, and many of our customers want to have one-stop buying for their equipment, so a dozer would be an important machine," he confirms. "If you have a share of mind at the dealer level of 25%, how do you create more interest when he sells other brands? If you can increase that to 75%, then you have a different relationship with the dealer – that was the logic behind our acquisitions, as well as being wider spread, both in terms of applications and geographically. But we also want to have more market share in those applications, so the challenge is to grow in two dimensions.

operators use the equipment. That's when you realize that there's room to develop a technology that the customers don't even realize exists today, as was the case with telematics a few years ago."

Exhausting the possibilities

The many advantages of telematics are certainly now hard to ignore, including what might, a decade ago, have seemed an unlikely means of reducing fuel consumption. In a similar vein, it seems to me that it's now hydraulic – rather than engine – technologies where the majority of improvements in fuel consumption are being made. Does he agree?

"I think so. There is still much more to do on the engine side, but there we can leverage the technology from cars and trucks, where there's the volume and big investment. Hydraulics is different; you're more dependent on your own competencies and skill, and cooperation with the hydraulics manufacturers.

"Once again, we're talking about steps; there will be new technologies to adopt. Fuel efficiency is more important in some areas than others, such as heavy equipment, where you can afford to invest in technologies that pay off. With the smaller type of equipment, it's less important, so you need to balance the investment in product cost."

TOP: **Could a future stage of emissions compliance tackle CO_2 output – and how should it be measured?**

ABOVE: **Engineers need to be out and about, looking at how customers actually use their equipment before coming up with technological advances**

That leads us nicely on to the topic of zero emissions, which was put forward as a goal at the Innovation Forum – but is that truly viable, and if so, would it be via relocating the source of the emissions, through greater use of electrification, rather than carbon-neutral fuels, perhaps?

"It probably won't happen on all machines," he admits, "although you can envision a whole fleet being hooked up to the grid. There will be suitable applications; we just have to apply it where it really fits. Compact equipment is usually used inside cities, so it could be that governments will push contractors to have a fully electric excavator or whatever.

"But the beauty of being part of the Volvo Group is that it gives us access to technologies like alternative fuels, which are expensive to develop – so when the demand is there, we'll be ready to react."

The first step: fuel efficiency

More immediately, fuel efficiency is the easiest step in the direction of zero emissions, and Anders points out that most new generations show 5-10% improvements just through the use of conventional technologies: "For me, that is the real battlefield; optimizing our existing technology to reduce fuel consumption. I think as an OEM, it's becoming increasingly important to be really good in system integration; how do you orchestrate the whole machine or the systems, in an optimum way?

"Getting back to dozers, though, I guess we'd do it more innovatively. These are very heavy, tough applications, and that fits the Volvo brand, so if we want to play in that sector, I would expect us to be up there."

Applications don't come much tougher or heavier than mining, and unsurprisingly we drift on to the topic of Volvo's most recent acquisition, Terex Trucks. Following months of speculation about the possible fate of its 'spare' articulated trucks, it's fair to say that most journalists were surprised to learn that it was effectively business as usual for now – the division would continue to run as a self-contained business unit within Volvo CE, producing all existing models under its own brand. But that doesn't mean it will be running in isolation, verifies Anders.

"When you acquire something, you need to stabilize it and bring it into the family, but it has a different distribution as well as technology, so we don't want to rock the boat. It's natural that our industrial design and technologies will come together, but we both need to learn more about each other before we start moving, and we'll do it in smaller steps."

And what about the potential for new trucks, I press – with extra investment, could the Terex rigid models one day be hauling in excess of their current 100 tons limitation? "Volvo isn't into heavy mining, we're on the borderline, so the natural question is, 'What kind of loading equipment do you have for a 100-ton truck?'" he corrects me. "Before shooting for even bigger trucks – and without implying we're developing an excavator three times the size of our EC700! – we need to focus on pieces of equipment that work together. But then you get into new technologies, such as diesel-electric."

That sounds like an acquisition, partnership or rebadging deal with another OEM could be an ideal solution, I suggest. "We have a cooperation with JCB on skid-steers so it's been done before," he agrees. "It could work both ways, of course."

"If you take an articulated truck, 90% of the power is for propulsion; the rest is for hydraulics for steering and tipping. An excavator is all about hydraulics and a wheeled loader is more like a 50/50 split, so you need to apply a few different technologies, focusing on different areas, to really enhance the fuel efficiency."

When I recall that a wheeled loader operates for much of its duty cycle at only 60% of peak power, and suggest that it's the ideal machine to take advantage of a downsized engine, maybe supplemented by a little extra something, Anders tantalizingly adds: "Maybe have two engines, the second one kicking in when you need it," but when I press him on the viability of this donkey engine solution, will only add: "It's hard to tell; I'd rather stay away from evaluating that," and returns to the subject of 'ordinary' models.

"You want to have the engine speed when you dig into the pile and unload, but you don't need the revs when you're driving. So how do you decouple the system, so you get independent engine revs, so it can run on a constant level? It becomes very complex to manage, but I think that's the future.

"Then, of course, you enter into advanced technologies to cut it even further – hybridization, electrification and CVT, for example."

Well, now you come to mention it, Anders, is anything likely on that front soon? "It's no secret that we're looking into most of this stuff, but there are so many things happening right now, the right strategy is crucial. Do we do it in steps? Or do we maybe skip a step, because developing a new transmission generation, for instance, is a hell of an investment – you need to get the payoff for that before you can launch the next one."

"SOMETIMES YOU WONDER IF SOME OF THE COMPETITORS REALLY ARE COMPLIANT, AS WE DON'T HAVE ANYBODY THAT CHECKS THIS OUT IN EUROPE"

So given that Volvo's hybrid wheeled loader prototype (*iVT* Nov 2008) is now unlikely to ever hit the market in that form, might there not perhaps be some nice, cheap ways of implementing some of the more inventive fuel-saving technologies? Sadly not, he responds, pointing out that even larger-volume hybrid products such as buses are frequently dependent on government funding. Volvo wants its machinery to stand on its own merits, and provide that all-important TCO benefit.

"It's unlikely that you'll really get the fuel-saving benefits from the hybrids you see in the marketplace today. When you really get into it and measure it, there's so much more that can be done with conventional technologies, and at lower cost."

Governance needed

That leads me to speculate just how workable a widely anticipated future emissions stage tackling CO_2 output would be. If that was to be measured from the engine, rather than the duty cycle, then surely a wheeled loader with an older engine but with more efficient hydraulics or telematics (or operator) than its competitors would be unfairly disadvantaged, as would a hybrid that's recapturing energy produced by a similar engine to that used in its non-hybrid equivalent? If it was to be measured by duty cycle, that's potentially a huge can of worms awaiting opening.

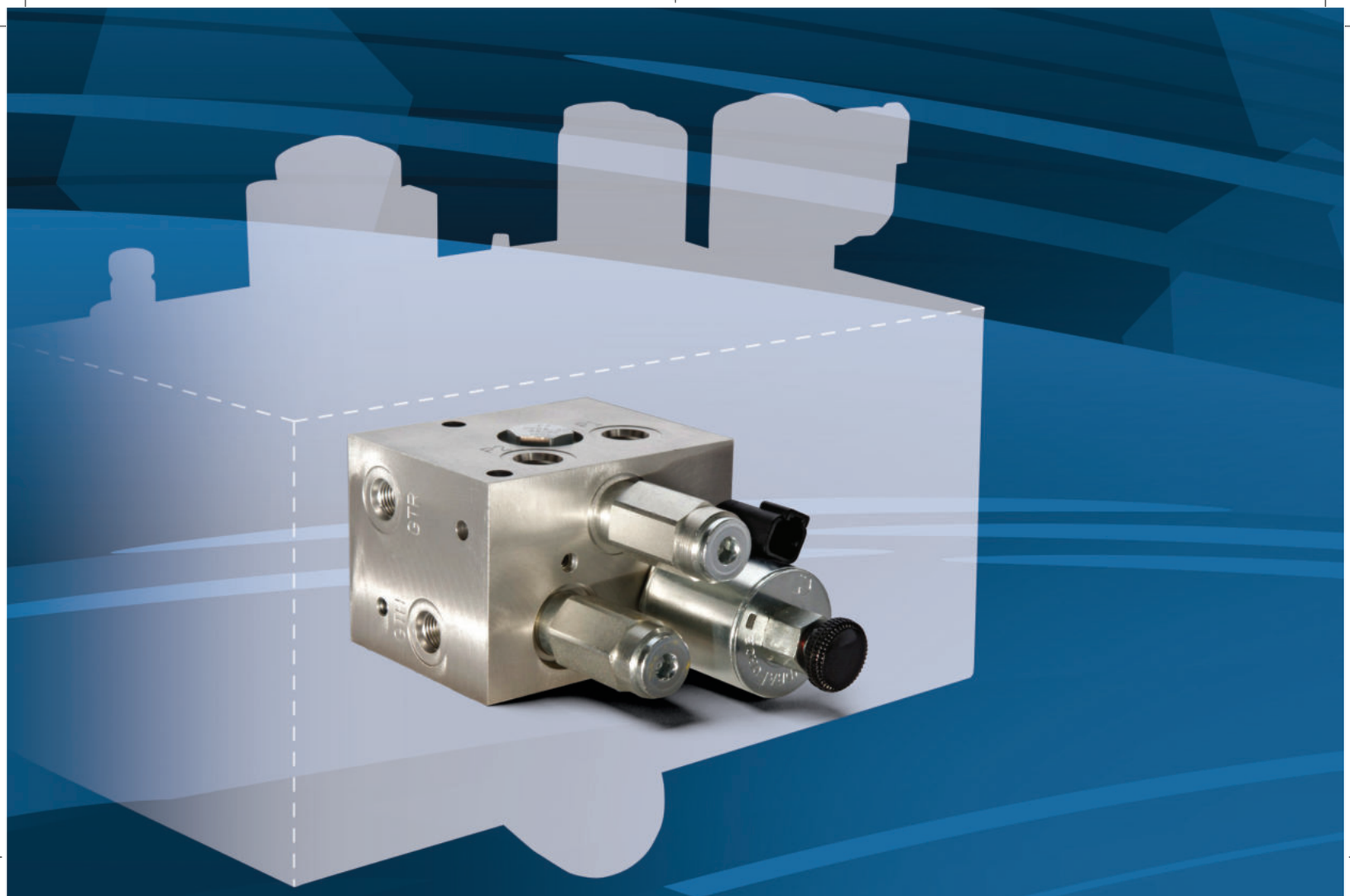
"I think what we're lacking in Europe is a really strong governance body," states Anders, slightly to my surprise. "In North America, you don't mess around with the EPA, or it will cost you a hell of a lot of money. We don't have anything similar over here, and sometimes you wonder if some of the competitors really are compliant, as we don't have anybody that checks this out. We'd rather see a strong governance body before they start talking about stage X, Y and Z.

"We face a consistent flow of all kinds of legislation, which creates complexity for us, because there are no global standards, even maybe regional standards. You need staff just to keep track of all this movement, and make sure the machines become compliant. It's a science in itself!"

It would be a nice change to go to an exhibition, I suggest, where OEMs are once again launching machines with incredible new technologies – rather than just engines compliant with the latest legislation.

"Yes, it's boring," he agrees, before adding hastily, "but it's important! It drives so much cost for us, but all of this compliance is for society's benefit, not for our customers, so the industry has been losing out on features that benefit the user. Now I would like to shift our resources to that sort of area – I have a long wish list that's been gathering dust!" **iVT**

CLOCKWISE FROM BELOW: **System integration is probably more important than cool new technologies; the 70-ton EC700B is currently Volvo's biggest excavator; the Terex TR100 is now Volvo's biggest hauler – meaning larger future trucks could require bigger excavators to load them; no, it's not Illya Kuryakin from The Man From U.N.C.L.E. – Anders has been getting his hands dirty at Volvo CE since 1978**



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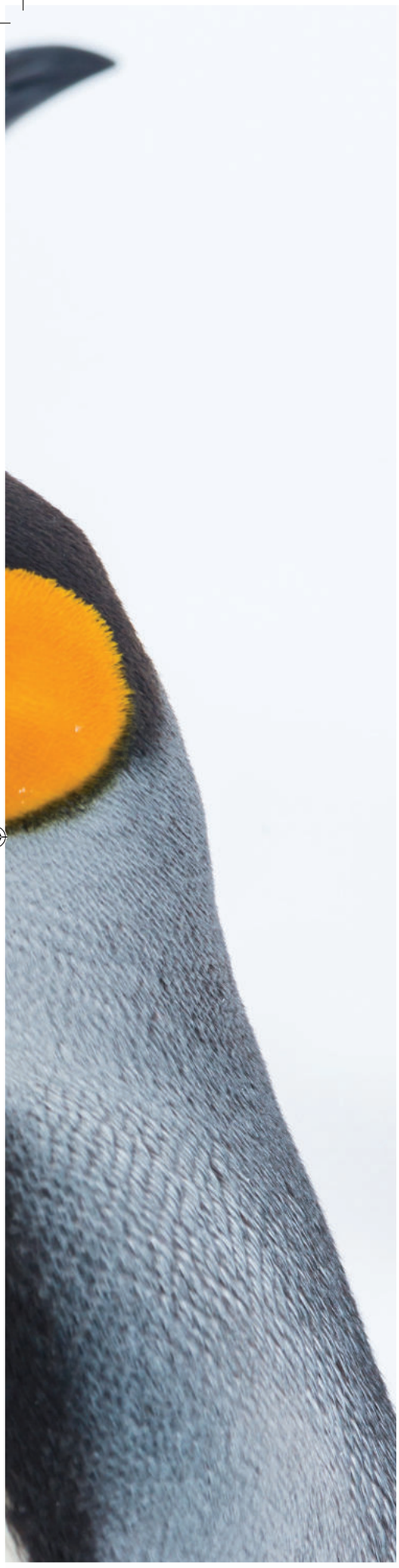
STEVEN CASEY, ERGONOMIC SYSTEMS DESIGN

LOVIN' A COLD CLIMATE

MACHINES CAN BE BUILT TO HANDLE SUBZERO TEMPERATURES WITH APLOMB – BUT IF OPERATORS AREN'T CATERED FOR EQUALLY WELL, PRODUCTIVITY AND SAFETY WILL BOTH SUFFER. IT REQUIRES A LOT MORE THAN FITTING AN EFFICIENT HEATING SYSTEM TO ENSURE THEIR ETERNAL HAPPINESS...



One of the most fundamental considerations in the design of any vehicle cab and operator environment is providing protection from cold temperatures and related environmental conditions such as frost, ice, snow, wind, water and condensation.

In addition to being stressful and uncomfortable, a chilly operating environment can degrade operator performance in a number of very important ways, to say nothing of the potential impact on health and safety. Understanding human sensitivities to cold temperatures and the consequences of exposure can help designers focus on vehicle features and functions that can act as countermeasures to extreme cold and its effects.

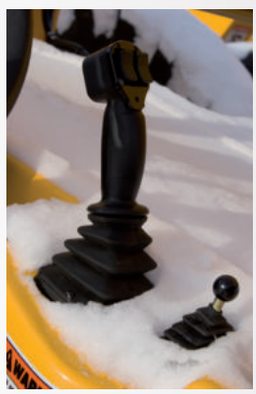
Don't get cold feet

Aside from the obvious impact a cold environment will have on human comfort, a cold work setting will also have deleterious effects on a range of human sensory, motor and cognitive performances. The hands and feet are among the first parts of the body to be affected by cold temperatures.

A measure called hand surface temperature, or HST, is the most common metric in the study of cold environments and human performance involving the hands. Cold temperatures can affect an operator's ability to feel and sense the exact position of a control or the actions of a machine through the hands, as well as impair the operator's attempts to control the vehicle with the hands and fingers.

The lowering of HST through low ambient temperature, windchill, ice, snow, water, or a combination of the above, has two primary effects. First, there will be a numbing of cutaneous sensitivity, which begins to occur when the HST falls to about 8°C (46°F) resulting in a loss of feeling in the hands and fingers. Then there is a rapid loss of skin sensitivity as the HST falls below 8°C, which will continue as the temperature falls.

The direct 'stiffening' effects of cold temperatures on the hands and fingers certainly play a role in this, but the condition is amplified by the body's natural protective response to cold, which is to pull warm blood away from the extremities in order to better insulate and protect the more critical core body organs.



TOP: **Walkways should be a major consideration, to ensure the risk of injury to service personnel is reduced**

ABOVE: **The choice of material for control handles can be crucial**

Without a controlled environment, or at least cold-weather gloves, the operator will experience a notable loss of sensitivity of the hands and fingers as temperatures migrate downward below 8°C.

Second, and in addition to a loss of sensitivity in low temperatures, the impairment of hand performance results from a loss of manipulative ability, which occurs between an HST of 12-16°C – somewhat above the onset of the loss of sensitivity at 8°C. Operators can experience difficulty operating the controls, especially joysticks and small keypads that require multidimensional or fine manipulation. Temperatures in and below this region can also reduce the grip strength of the hands – something to consider in the design of hand controls, handles, and stair and ladder handrails that might be used in severe cold.

Shivering is a natural response of the body to generate heat when core body temperature begins to fall. Although shivering results in a four- or fivefold increase in the production of heat by the body, this can result in obvious debilitating effects when the hands or feet are required for vehicle control or other psychomotor activities, including maintenance.

When core body temperature falls within the range of 33-35°C (91-95°F), mild hypothermia can set in, with symptoms including shivering, feelings of extreme cold, hunger, lethargy, confusion, muscle spasms, difficulty with motor tasks, slow reflexes and slurred speech.

COLD COMFORT

Moderate hypothermia occurs when the core body temperature falls within 30-33°C. Its symptoms may include a cessation of shivering, semi-consciousness, loss of memory, irrational behavior, and a slow and/or irregular pulse. Severe hypothermia occurs when core body temperature falls below about 30°C, and includes symptoms such as dilated pupils, a faint heartbeat and unconsciousness.

Obviously, with all of the above effects of cold, ranging from simple discomfort and numbness of the hands to severe hypothermia, it is far better to design a cab or operator environment capable of maintaining ambient operating temperatures of roughly 22°C (72°F) – and avoid these negative outcomes altogether.

How to prevent climate change

Aside from cold-weather clothing, a heated cab with temperature and airflow control is certainly the most common means of dealing with a frigid environment. Ideally, the operator should be able to easily control the temperature, airflow and air direction.

Speaking generally, most operators prefer to have warm air flow near the floor and feet than directly at the chest and face (the opposite is generally true for cold air generated by air-conditioning in a hot environment).

Thermostatic control of temperature, in which the operator sets a desired temperature and the system automatically maintains it at, or close to, this temperature is generally preferred over a manual system that requires an operator to continuously adjust an output temperature.

As a peculiar case in point from the marine environment, Russian nuclear-powered ice-breakers are known for continuously pumping heated air throughout all cabins on the ship – at all times of day and in all operating environments! There is no shortage of energy or heated air on board – however, there are no vent controls in individual rooms to reduce the flow of hot air into the room or stop its flow altogether.

The only solution for the poor occupant? If you are too hot, you open the porthole to the raw Arctic air outside; if you are cold, close it – at least until you once again get too hot not too many minutes later. Most occupants will therefore usually resort to bundling up and opening the porthole.

MAIN IMAGE: **For large machinery in particular, such as this Cat mining truck, it is important that snow is prevented from accumulating on walkways – or is easy to clear when it does**

ABOVE: **Bulkier than usual boots may call for wider spacing between pedals**

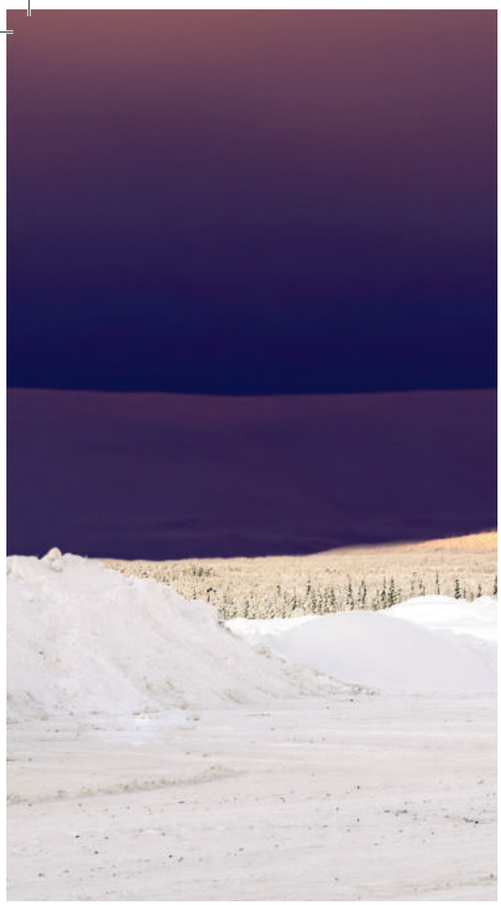
The ability to defrost windows and reduce the humidity from cabin air is another important aspect of environmental control in a wintry environment. Wet shoes and clothes, and melting tracked-in snow add humidity to the air, which must then be removed in order to avoid condensation on interior surfaces, dry out clothes and surfaces, and maintain operator comfort. Heating elements fitted in windscreens and windows, as well as mirrors, and control of airflow on glass surfaces, are also usually necessary in cabs that are operating in cold and wet environments. Vehicles that switch on remotely or automatically, and preheat the operator environment in preparation for the arrival of the operator, are not unheard of.

Heated seats have become a common feature in passenger cars and are also available with many industrial vehicle designs. As with overall cab temperature regulation, from the operator's perspective having total thermostatic control over seat temperature is generally far more preferable to simple on/off functionality. At the very least, steps in seat heating output, such as low, medium and high, would be more preferable to 'all on' or 'all off'.

One particular northern European car manufacturer outfits one of its luxury models with heated seats described by one automotive reviewer as "nuclear-powered bun warmers". Such capability might be desirable during dark Swedish winters, but perhaps not quite so necessary further south.

Feeling the heat

There is no shortage of devices and features that have been developed by automotive, motorcycle, truck



TOP: **For open-cab applications, such as this Pettibone telehandler, ensuring the information display is protected from the elements becomes important**

ABOVE: **There's snow virtually everywhere on this Cat ADT – but crucially not on the access steps**

and industrial vehicle manufacturers to address operator requirements in cold environments. Heated steering wheels, for example, have become more or less commonplace on luxury automobiles and are surprisingly well received by many users.

Experience in the marketplace and customer complaints strongly suggest that the entire circumference of the steering wheel rim be heated, not just limited areas, such as the 2 o'clock and 10 o'clock positions, as has been done by one manufacturer.

BMW began offering heated door locks some decades ago, a feature that would be much appreciated by anyone who has attempted to open a frozen or iced-over car door in the depths of a harsh Canadian winter. Heated windscreen washer nozzles have also been available for some years. Motorcycle manufacturers Harley-Davidson and BMW offer heated handgrips for their products, and numerous aftermarket suppliers sell all manner of battery-heated gloves, boots and clothing.

Surface conductivity

One aspect of the 'touch' interface that is often overlooked concerns not just the ambient operating temperature, but the temperature and conductivity of the element being touched by the operator. A handgrip or handle that's made of a conductive material such as stainless steel can have the same temperature as a handgrip or handle made of a non-conductive material such as wood, rubber or plastic. Due to its conductivity, however, the stainless-steel handle will inevitably impart its temperature to the hand more readily than the wood or rubber handle. If the handle is cold, it will feel much colder than a non-conductive handle, and if it is hot, it will feel much, much hotter than the non-conductive handle.

This phenomenon becomes of particular concern in a hot operating environment when conductive hand surfaces are literally too hot to touch, but it can also be an issue in a cold environment where the conductive surface will feel much colder than the non-conductive surface – even though they actually are the same temperature.

Wherever I lay my hat...

An often overlooked design element associated with industrial vehicles operating in Arctic environments concerns the space – not to mention the extra storage space – needed to accommodate the additional cold-weather gear of an operator.

The 95th percentile male shoulder circumference increases from 124.2cm under normal circumstances to 151.5cm when wearing 'Arctic' clothing, something that is vitally important for seating and cab sizing. Chest depth increases from 26.7cm to 32cm, and 95th percentile shoe length increases from a norm of 21.5cm to a length of 23cm when a heavy winter boot is taken into account. Heavy gloves and winter mittens can not only impair the operation of manual control inputs, but they can also require additional spacing around controls.

Once inside and acclimated to a nice warm cab, many operators will soon remove their heavy outerwear, especially coats and gloves. A place to hang a heavy coat well away from the operator's lines of sight to the outside work environment is therefore usually called for.

It's not just the cab

Operating an industrial vehicle in a cold environment typically involves activities outside the confines of that nice warm cab. Steps, ladders, stairs, walkways and work platforms should be designed with inclement weather in mind, including snow and ice. Can any snowfall be removed easily, or, better yet, not accumulate on walking surfaces at all through the design of the tread – or even heated surfaces? Is there a need for overhangs or other structures to protect work or access areas from snow or rain? Do structures over the doors or walkways funnel melting snow or ice (and especially falling snow or ice) away from the operator below?

These issues can be particularly important to consider in surface mining applications where large machines work around the clock in nearly every environmental condition imaginable.

Considering the discomfort and loss of manual dexterity that can be experienced when working outside in the extreme cold, designers must always ask themselves if there is a way to make the task easier, less demanding of fine manipulation or adjustments, or even just faster, so as to minimize the exposure in the first place. It could even be argued that the best countermeasure for operating an industrial vehicle in the extreme cold is to avoid the exposure in the first place. **iVT**

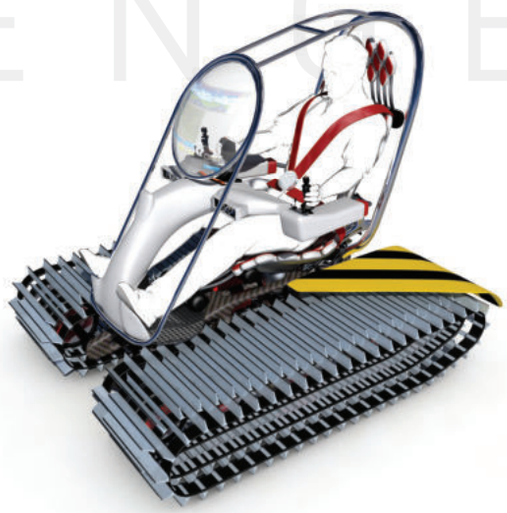
For further information, contact: **Steven Casey,** 5290 Overpass Rd, Suite 105, Santa Barbara, CA 93111, USA | Email: scasey@ergonomicsystemsdesign.com Web: www.ergonomicsystemsdesign.com

DC DESIGN

DEVISE AN IMPROVED DESIGN FOR ANY VEHICLE THAT TRADITIONALLY WORKS IN EXTREME COLD-WEATHER CONDITIONS

TOP: ***Better grip and stability on side slopes is provided by the ability of the tracks to tilt on their longitudinal axis***

ABOVE & RIGHT: ***A mini groomer – for rescue purposes – can go where the main machine would struggle***



A STRUCTURAL VIEW

Lumede/Oliver Becker

Lutz Meyer and Oliver Becker graduated in industrial design from the Muthesius Kunsthochschule in Kiel, Germany. They have worked on several projects for Atlas Weyhausen

The basic idea for our design was the need to improve the structural and ergonomic performance of snow groomers in alpine or similar mountains, in traditional applications such as preparing the slopes, transport of goods to remote places and search-and-rescue operations. We did not interfere with the powerplant, retaining the usual diesel engine and hydraulics, but instead concentrated on finding new ideas for structural and ergonomic improvements.

Firstly, to improve the traction and grip, we made the two banks of tracks able to tilt on their longitudinal axis, so as to keep more of the tracks in ground contact on uneven terrain.

The winch, which is usually mounted on the rear transport platform, has been divided into two components. The cable drum and the motor are located beneath the cabin, putting their weight closer to the ground. The winch arm is mounted on a circular structure on top of the cabin and can rotate freely through 360° without the risk of the cable harming the structure or personnel. Our groomer is also equipped as standard with an additional mini groomer, which is capable of reaching sites in extreme terrain, where the large machine cannot go. Its main purpose is for the rescue of injured persons.

Several ergonomic improvements have helped to enhance visibility. To provide a better view, we made the cabin circular, with windows all around. We also created a rooftop window, as in mountainous areas it can be important to have a good view overhead.

The cabin has three 60° rotating doors to provide easy access to the left, right and rear (the carrier platform). Sliding doors have the advantage that – even with strong winds – they cannot slam or move involuntarily.

Better night-time visibility is guaranteed by the circle of spotlights clustered around the top rim of the cabin – these can be activated together, or one section at a time, from the cabin.

The cabin is large enough to contain three seats in the front, while in the back it has space for two stretchers. The back door is used to admit the stretchers, which are stored on a post at the rear of the cabin. In the event of a rescue, they can be lifted by the rooftop winch.

The driver's seat is positioned further forward than those to the left and right, so as to provide the best view. Furthermore, it can be tilted by up to 20° to either side to improve comfort and security while working on slopes. All instruments use a head-up display in front of the driver, which inclines together with the seat. The seating cushions are made from a number of single elements, to allow damp clothing to breathe and dry.

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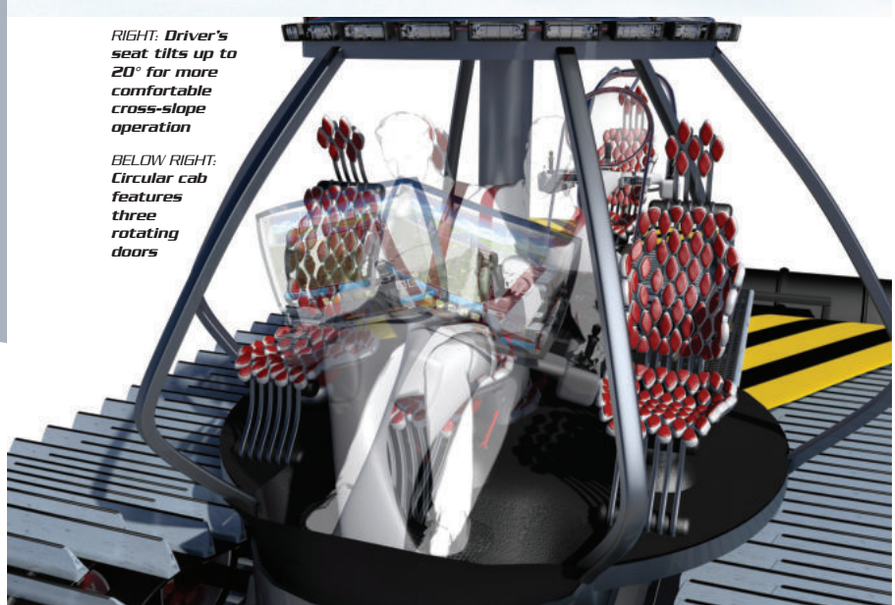
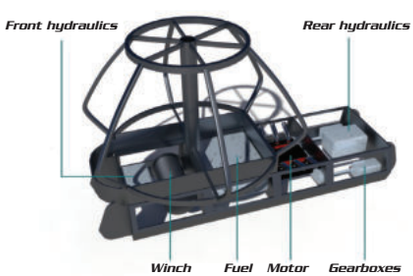


RIGHT: ***Driver's seat tilts up to 20° for more comfortable cross-slope operation***

BELOW RIGHT: ***Circular cab features three rotating doors***



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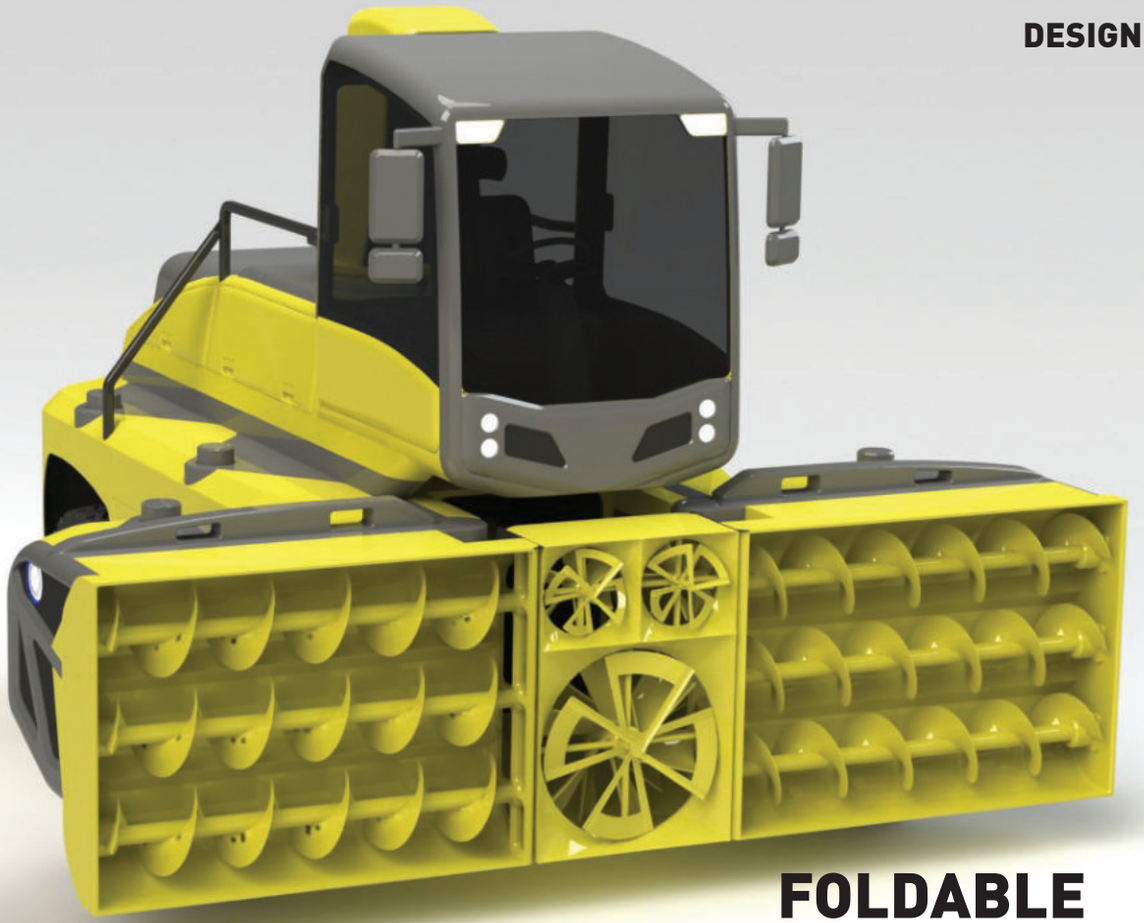

FOLDABLE SNOW BLOWER

TOP & ABOVE: ***Three front elevations highlight the snow blower's transition to work mode from its configuration for compact storage***

LEFT: ***The rear-mounted chute enables an unrestricted view to the work area ahead***

Javier Gutiérrez Casal

A freelance mechanical design engineer based in Pontevedra, Spain, Javier has worked for many companies specialized in the development of industrial equipment

One machine that invariably works in extreme cold weather is the snow blower. Looking at such a machine, you can clearly distinguish two parts: something that resembles a meat grinder on the front, and an industrial vehicle that is adapted to perform the function of supporting structure.

My design, in which all the traditional elements of a snow blower are integrated, enhances safety, maneuverability and efficiency with the capacity to remove 50% more snow. It also means that the vehicle occupies less space when not in use.

This 6x6 vehicle is powered by two diesel engines – one powering the transmission, steering and suspension system, and the other, the hydraulic system that drives the snow blower attachment. All wheels are driven by electric hub motors and steered by electric motors and a reduction gearbox situated on top of the articulated single-arm suspension system. The wheels can be steered independently and the ground clearance of the vehicle is regulated by hydraulic cylinders placed in each articulated single arm, which can modify the distance and angle between the attachment and the floor.

The front attachment consists of two halves, each housing the augers and auger housing. Each of them is moved by a hydraulic system that governs the positioning of the front wheels, placed tangentially to the trajectory described by each half. When the system is completely open, three drives will be positioned between the two halves to move the snow displaced by the augers and blades to the launcher barrel. Under the cockpit there is a fourth impeller to assist the movement of the snow. This configuration, where the articulated chute is located behind the cab, will not hinder the driver's vision when the snow blower is at full steam.

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DOUBLE WHAMMY

Pope Design

Jon Pope has designed heavy equipment for over 17 years. He has worked for a variety of off-highway OEMs, whether as an independent design consultant or employed by Teague

This dual articulating, dual snow blower is designed for clearing runways and ice roads, and as I was able to keep the overall height to just under 14ft, it could also be used on most major US highways and many major secondary roads. When used in single snow blowing configuration, the rear snow blower tucks under the frame and follows behind the front snow blower. When the machine is used in dual configuration, the rear snow blower swings out to enable the clearing of a 24ft-wide path in one pass.

It's all diesel electric (including the lift actuators for the auger and impeller), with a powerplant in the front chassis and an identical one in the rear chassis, so it's a much simpler system with almost none of the torque loss that would result from hydrostatic motors and pumps.

Because each wheel assembly has its own traction motor, this enables the use of independent suspension and removes the need for a solid axle, which allows the engine to sit much lower in the frame to help bring the overall height down. It also allows each wheel to turn at a different speed when the unit articulates, which helps traction, control and tire wear. The independent suspension also eliminates the need for a trunnion in the upper frame to allow the machine to 'flex' while using the on and off ramps. It can also turn 180° in place by rotating both chassis and the cab at the same time and counter-rotating the drive wheels simultaneously.

The upper catwalk spreads the load around the thin middle section of the upper frame to allow the cab to sit lower in the frame so as to keep the overall height down.

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ON THE WEB

For more detailed explanations, extra images and desktop wallpapers, visit:
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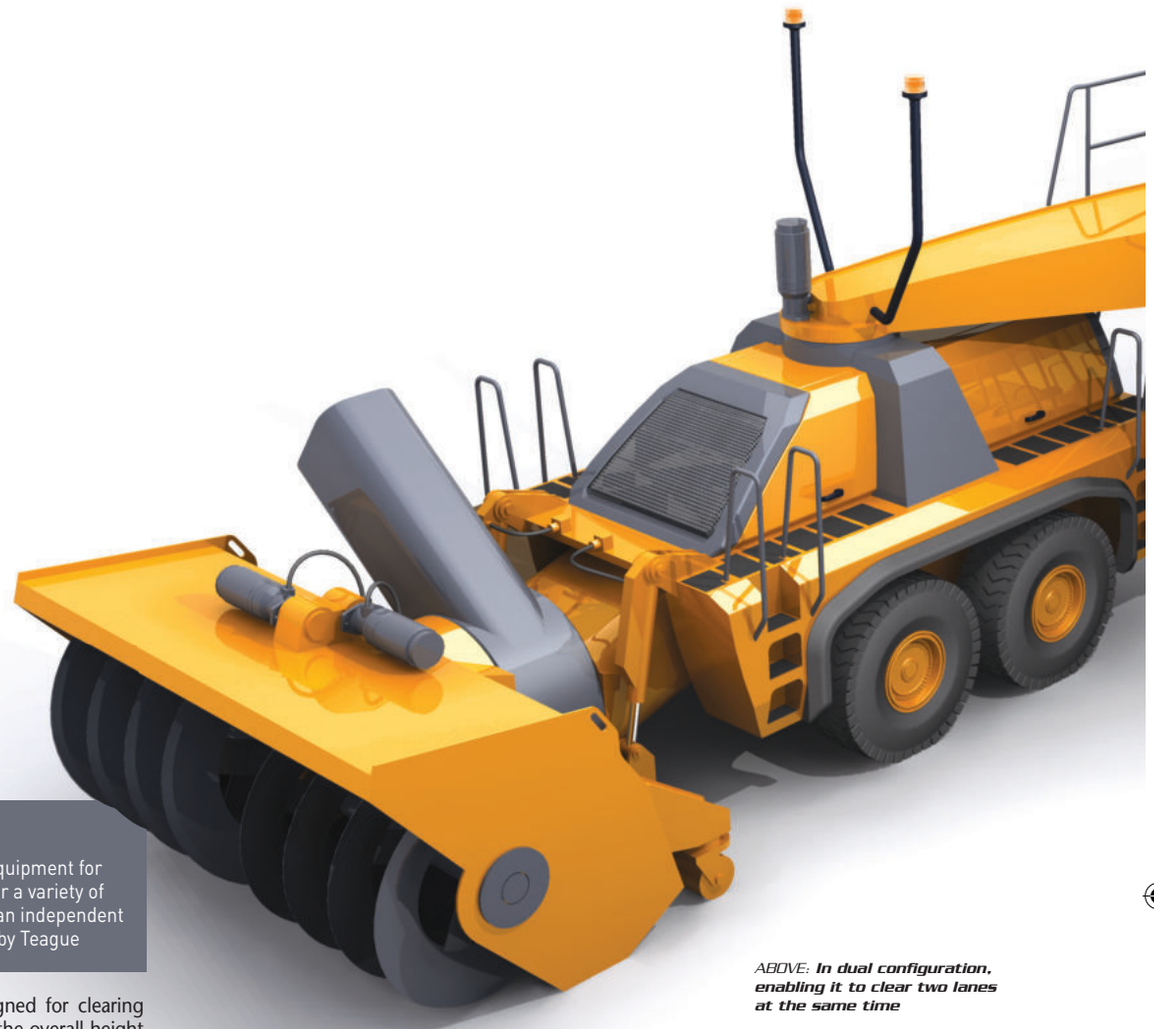
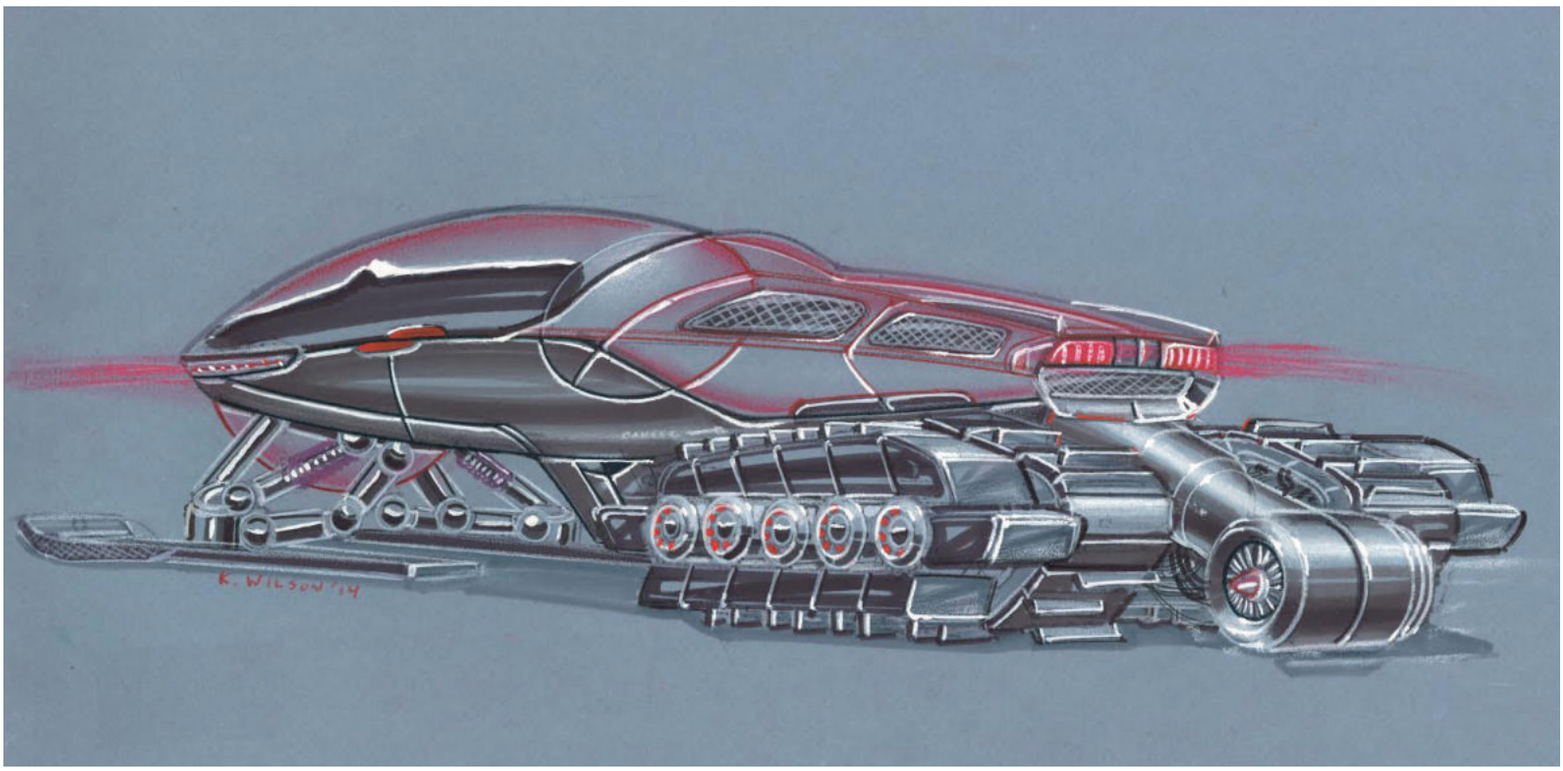


ABOVE: ***In dual configuration, enabling it to clear two lanes at the same time***

RIGHT: ***With turn-on-a-dime levels of maneuverability, the snow blower's huge size doesn't cause too many problems***

BELOW: ***Center-mounted cab allows for 360° visibility – no matter what direction the machine is traveling in***

Check out another two of Jon Pope's exclusive winter designs at our online Design Challenge archive



THE SNOW SCOUT

Kevin Wilson

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

The Snow Scout is my concept for an amphibious machine for operation in arctic/cold weather environments. With the ability to adapt to a variety of surface conditions, including solid ice, ice/water mixtures, shallow water and other unimproved surfaces, it would be ideally suited for scouting, utility or rescue operations.

On solid surfaces, its inner tracks, powered by independent electric motors on either side (to assist with steering), enable it to traverse snow and ice. Two detachable outer tracks coupled to the inner track frame utilize hollow treads that can be filled with air or foam. These treads separate from one another into individual flat panels that propel the Snow Scout forward, similar to a paddleboat. This idea was successfully demonstrated by the DARPA CAAT (Captive Air Amphibious Transporter) concept in 2012. A clutch between the drive sprockets of the inner and outer tracks enables the machine to selectively engage the floating tracks in shallow water/ice as needed – see www.youtube.com/watch?v=aAxpJNI5u4Q

Similar to modern electric vehicles, battery cells would be strategically placed throughout the vehicle chassis for optimum weight distribution, along with buoyant foam for flotation. Steering in shallow/icy water is accomplished with the help of a retractable tail thruster that can pivot about a central axis. The steering/front suspension borrows elements from a typical snowmobile setup, along with providing attachments for a number of work implements such as shovels, plows, blowers, etc. Specially designed front skis assist in the transition from water to land, while a hidden winch (to protect it from the elements) and high-powered halogen lighting are placed around the driver's cabin for added utility.

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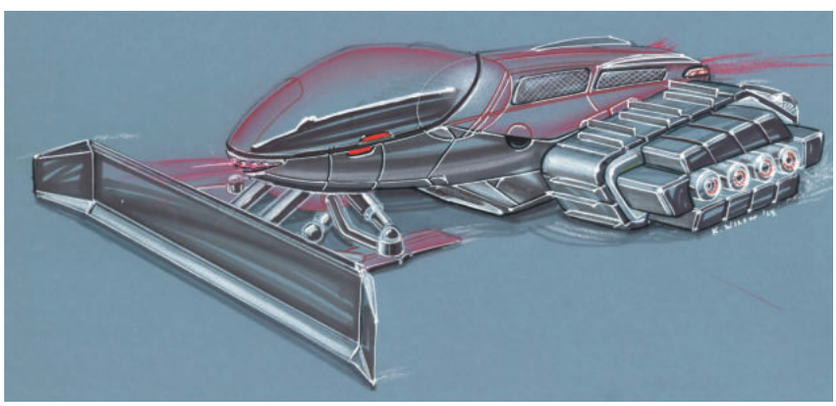

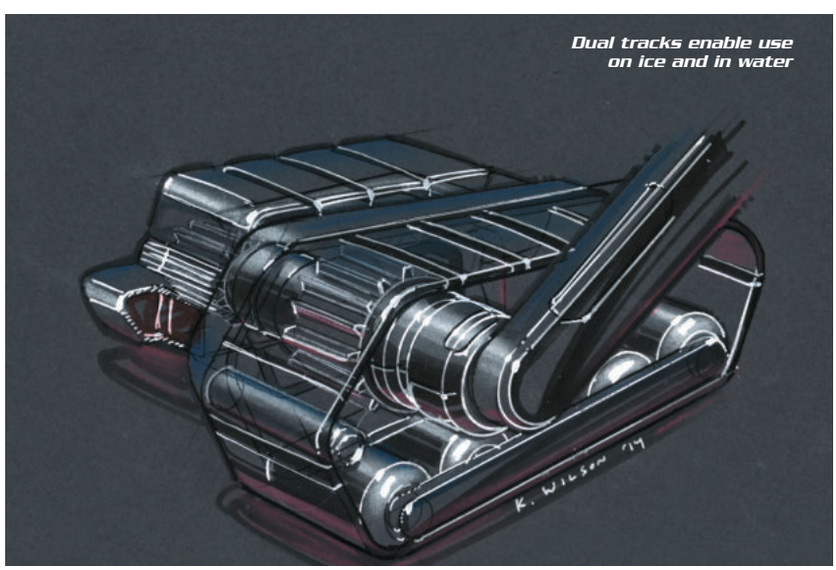

Dual tracks enable use on ice and in water

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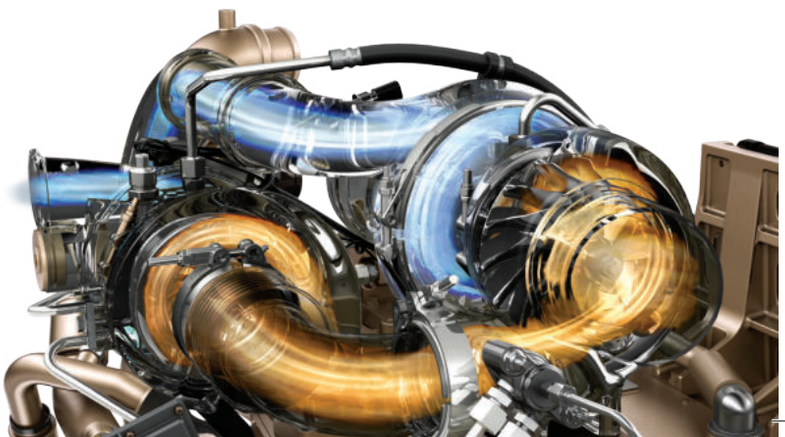


HAMON STEWART, IVT INTERNATIONAL

BEST **IN SNOW**

PRINOTH HAS EVOLVED ITS ALREADY PROVEN LEITWOLF SNOW GROOMER INTO AN EVEN MORE IMPRESSIVE MACHINE, PAYING CLOSE ATTENTION TO OPERATIONAL DEMANDS AND IMPROVING PERFORMANCE LEVELS

Extreme operating conditions for industrial vehicles demand exceptional solutions and present considerable design and engineering challenges if a machine is to operate successfully in difficult surroundings.

Snow groomers are machines tasked with the compaction and smoothing of snow for recreational purposes and are needed to prepare pistes and cross-country trails, and even to profile courses such as half-pipes – often in extremely cold temperatures. A variety of suitable conventional vehicles, including snowmobiles and SUVs, can be fitted with attachments for these tasks, but modern purpose-built snow groomers offer considerably wider potential and outstanding capability.

Italian company Prinoth – a subsidiary of the Leitner group – manufactures snow groomers at its facilities in Italy and Canada. With its corporate headquarters in South Tirol in Italy, Prinoth has expanded to also now produce tracked utility vehicles in Canada for use on snow and elsewhere, as well as tracked vehicles for forestry and vegetation management from its facilities in Herdwangen, Germany.

Working in a winter wonderland

The company is now producing the second generation of its well-proven Leitwolf snow groomer, which rises well to the challenges of winter.

Andreas Muigg, Prinoth's head of program and product management, comments, "The engine and the aftertreatment system has to cope with a standard temperature range of -30° to +25°C and an altitude of up to 4,000m above sea level. In special cases, in response to customer request, the operational temperature range can be extended down to -50°C. A heater is fitted as standard for the engine and another for the oil tank, both powered via an external power supply. There is also a bypass inside the oil cooler for low temperature start-up to reduce backpressure."

"THE SELECTION OF THE LEITWOLF'S ENGINE WAS MAINLY CONCERNED WITH EMISSIONS, POWER, AND MATCHING THE ENGINE TO THE VEHICLE SYSTEMS"

With final drives sourced from Lohmann, the Leitwolf is powered by the Mercedes-Benz 12.8-liter six-cylinder OM 460 LA engine, rated at 2,200Nm @ 1,300rpm and 375kW (510hp) @ 1,800rpm, and featuring turbo diesel direct injection and intercooling, fully electronic engine management and a high-pressure injection system with individual injection pumps.

Muigg explains, "Most production engines from leading manufacturers are generally capable of dealing with the temperatures our machines work in. So the selection of the Leitwolf's engine was mainly concerned with emissions, power, and matching the engine to the vehicle systems."

Prinoth proudly states, "With the latest SCR technology… the Leitwolf [was] the world's first production vehicle to meet the new Euromot IIIB/Tier 4i exhaust emission standard… fine particle emissions have been reduced by 90% and nitrogen emissions by 50%."

And all this with a simultaneous reduction in fuel consumption. While the fuel system doesn't incorporate any components specifically for cold-temperature operation, the OEM specifies the grade of diesel it requires as EN 590, ASTM D975 N.1 D, MB 137.0; MB 137.1.

ABOVE: **New fenders in a modern design prevent snow from the tracks being thrown over the tiller**

RIGHT: **The 12-liter Mercedes-Benz engine gave Prinoth a headstart to meeting Tier 4i, but the fuel system requires no modification for cold-weather operation**

AdBlue crystallizes at -11°C, but as it is only used in the aftertreatment system, this should not affect the cold-start capability of the engine. However, its exhaust gases will not be fully processed by the aftertreatment system until normal operational temperatures are reached. Muigg comments, "There are pipes inside the AdBlue tank around the suction point which are heated by the engine coolant, needing in the very worst scenario only a short time to fully liquefy the AdBlue."

The cooling system has, of course, been designed with particular attention to the intended operational environment. Comparing summer storage requirements with those of non-winter vehicles over the winter months, Muigg confirms, "There are no special requirements in the storage of the Leitwolf during summer."

Cold light of day

Regarding adverse cold-temperature effects on belts and hoses, Muigg says, "Effects from UV light are more of an issue than movement as most of the high-pressure hoses on the Leitwolf don't really move, so those that aren't shielded under bonnets and so on must be resistant to UV light."

Hydraulic hoses and a few other hydraulic components are supplied by Eaton and Alpha Gomma. The hydraulic oils have been selected for their suitability, including lower viscosity, and Muigg reports that there are no problems with the Leitwolf's hydraulics in the cold.

He also comments, "The new Bosch Rexroth series 40 pumps offer higher oil-flow volumes, meaning the engine can therefore be used in the lower rpm range without reducing working speeds. This further reduces fuel consumption."

Prinoth has also improved the pipework of the vehicle for better power transmission, he explains:

"Together with colleagues on the production line, customer service and R&D, we had a review of our activities to optimize the routing regarding accessibility and reducing flow loss. This has now resulted in a better efficiency of the powertrain of about 2%."

Prinoth specifies the required hydraulic fluid to be Dexron III, Dexron II, Type F, Type A Suffix A or Panolin HLP Synth 46, York Bio 777 VG 46 and, for the transmission oil, synthetic gear oil PAO basis, viscosity: ISO 220, SAE 75W 90 or 75W 140, API GL-4 or GL-5.

The principal materials used are case-hardened steel and aluminum, with other materials selected where required according to their resistance to the cold. Muigg points out that standard, off-the-shelf components have generally been selected, provided they meet the specifications, and adds, "Adhesive and rubber were chosen according to the operational temperature range, but the other materials used are relatively normal. Plastic components sourced from suppliers are already designed to function properly in the intended cold temperatures."

He continues, "The vehicle's paint is a special powder coat according to our own internal specifications to avoid early abrasion and rust on the main steel components. For special components, such as the tiller, an anti-stick paint is applied to avoid snow accumulation."

The unbeaten tracks

Muigg explains that the machine's 4.5m-wide track design features a series of 'ice picks' for additional grip to avoid side-slip on extreme slopes: "The Leitwolf is designed to be able to travel at up to 45° in any direction, although it's always best to minimize travel that involves a sidewards angle of 45°. The oil sump is specially designed to deal with any angle of up to 45°."

He clarifies further: "To deal with the difficult types of snow, the shape of the crosslink, as well as the track pitch, is important for driving characteristics – climbing uphill, as well as stability going downhill. A challenge is the ice build-up on the crosslinks of the track which can compromise the driving behavior.

"To avoid this, we implemented a 'spoiler' at the front of the cabin and a drop lip made from rubber under the side windows to drain the melted water away from the tracks. Additionally, a rubber curtain keeps away at least part of the snow dust from the warm elements of the coolers, so we minimize water dropping onto the tracks again."

The track's contact surface can also be adjusted by a simple raising or lowering procedure. Decreasing the amount of working surface improves maneuverability, while increasing it improves the vehicle's climbing ability and thrust, which is further improved by the Leitwolf's low center of gravity.

LEFT: **A perfect view is provided from the center seat, while the cabin can be accessed from either side**

WINCH MOB

The Leitwolf features a winch with manual or automatic control that provides up to 4.5 metric tons of tractive force. Muigg explains that the winch rope is "well-developed and proven standard steel cable, and was developed in partnership with Teufelberger. It's available in several lengths up to 1,200m and has a diameter of 11mm and a breaking load of 150kN."

Taking center stage

Hydac supplies the main vehicle suspension as well as the cooling system, while cab suspension is from Sachs and AMC. Muigg elaborates: "The Prinoth concept of a center-seat cabin results in an engine installation behind the cabin structure. To ensure efficient noise insulation, damping material has been applied on the rear wall of the cabin and inside the structure. Vibration level plays a major role in the operator's comfort, and a shift in the groomer can last eight hours.

"So we tried to isolate the cabin from the vibrations created by the undercarriage with tracks. In order to identify the relevant frequencies in the different working speed ranges, both simulation tools and real measurements were used during the development phase to find the best suspension for the front and rear mountings.

"In addition to this complex task, the behavior of the damping elements has to be constant through the whole temperature range. This requires a close and continuous partnership with the supplier of the damping elements. We optimized not only the 'symptom' in the cab, but also the source by positioning

LEFT & ABOVE: **The wider blade ensures greater thrust and makes the Leitwolf 45cm wider than other models in its class. Its teeth facilitate the breaking up of ice and snow and increases the efficiency of slope preparation**

the running wheels in the best way for the specific distance between the crosslinks of the track."

Current events

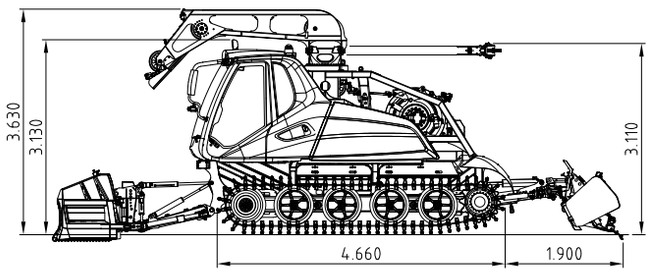
In very cold temperatures, batteries provide reduced power output – a situation compounded by the increased power requirement to start an engine. The Leitwolf's operating voltage of 24V is supplied by two 12V 180Ah batteries, providing a starting capacity of 1,000A.

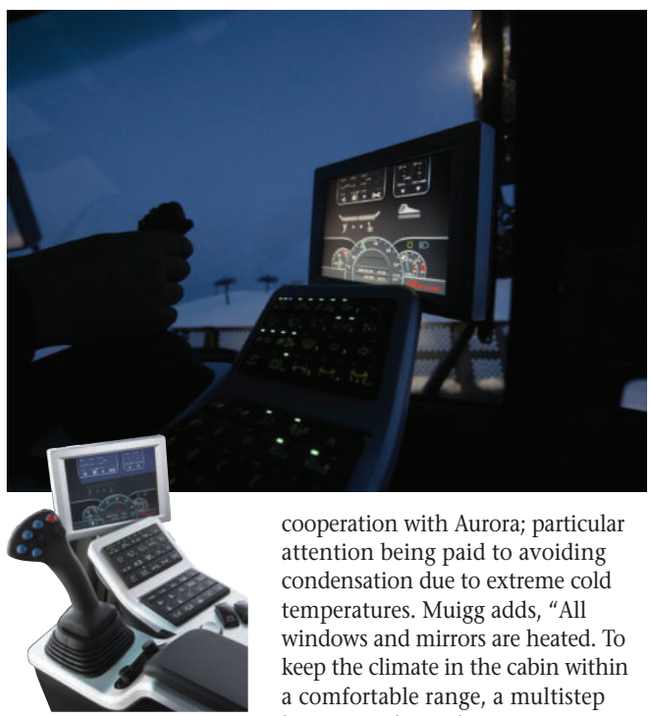
"We vary the batteries we use from time to time and they generally come from the commercial vehicle sector. We select them according to price and reliability," adds Muigg.

While a heated rearview camera is provided as standard on a winch vehicle and as an option on the solo vehicle, he advises that the Leitwolf's electronics in themselves are not affected by the cold. Prinoth's datalogging software, named Resource Management, records the most important vehicle parameters and then analyzes them to generate reports, including the total cost of ownership and technical reports to improve usage times and highlight usage patterns to the owner, so as to identify possible ways of improving usage efficiency.

Lighting is supplied by Hella and others. Muigg highlights that hot lights cracking in extreme cold is no longer an issue – so halogen lamps, where used, will still get hot but are designed to be reliable, with cooling fins to deal with all thermal issues.

The heating, ventilation and air-conditioning has been developed in cooperation with Aurora; particular attention being paid to avoiding condensation due to extreme cold temperatures. Muigg adds, "All windows and mirrors are heated. To keep the climate in the cabin within a comfortable range, a multistep heating and ventilation system is installed as standard. To ensure the functionality, the cabin was CFD-calculated and finally tested in a climate chamber before going into full production."





ABOVE: **The 8.4in transflective display is easily legible, whether in direct sunlight or at night-time for an easy view of all information. A multifunction joystick enables one-handed control of the main vehicle functions**

The main vehicle functions are controlled by two left-hand joysticks for the two tracks, while the right-hand joystick adjusts the attachments.

Regarding design challenges or achievements relating to the cold, Muigg says, "Perhaps the most important topic is the view for the driver. The vehicle has to deal with snow fall, snow dust, snow balls thrown by the tracks, ice… and especially the window heating and the heating system inside the cabin has to ensure a clear view. The temperature gap between inside and outside boosts condensation, so additionally the humidity in the cab has to be controlled by the system."

Snowed under

Muigg's views on the future are cautiously optimistic: "The business sector faces increasing cost pressure. Our goal is to offer an integrated solution for the customer – this, of course, includes, an efficient snow groomer with the minimum of downtime, but in addition it is becoming increasingly important to help skiing areas with additional aftersales support and management and training services."

Prinoth has evolved the already proven Leitwolf into an even more impressive machine, paying close attention to operational demands and actual performance – and for a specialized vehicle such as this to function effectively in very harsh conditions, additional attributes are clearly required and unusual challenges need to be overcome.

For Prinoth, the proof is in the Leitwolf's continued success in action at sites throughout the world. **iVT**

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JOHAN SJÖBERG, iVT INTERNATIONAL

THAR SHE BLOWS!

CO-DESIGNED WITH THE SAME AGENCY RESPONSIBLE FOR THE KOENIGSEGG SUPERCAR, ØVERAASEN'S AWARD-WINNING TV1000 SNOW BLOWER BOASTS STUNNING LOOKS, AS WELL AS SOME GREAT ENGINEERING AND A FRIGHTENING AMOUNT OF HORSEPOWER

Few industries take snow clearing as seriously as airports. Flights must run on time, regardless of how – and in what quantities – the white stuff chooses to come down. In an effort to help airports keep runways and taxiways clear during the winter, the Norwegian OEM Øveraasen has developed its Performance Line of snow-clearing equipment – while adding some much-needed style to what is often dull and boxy airport equipment.

"We wanted the exterior to reflect the quality on the inside," explains Øveraasen's R&D manager Jan Ivar Thorsrud, reflecting on the TV1000 snow blower. Its futuristic design, which has earned the company an Award for Design Excellence from the Norwegian Design Council, was developed together with Eker Design, perhaps best known for its work with the Swedish Koenigsegg supercar.

The flagship of the Performance Line, which also includes a range of sweepers, the TV1000 is capable of shifting 6,000 metric tons of snow per hour. The machine is based on the TV2000, which, with more than 2,000bhp of engine power, and a capacity of 12,000 metric tons per hour – equivalent to two passenger cars every second – is the world's largest self-propelled snow blower.

"The TV2000 was designed for airports with fast turnaround times and very heavy snowfall. So when designing the TV2000, we used the most appropriate technology to achieve the best solution for such conditions, without compromises," says Thorsrud.

"Now, with the TV1000, we are making similar technology available to a wider market," he continues. "So, here, some of the more costly solutions used in the TV2000 have been replaced with more conventional

The TV1000's powerful impeller throws the snow up to 50m sideways

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STYLE IN THE SNOW

Bård Eker, managing director of Eker Design, explains the thinking behind the design process of the TV1000 as part of the Øveraasen product line.

The TV1000 was designed from the inside out, which meant taking into consideration the function and positioning of the internal system and components. During the shaping process of the outer shell there were several features to be taken into consideration. We wanted a clean surface to avoid ice build-up on the shell, as the engines create a high degree of heat which should not be transferred to the shell due to problems with the melting and freezing of snow and water. Therefore the internal heat transportation was simulated and sorted out before we started the external design process.

The aerodynamic styling should also help the wind to clean the outer surface, so the exhaust system and other technical features were therefore kept inside the body. Internal ventilation was also a steering parameter for the design, and plays a part in the visual aesthetics. All lights have been positioned at a high level to be easily seen by the following truck drivers when units are operating close behind each other on the runway.

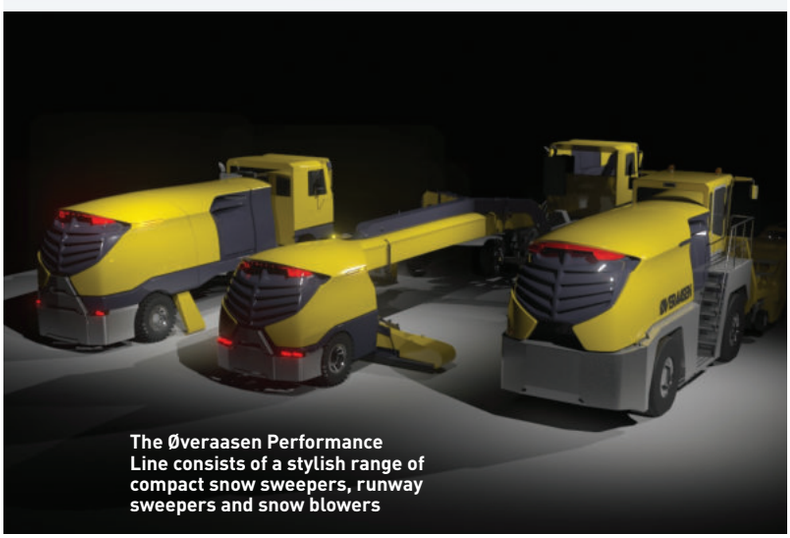
Corrosion issues with steel materials have been avoided where possible to eliminate downtime and reduce high maintenance costs. We wanted to use internal parts as part of the exterior where appropriate, which meant enlarging the fuel tank all the way out to the outer surface. We also wanted these parts to be corrosion-free and environmentally friendly, which led to our choice of recyclable composite materials.

To obtain a common design language between Øveraasen's future product line, improved efficiency of production and logistics, and to lower the investment costs, we wanted to build the whole product palette based around the same module system. The TV1000 is a product based on this module system and uses the same main cover as the RS-series. It was crucial to design this without losing each product's uniqueness and for each product to have a strong design statement without losing any aesthetic quality due to the reuse of common components.

Production line efficiency was a very strong driver through the project, which meant the new design should contain far fewer components than before, and the use of subassemblies should be preferred on the production line. Correct implementation of this will also improve the service, spare part and aftermarket situation.

Design-wise, we presented three different design-shape variants of the same internal design concept: one proposal with an estimated lifetime of five years; the second with a 10-year estimation; and the third with a 10+ year view. Øveraasen chose the latter, with the knowledge that its futuristic design language could well make it harder to convince the traditional marketplace. However, so far, this seems be have been the right choice with the majority of feedback on the design being extremely positive.

All the above was vital in obtaining a lower cost of ownership, and the long lifetime of design and materials as well as the aesthetics.



The Øveraasen Performance Line consists of a stylish range of compact snow sweepers, runway sweepers and snow blowers

Øveraasen has gone to great lengths to ensure that maintenance can be carried out simply and safely. On the TV2000, both side openings and the rear part of the cowling (i.e. radiator grille) can easily be opened using the hydraulic system. The grille turns into a staircase when lowered, with handrails that can be raised alongside. When opening the sides, working platforms and railings emerge

technology. The result is a machine that clears snow efficiently and at high speed at airports with moderate snowfall. So for instance, TV2000 is used at Oslo Gardermoen Airport, located at some altitude and with high snowfall during the winter; while TV1000 is used at Stockholm Arlanda Airport, which has a more coastal climate," he explains.

A clean sweep

Airport runways are cleared of snow using teams of snow plows – known as 'sweepers' in airport terminology. At Arlanda Airport, for instance, 8 to 10 sweepers cover the width of the runway, driving abreast (see *Runway success*, p39). In this fashion, 3.3km of 45m-wide runway can be cleared of snow in less than 10 minutes.

The primary purpose of the large snow blowers is to remove the windrow created by the sweepers, preferably at the same speed as the sweepers and at the same time. In addition, at some airports, sweepers are unable to go right to the runway's edge for risk of damaging the landing lights fitted in the ground. The snow blower's powerful auger chews up the snowdrift formed by the sweepers and throws it up to 50m sideways.

The high capacity of Øveraasen's snow blowers ensures they can keep up with the rest of the snow-clearing team, which clears snow at a pace of about 25-40km/h, with travel speed decided by the team leader driving at the front of the snow-clearing vehicles. If the snow blower falls behind, the team leader can choose to slow down the team or allow the snow blower to finish off on its own. A less powerful snow blower may not be able to finish in the time slot allocated by the control tower and could be forced to go out again later, by which time more snow might have fallen. With the powerful snow blowers from Øveraasen, this scenario is avoided and the runways can be cleared more efficiently.

Big beasts

The TV2000 measures 11.5m in length and 3.5m in width, weighing in at just under 40 metric tons, while at just under 11m and with a weight of 32 metric tons, the new TV1000 is slightly smaller. Both can clear snow up to 2m deep and a width of 3.4m, including wet or icy snow, with a throw length of up to 50m – though these maximum parameters cannot all be achieved simultaneously. The actual workload is decided by the driver, with compromises having to be made to adjust the output to the circumstances. But given the same conditions, the TV2000 will work its way through a snowdrift twice as fast as the TV1000.

In addition to its more stylish exterior, the TV1000 also features a 'flying cab' that can be moved in the lengthwise orientation of the vehicle, enabling the driver to choose the most appropriate position for the driving conditions.

RUNWAY SUCCESS

Stockholm Arlanda Airport aims to stand at the forefront in the battle against snow and to offer black tarmac all year round, irrespective of the weather. For the past year, an Øveraasen TV1000 snow blower has been part of its snow-fighting force.

The snow blower is part of a snow-clearing taskforce that also includes 8 to 10 snow plows – or sweepers. With its powerful engine, the Øveraasen snow blower is able to keep up with the rest of the snow-clearing group, improving productivity of the operation as well as of the safety at the airport. A less powerful snow blower would have to work behind the other vehicles at its own pace.

The Øveraasen snow blower also handles snow at Arlanda's snow dump site, which receives snow brought in by lorries from across the airport. The snow blower picks up the snow offloaded by the lorries and spreads it as far as possible across the site. This reduces the amount of mechanical handling necessary at a later stage.

"The Øveraasen TV1000 is very easy to handle," says Magnus Lindner, head of driver training at Swedavia, the company running operations at Arlanda Airport. "Frequently, vehicles get very complicated with all their computerization. Øveraasen has managed to maintain a simple user interface, which is very helpful if a driver has been away from a particular vehicle type for a while. He can then easily get going, which saves time and contributes to efficient operation."

"The driver's cab is comfortable, which is a great advantage during long working days with heavy snowfall. The ability to move the cab to a forward position gives a great view of the working area, even if this is at the expense of a more restricted view of the discharge chute."

The snow sweepers at Stockholm's Arlanda Airport work in teams of 8-10 vehicles, clearing 3.3km of runway in less than 10 minutes (Photo: Daniel Asplund)

Both machines are designed for a polar climate – temperatures of -40°C are no match for Øveraasen's snow blowers. A powerful diesel heater ensures driver comfort at all times, even when the engine isn't running.

Double diesels

The two machines have similarly configured powerplants – but for different reasons. Both use two separate diesel engines, one for the roadwheels and a larger one to drive the snow blower. In the case of the TV1000, this was driven by the need to run the output shafts for the roadwheels and the snow blower at different speeds while avoiding the need for an extra transmission. In the TV2000, the challenge was one of physical size.

"When you consider engines in excess of 2,000bhp, you start looking at marine and industrial engines, which are very large and difficult to design around. It was easier to use two separate engines side by side," Thorsrud explains.

The TV2000 is therefore propelled by a turbocharged Mercedes-Benz 500 series V8 diesel engine with 611bhp (450bkW) providing 2,700Nm. The blower engine is an MTU V16 diesel providing 1,520bhp (1,120bkW) and a maximum torque of 6,000Nm.

The TV1000, meanwhile, powers its wheels with a 306bhp (225bkW) six-cylinder Volvo Penta diesel that gives 1,250Nm, while the blower uses a larger Volvo Penta unit with 768bhp (565bkW) delivering 3,287Nm.

But the greatest difference between the two drivelines is evident in the transmission. The TV1000 uses a 6-speed automatic Allison gearbox, while the TV2000 makes extensive use of hydraulic motors. This results in a transmission able to provide infinitely variable output and very smooth transfer of power. Its two hydraulic motors, powered by the engine, drive a two-speed Oshkosh center-mounted gearbox with a selector for high and low gear.

This variable output enables the diesel engine to operate at the most appropriate speed, and the output to the blower head and the roadwheels can be controlled more easily. In addition, the hydraulic motors are reversible; a useful feature should the auger get jammed.

However, this all comes at a cost – the hydraulic motors inevitably make the TV2000 more expensive to build as well as to operate. Transmission losses in the TV2000 are in the region of 25%, but just 3% in its smaller sibling.

Both vehicles have Kessler front and rear axles, driven mechanically from the gearbox, and independent four-wheel steering. Both the front and the rear axles are fitted with stabilizers, differential lock and pneumatically operated drum brakes. The TV1000 uses Michelin Snow Plus tires, while the TV2000 uses Michelin XLS.

The machines also have hydraulic suspension offering automatic level control, keeping the chassis horizontal

ABOVE: **The futuristic styling of the rear cowling of the TV1000 has earned Øveraasen the prestigious Award for Design Excellence from the Norwegian Design Council**

LEFT: **The snow blower engine and the clutch (the white box under the air filter). TV1000 has a walk-in engine compartment, featuring a door on each side of the machine, enabling daily care and maintenance to be carried out in sheltered conditions even when outdoors. The door opening is visible to the right in the picture. During normal servicing indoors, the rear cowling is lifted hydraulically**

TOP: **The flying cab can be moved to a forward position to offer the driver a better view of the working area**

at all times. This is especially relevant at the front of the vehicle, where the load can vary greatly, as the blower head extends forward of the front wheels. This arrangement can sometimes double the load on the front wheels during operation.

All systems are controlled electronically from the cab. The TV1000 uses the latest H1 series hydraulic components and PLUS+1 control system from Danfoss Power Solutions. The TV2000 has 90 series hydraulic components from Danfoss, with a control system – developed in cooperation with Swiss company MDS – based on components from Intercontrol. For both vehicles, the hydraulic fluid is specially selected for low temperatures and heated.

Two-stage throwing

The blower head is a two-stage mechanism with an auger feeding snow into an impeller that throws it sideways at high speed. The head is controlled using an electrohydraulic parallelogram lift, which enables it to ride on top of the snow layer, avoiding high friction and excessive forces.

The blower head is driven by the diesel engine via a transmission of Øveraasen's own design, consisting of a clutch and a reduction gearbox.

"The gearboxes we manufacture are tailor-made for the requirements. Off-the-shelf gearboxes are designed for completely different duty cycles to what we need," says Thorsrud.

The auger drive is fitted with a Safeset safety coupling to prevent overload. This features a hollow steel section that is expanded by pressurized oil during operation, creating a friction-based connection between the shaft and the hub. At overload, a safety valve releases the pressure, the torque disappears, and the impeller is disconnected. The oil inside the mechanism has a constant friction coefficient, enabling precise control of the permissible torque. The safety coupling can easily be reinstated once released.

The TV2000's auger is driven via hydraulic motors, and mechanically on the TV1000. On both vehicles, the impeller is driven mechanically – and this is the only exception to hydraulic drive in the bigger model, reducing transmission losses to make maximum use of the available power where it's needed most.

Norwegian snow-how

A particular consideration for airport winter equipment is the paintwork. The chemicals used to keep airport runways and taxiways ice-free are aggressive, so the paint thickness is 250-300μm – 10 times that of the paintwork on a car.

For the exact same reason, the quality of steel chosen for chassis components has to be selected with care, while cables require insulation able to withstand any ingress.

Snow is difficult to define for handling purposes. Unlike many other materials, there is no way of knowing what its weight and density is going to be. New snow can be light and fluffy, while wet snow is dense and heavy. Old snow that has been moved around a couple of times has other properties still. Many of the components are therefore generally oversized to be able to cope with a worst case scenario.

"Another challenge when working with snow is that it is airborne, so care has to be taken to avoid snow entering the air intake," Thorsrud adds. "The openings need to be correctly designed, as do the ducts inside the machine.

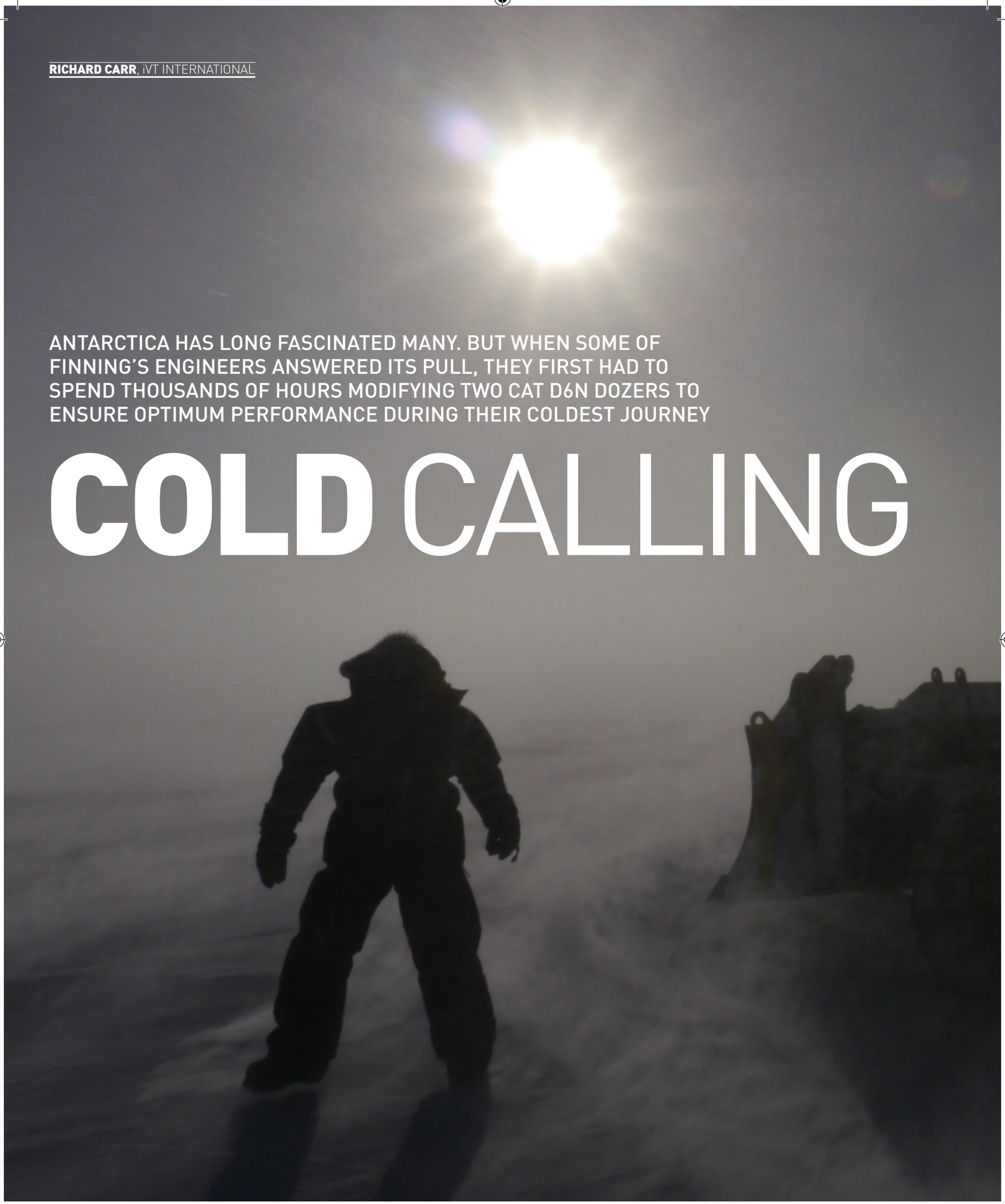
"All our knowledge of snow boils down to experience. There is no way you can work this out with theoretical calculations, however we get lots of practice as snow is something we have in abundance. Unfortunately snow isn't something we can sell, but our knowledge of the white stuff is something we can share with the rest of the world." **iVT**

RIGHT: **The snow blower head is a two-stage mechanism with an auger feeding snow into the impeller, which throws it sideways through the discharge chute**

RICHARD CARR, iVT INTERNATIONAL

ANTARCTICA HAS LONG FASCINATED MANY. BUT WHEN SOME OF FINNING'S ENGINEERS ANSWERED ITS PULL, THEY FIRST HAD TO SPEND THOUSANDS OF HOURS MODIFYING TWO CAT D6N DOZERS TO ENSURE OPTIMUM PERFORMANCE DURING THEIR COLDEST JOURNEY

COLD CALLING



Ever since I can remember, I've been obsessed with Antarctica – meaning my bookshelves now groan under the weight of inspirational accounts of the exploits of legendary explorers such as Roald Amundsen, Sir Ernest Shackleton and Captain Scott. And much has changed in the 115 years or so since the first attempts to reach the South Pole – the huskies and ponies that were initially used for transport (and later served as food) are no longer permitted for 'environmental' reasons – to put it delicately – with snowmobiles and dozers now being the approved method of transport and haulage.

Then, a couple of years ago, the British explorer Sir Ranulph Fiennes – in a case of history virtually repeating itself – found himself competing against a Norwegian expedition to make The Coldest Journey – the first crossing of the southern continent in winter.

Having used a Caterpillar dozer on a previous expedition, this was his first choice to do the donkey work, and Cat happily supported the latest project by supplying two D6Ns. The expedition landed in Antarctica on January 18, 2013, though Fiennes was forced to pull out shortly afterwards, suffering from extreme frostbite. Nevertheless, the rest of the team continued, until an unexpected series of crevasses soon forced them to call a halt for safety reasons. But the scientific research continued and, all told, they eventually notched up 2,500 miles over 307 days.

Nevertheless, I was still very keen to find out more about the whole adventure – and in particular, the engineering adaptations that were required to prepare the dozers for operation in what is probably the planet's most extreme environment. That entailed me visiting Finning, Cat's UK dealer, which had carried out the bespoke engineering for the machines, and having a lengthy chat with Richmond Dykes, operator trainer and engineer, who, along with Finning Canada's Spencer Smirl, was responsible for their subsequent driving and maintenance. Not to mention a lot of the preparatory work, because in much the same way a baseball player might sleep with his bat, they needed to build a 'relationship' with the machines on which their lives would depend.

With 101 modifications, the two dozers are clearly not your average

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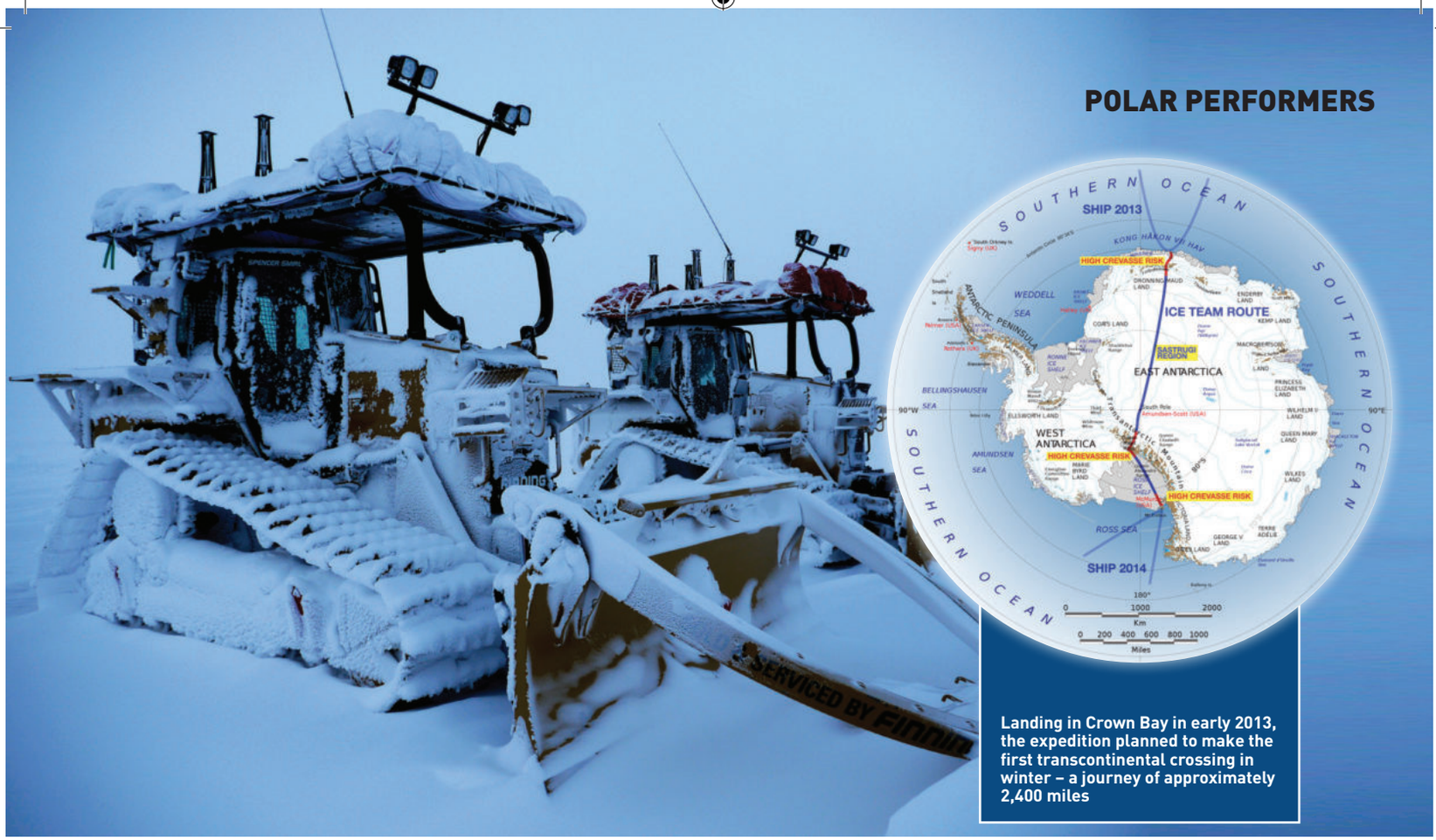


Landing in Crown Bay in early 2013, the expedition planned to make the first transcontinental crossing in winter – a journey of approximately 2,400 miles

D6Ns – but what surprised me was how relatively little on the inside actually needed to be upgraded.

Cat's standard winter testing procedure covers operations down to approximately -40°C, meaning its machines will perform just as well in Africa as they will in the Arctic Circle. But facing a potential wind-chill of -90°C, nothing could be taken for granted and after several thousand hours of CAD modeling and design modifications by Finning design engineer Andy Thomas, the first D6N was sent to Sweden for testing in early 2012. A large part of that involved hill-climbing in -20° to -40°C temperatures, to see how the undercarriage (see *Breaking the ice*, p49) would cope with stresses and strains rarely encountered in traditional dozer applications.

Hot and bothered

"That proved some key things that we'd worked on, and highlighted areas where we needed to do other things," Richmond explains. "Then it was all about refining it – how it would work in relatively warm temperatures. Because even in the coldest environments, machines can overheat – and when we set out, we noticed they were too well insulated."

BELOW: **Testing in Sweden involved applications these dozers would rarely encounter on a job site**

BOTTOM: **The D6N was the biggest machine available that enabled the operator to sit fully facing forward, rather than being angled to one side**

So, for instance, the perforated access panels on the standard D6N bonnet configuration had been sealed up to keep the heat within the engine bay, but the front grille was fitted with flaps that could be opened and closed to regulate the temperature. So with most of the driving taking place into the wind coming off the Pole, they were usually shut to retain the heat, but in the event of a tailwind they were opened to let it escape.

"But on some of those warm days, we had everything open and we still couldn't stay cold enough," grumbles Richmond. "The engines were fine as regards to cooling; the problem was the auxiliaries bolted to them. So there were times when we'd have to stop, take the load off the machine and cycle our implements – rev the engine up to full RPM while the door was open, and then we'd be fine for another half an hour. So it was just a case of finding that happy balance – obviously we had to be prepared for the worst outcome, and be able to keep driving if it did drop to -90°C."

With its reversible design, the D6N's modified cooling fan also came in useful. "Blowing mode was the preferred way to travel, because we didn't want to ingest snow into the engine bay and have pools of water in there," he explains. "But in the event of a worse-case scenario, we could adjust the pitch of the blades and have it sucking air in."

One unusual mod to solve a cooling/overheating conundrum involved the application of lagging with a carbon fiber outer layer to the blade cylinders. "Obviously, we weren't doing much actual dozing down there, so we didn't want to shock-load the hydraulic system with freezing cold oil coming back into those rams again. So the lagging allowed us to cycle from time to time and put hot oil into them. When the machine started to get too warm, we

had cooler oil in those cylinders that we could introduce back into the system to gradually cool it."

If you can't stand the heat...

The overheating problem didn't just affect the dozers – although the cab was effectively standard as far as HVAC was concerned, the need to be wearing full safety gear in the event of a dozer disappearing into a huge crevasse meant Richmond suffered too. Intra-panel insulation was therefore not required.

"I used to drive with my winter boiler suit on, but my upper body out of it," he says. "That was warm enough, and if something did go wrong, it was just arms in, grab the karabiner and the rope, and out you go through the escape hatch in the roof. [This was fitted to compensate for the lack of rear window access, the window having been covered with a mesh frame to prevent the driver being injured if the cable snapped during winching.]

"There was no insulation in the cab, only in the outer panels where

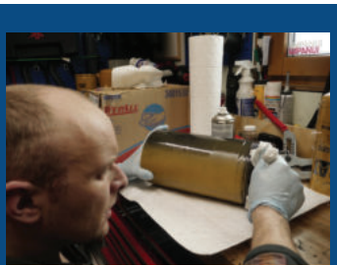
"WE'D START LIFTING THE BLADE SLIGHTLY, TAKING ABOUT 10 MINUTES TO PUT IT THROUGH A FULL CYCLE, SLOWLY INCREASING THAT WARM OIL THROUGH THE SYSTEM"

SERVICE WITH A SMIRL

Frustratingly, all but one of the cars I've ever owned has required the renewal of its MoT certificate in the first four months of the year, invariably leading to numb fingers as I lay underneath and frantically attempted the necessary repairs. So quite how the Finning guys would service and repair their machines in infinitely more unfavorable conditions was mindboggling – until I discovered they had a nice warm, insulated tent in which to do it. Fitted on top of Cat's forestry roll cage, with the exhaust being lengthened to pass through the upper canopy, this could be unrolled to protect them from the elements, capturing heat from the engine to create a residual temperature 20-30°C warmer than the external environment.

Yet incredibly, the rip-stop nylon tent was not always used, claims Richmond: "We didn't want to risk damaging it in winds over 30mph – if we'd lost it doing something as trivial as a service and there had been a catastrophic failure that made us park up for a week doing repairs, we'd have been at the mercy of the elements.

"The selection process had tested our skills in a cold-testing chamber, down to -58°C, to see how we performed and how it affected our mental ability. During the expedition, some of the guys would be wearing full gear within weeks of the sun



the auxiliary hydraulic components were, which meant the heat came back into the cab. So we just put two standard circulating fans behind the driver, which moved air around to create a draught."

Fueling debate

Overheating was anything but a problem for the fuel, however. Dozens of motor graders are said to litter the bottom of American lakes following dim-witted attempts to thaw out the fuel lines by building a fire on the ice beneath them, but the Finning design team took a much more professional approach.

They fitted a Webasto heater instead, which drew 2.5-3 liters an hour from the fuel tank to pre-heat the entire coolant system to 76-82°C. "There were heat exchangers in the fuel and hydraulic tanks, so it brought those as well as the engine up to the required temperature," Richmond explains. "Water was sent round on a constant circulation system – whether from the Webasto or, when that was turned off, the engine itself."

MAIN IMAGE: **Each D6N towed around double its designated capacity, with the living and science cabooses directly behind. Occupants could keep tabs on the driver via the videoscreen (inset) to make sure he hadn't fallen asleep**

ABOVE: **Spencer Smirl demonstrates the need to take bulky clothing into account when designing cabs for extreme climates (see p16)**

disappearing, while I was happy running about in a medium base layer. Some of them had problems with hand circulation, but I was fine."

One major modification was performed to enable easier servicing, with the heavy belly plates being replaced with bespoke 8mm 'bomb doors' that could swing down to provide full access to the underneath of the engine and the transmission after the removal of just two bolts.

My first attempt to visit Richmond had fallen through several months earlier due to an ill-timed clutch release bearing failure on my car. While faced with the many trials and tribulations of replacing the unit, such as impromptu bike rides to the local motor factors for 32mm sockets for removing the driveshaft nut, and then searching for a 6ft length of steel pipe to add leverage to the new, larger breaker bar needed to undo it, I had ample time to speculate how the choice of both tools and spare parts had been made. They would, after all, be a long way from the nearest Halfords…

"For weight reasons, we probably only had 80% of the tools needed for these machines, and Snap-On sponsored us with about £60,000 worth of them. But we'd brought tools to handle every major type of problem; anything else we could get round one way or another.

"As for spare parts, it was basically fan belts, filter kits and oils, hydraulic and transmission pumps, injector pumps and injectors due to the lack of lubricity, turbos and starters. And I think we took four alternators, because if we'd lost our charging capability, we wouldn't have been able to run our lights."

As it turned out, seals on the oil filters weren't problematic – as long as the guys followed the correct procedure. Trial and error revealed this meant the new filter being left in one of the cabooses to warm up; then the sump was emptied, and the replacement filter brought out swaddled in Richmond's boiler suit and quickly hand tightened. "Then I'd tell Spencer to start it up again, get the engine back up to temperature, and then incrementally tighten it until it was sealed. If you rushed it, it would have puckered, and that would be it. We got quite proficient after the third or fourth time of doing it; we were servicing it about every 250 hours."

Although the engine needed only one real modification – the jet fuel conversion – the extreme conditions also demanded exceptional fan belts. The 'Endurance' fan belt was therefore created especially, using a special blend of rubber, and tested to -70°C to ensure it wouldn't shred. Carrying just 10 or so spare (and unused) for each dozer, this required a substantial investment, given that machines destined for the Arctic Circle will continue to use the previous design. "But they'll definitely be available for the D6N in future, should a customer need them," Richmond clarifies.

Not that this made start-up easy: the daily routine involved Richmond getting up at 3.00am to switch both heaters on for a few hours. Spencer Smirl would then go out at 5.30am to crank the dozers over, get them up and running under their own steam, and do the daily walkaround.

"By about half-past six or seven o'clock, the transmission was up to temperature," Richmond says. "We'd start lifting the blade slightly, taking about 10 minutes to put it through a full cycle, slowly increasing that warm oil through the system. Then that was us ready to hitch back up and move off for the day."

"It's just as well you didn't have to worry about AdBlue as well," I quip, before remembering that even if the standard Caterpillar C6.6 engine relied on this SCR aftertreatment with a propensity for crystallization below -11°C, it wouldn't have been required anyway, given its only real modification was the switch from diesel to Jet A1 aviation fuel. Like SCR, diesel also crystallizes, though not until -30° to -40°C. Containing no waxy lubricants, however, jet fuel is 'pure' – but because this can lead to increased wear of the injector system, a lubricity filter had to be fitted at the point just before the fuel enters the injectors. No other mods were required to accept the fuel – however, due to its slightly higher burn temperature, there was a power loss of about 8-10%.

Nevertheless, given that the engines would have had to be left running overnight if it wasn't for the Webasto heater – which therefore reduced consumption by 60% or so – the extra demand that placed on the fuel supplies was all relative.

"WE KNEW WE WERE GOING TO HAVE TO CROSS CREVASSES AND SNOW BRIDGES – IT'S MUCH MORE PREFERABLE DRIVING ACROSS THOSE IN A 24-TON MACHINE THAN A 100-TONNER!"

On the pull

Transporting all its own fuel – 120,000 liters of it – the ice train stretched close to 80m long, starting with the accommodation caboose behind the dozer, then the science caboose, and seven fuel scoots, with each machine towing around 80 metric tons apiece.

So given that the D6N was initially designed for a 40-50 metric ton pull, why wasn't a bigger model chosen? "There's a happy medium," answers Richmond. "Yes, we could have used a D11, but we knew we were going to have to cross crevasses and snow bridges – it's much more preferable driving across those in a 24-ton machine than a 100-tonner!

"The other reason is that the D6N is the largest model we have with a forward-facing seat – the rest are offset at 10-15° or so. So it helped to be sitting forward, with a view out to both ends of the blade. If something had gone wrong and we were at an angle, we'd be straining to see it at the other side."

ABOVE: **The extra fuel consumed as a result of having to split loads to cross crevasses more safely proved to be a further obstacle to the expedition's success**

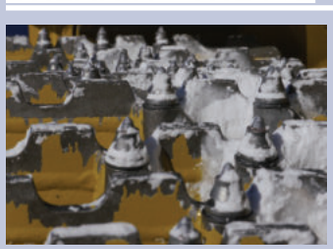
A handful of other essential modifications improved visibility further, perhaps most notably the Optronics 360 high-def camera setup from Spillard Safety Systems. This provided a complete 360° view around the machines, digitally processing horizon-to-horizon images to display the optimum surround view on a 10.4in non-reflective screen. "Even when we couldn't see anything through the windows, that allowed us to see to the tracks," he adds. "Even if we were blinded with light reflecting on the window, or from the snow, they cut right through to ground level as they reached out beyond the lights."

An extra screen catered for the data from the GPS and the ground-penetrating radar (see *A horseshoe for luck*, p52), meaning that for much of the time the operators actually focused their attention inside their cab so as to plot the safest course through the dangerous terrain.

In addition to the D6N's standard lighting package was a bank of four HID lights and four LED lights above the cab, which enabled a variety of lighting setups in response to the conditions. "But when there was spin-drift, the reflections meant it was just like having a white sheet dangling down," says Richmond.

"Sometimes it was better to drive with all the front lights off, and just the spotlights behind you shining

BREAKING THE ICE



The standard D6N comes with Cat's SystemOne undercarriage, but the OEM's even-tougher 'Arctic' variant was adopted – as well as adapted – for the expedition. Several minor drivetrain changes were carried out, with new rollers and idlers, and the final drive was refitted with bespoke SKF silicon seals to ensure oil didn't leak into the transmission.

The main changes were, however, to the tracks themselves, giving them more 'bite'. "We added 50mm on the original grouser pads, castellating them to help us to tackle the blue ice," Richmond reveals. "We also fitted them with tungsten carbide tips – as used in road planers – which protruded another 28mm above the grouser pads."

So how did drawbar pull compare with operation on soil, I enquire? "We had round about 8:1 coefficiency. Snow wasn't a problem at all – if it was damp and wet, we got a good bite into it. If it was light and fluffy, we had to be on the throttle to adjust for that.

"But the blue ice was like marble! If you drove in too fast, the grousers would just skid, and then shoot out a slab behind you. That was when we had to put the spikes in; they're point-loaded, and we could actually get a strip that we could drive across.

"But there were times where we couldn't tow the full load; we had to split it into half, or thirds, even, depending on the gradient. So we were supposed to be traveling the distance once, but we were effectively traveling it five times, or even more, which really ate into our fuel supplies.

"I'd actually contemplated serrating the cutting edge on the blade, just to get the ice shaved up. Or dynamite would have been a good thing – we should've taken some of that to save time filling in the crevasses!"

Richmond Dykes ended up in nine crevasses or so, and Spencer Smirl another three: "We had to make multiple passes, so it was usually the third or the fourth pass where something would go wrong," he says. "So as well as hitting large crevasses that could have swallowed a machine, the other reason we had to call it quits was because we were borderline on survival fuel if we had a predicament. We hadn't anticipated filling in all these crevasses – it was meant to be a driving exercise. We'd filled kilometers of crevasse to get to where we got to"

forward; sometimes it was better to run with no lights at all, on the rare occasions where there was enough moonlight. Personally, I'd have liked to try a yellow light instead of the bright white, because it cuts through the snow better."

That was the only alteration Richmond wanted to make while on the expedition (sadly, the quick fix of Toffee Penny wrappers wasn't readily available) – but soon after arriving home, he received an email from a supplier of parts related to his vintage car and tractor restoration hobby, announcing the availability of stick-on heated windscreen elements.

"I probably would have stuck two of them on the doors, and one across the back window," he muses. "We were reliant on two small adjustable vents to clear a lot of glass – if we were heading into freezing winds and snow, their heat wasn't always enough to keep the windows fully clear. So those elements might've worked – or the window might have shattered the first time you closed the door… And even in the UK, if you wear damp clothes in a cab, the heat exacerbates the condensation – before you know it, you've got an arm up against the window, trying to see out!"

ABOVE: **Each D6N boasted plenty of light – although a warmer color temperature might have worked better in whiteout conditions**

Taking charge

But speaking of electricity and heater elements, Richmond mentions that the battery also relied on the Webasto heating system. This sat on a plastic plate, into which copper tubes were embedded for coolant to pass through to warm the battery prior to starting. And should the engine fail to start, a back-up electric heating jacket enabled them to keep cranking over.

In fact, one of the few components that the Webasto didn't warm up was the transmission; instead this relied on stick-on electric heater pads. Powered from the hydraulically driven 20kVA generator behind the cab, and producing around 350W apiece, there was a copious amount of these dotted elsewhere as back-up around the machine: on the engine and the oilpan, the heater probe, and on the back of the fuel and hydraulic tanks.

Other than that, all the internal components were effectively standard D6N parts – although in terms of the consumables, they filled up with non-standard Caterpillar fully synthetic Arctic-grade oils. "We always cut our used filters open to investigate the papers, but there was never any problem," Richmond says.

It was on the outside where the changes were most radical, including a large canopy on the cab roof that housed a thermal tent to aid servicing (see *Service with a Smirl*, p46). Front and rear access steps also had to be adapted, as Richmond explains: "I'm a size 9 boot, but I went two sizes bigger so I could put extra pairs of socks on if I wanted. That meant the normal sort of step wasn't very safe any more so we designed and installed a bespoke gantry and step system to provide safer access and egress.

"We also fitted additional walkways round the machine to make access

easier while wearing winter clothing. The steps and gantry were made from a mezzanine flooring type of material to provide high-grip. If there was a snow buildup, we only had to give it a rub with the brush and it would all drop through the gaps."

We can rebuild it

So now, in the, ahem, 'cold' light of day, what has Finning gained from all of this? "I think it shows we've proven our bespoke capabilities," says Andy Thomas, the lead Finning engineer on the project. "What we're saying to customers is, 'Do not just accept a piece of equipment that is coming out of a factory for your application – talk to us about your needs, so that we can make your equipment the perfect fit for that specific quarry, waste or whatever application.

"What was really interesting was the data they were able to send back from the machines," he adds. "Once that's been analyzed, the knowledge that Finning and Cat will get from that … you can't put a price on it. You don't know when you're going to be called on to produce machines for such extreme environments."

BELOW: **Left to right: Spencer Smirl, Sir Ranulph Fiennes and Richmond Dykes after landing in Crown Bay**

BOTTOM: **The horseshoe boom proved indispensable for more mundane duties, such as handling fuel drums**

A HORSESHOE FOR LUCK

By far the most noticeable – and probably most important – modification was the crevasse boom that was fitted onto the front blade. This had two main roles – by supporting rails that enabled ground-penetrating radar to reach out 18m or so in front of the dozer, it provided a 'crevasse early warning system' and, with a 'ski' fitted below, it could also break their snow layer to provide one final warning. However, if that warning came too late and the dozer did crash through, the horseshoe-shaped attachment was likely to catch on the far side of the crevasse to prevent the machine disappearing.

Its other vital application was its use as a lifting boom, which proved crucial for rescuing its stricken partner wedged in a crevasse as well as performing a variety of more mundane daily duties such as nudging the fuel scoots loose after they'd frozen to the snow overnight. Initial testing revealed it provided an 8.5-metric ton lifting capacity, although this was later downgraded to four metric tons.

A large shackle welded to the centre of the blade, and others sited elsewhere, enabled towing from the front, the rear hitch or from the middle. These were designed to take a 50-metric ton pull – the rating of the Paccar winch fitted to each rear counterweight.

"That was predominantly for recovery work, which we'd expected to do once or twice per machine – in the end we must have used them 14 times," says Richmond. "That winch was paramount; we'd have had to call a stop to the expedition a lot sooner without it. We didn't want to drive across the crevasses hard-linked into the cabooses, because if we had gone down, we'd have bent the draw bar, or taken a caboose with us – so we used the wire rope as a soft link, meaning if something had gone wrong we could have put it into free spool."

Surprisingly though, Cat didn't ask the team to do any experimentation on their behalf during the journey. "They were happy enough with the data from oil sampling and failure analysis, stuff like that, but they never said, 'Can you put a sensor on here, or can you keep an eye on that,'" says Richmond. "They've got their own cold-weather testing, which is good enough for 99.9% of their products, so they didn't really need to do anything any more extreme."

"They're the only cats you would put out in the cold," Andy quips as we wrap up. But to be more accurate, given how well it seems the OEM's standard dozers can operate in well-below-zero temperatures, they're actually just two of many… **iVT**

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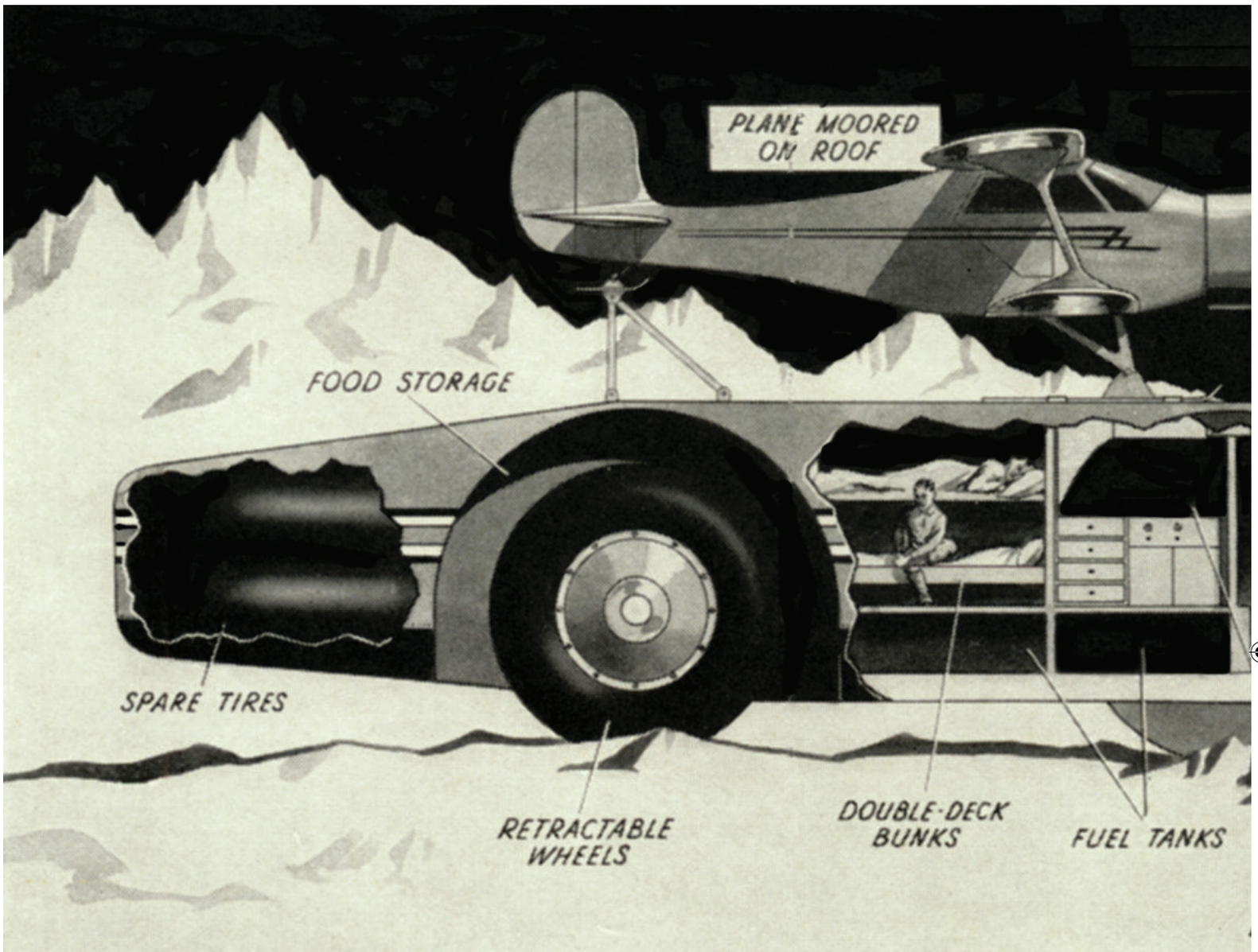
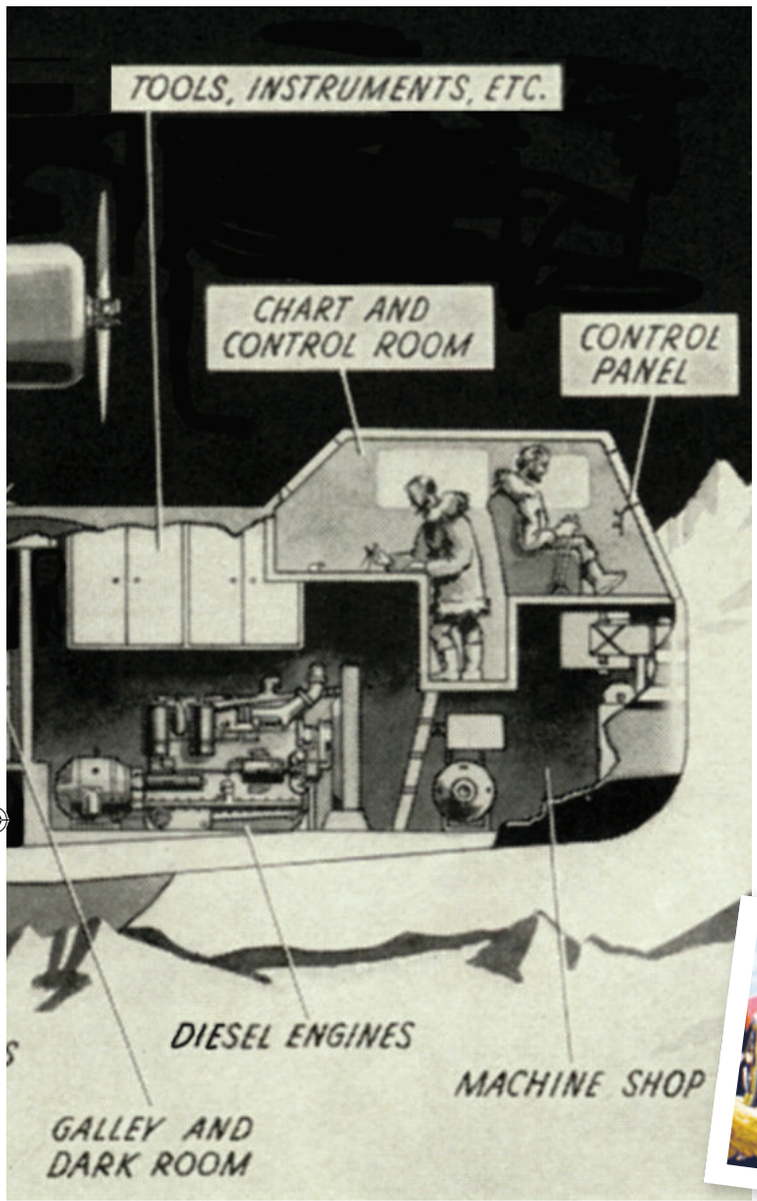


POLAR OPPOSITE

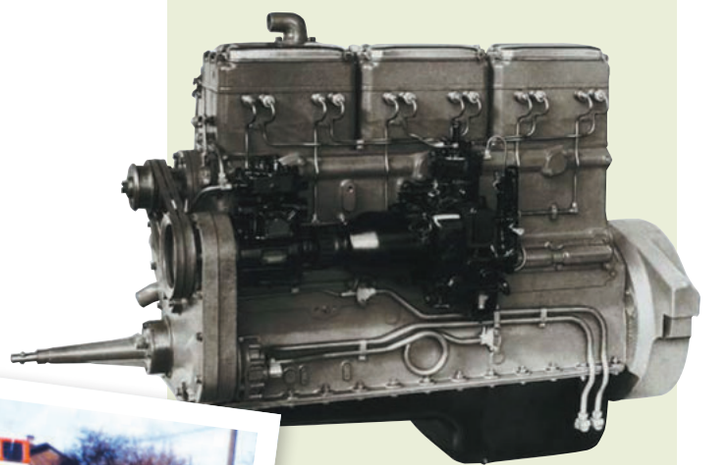
ALMOST 75 YEARS AGO, THIS 'COLDEST JOURNEY' WAS ATTEMPTED USING VERY DIFFERENT TECHNOLOGY TO TRACKED DOZERS. THE SNOW CRUISER WAS THE FIRST OF THE DIESEL-ELECTRIC GIANTS – AND USED TIRES!

One crisp October morning in 1939, a strange vehicle slowly made its way through Gary, Indiana, its bright red and silver paintwork gleaming in the sunshine. Much to the astonishment of the onlookers, this unique vehicle was destined for Antarctic exploration.

Nothing like this machine had ever been seen before – but perhaps more significant was the unfamiliar sound of its GE diesel-electric drive system in operation. Incorporating Cummins 'oil' engines, the Snow Cruiser became the forerunner of today's huge diesel-electric mining



The renowned Cummins H-6 Series engine with a displacement of 11 liters powered the GE drive system. Launched in 1933 with a distributor pump system and camshaft-operated injectors, the engine initiated the US revolution in diesel power for on-highway and industrial equipment. By the time of the Snow Cruiser, the engine came with the industry's first 100,000-mile warranty – illustrating the high dependability which attracted the design team.



LEFT: **A rare color photograph highlights the distinctive bright red and silver paint**

vehicles. This same technology is now experiencing a resurgence of interest for transport concepts in the automotive and off-highway fields. So how did it all begin?

The Snow Cruiser was the brainchild of Dr Thomas C Poulter, a physicist and polar explorer as well as a driving force behind two previous and well-publicized expeditions to the Antarctic using tracked vehicles to carry men and supplies across the ice sheets. After covering hundreds of miles in these tractors, in the most extreme conditions imaginable, he was well aware of how impractical the very cramped conditions in these vehicles were for polar expeditions. He firmly believed that the success of future journeys to the Pole could best be achieved with a large purpose-built vehicle specifically designed for the task, providing a permanent and relatively comfortable base for the crew, with sufficient working area for a well-equipped laboratory.

MAIN IMAGE: **The novel diesel-electric drive system gave a top speed of 30mph, while four-wheel drive and steering (4x4x4) allowed the vehicle to turn within a radius of less than 9m (30ft). Twin Cummins engines with an installed power of 300hp (224kW) at 1,800rpm were particularly compact for their day, with a power-to-weight ratio of 1hp to 15 lb (6.8kg)**

Planning for the expedition

When the USA announced plans for a third Antarctic expedition in 1939, he rushed to Washington and soon sold the idea of the Snow Cruiser concept, with an offer hard to refuse. The revolutionary vehicle would be built at private expense, and then loaned back to the government.

At that point he had less than six months to gain sponsorship and complete the machine, loaded with novel design features – all of which would be required to function in the harshest environment on Earth. But Poulter was a swashbuckler among scientists – he and his colleagues quickly capitalized on the popular excitement surrounding Antarctic exploration and persuaded no fewer than 70 US companies to donate

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ABOVE: **Local wildlife on the Ross Ice Shelf in January 1940 takes a cursory interest**

labor, materials, equipment and even cash for the project.

Always eager to be involved with interesting projects, the Cummins Engine Company decided to provide the engines – a decision made with considerable foresight.

On August 8, 1939, at a cost expected to approach US$300,000, construction started in earnest, with the expectation of driving the fully completed machine overland to Boston harbor in good time for the scheduled November sailing. Requiring a range of more than 5,000 miles, the finished vehicle would have room for a crew of five, together with enough equipment and supplies to last a year.

The Cruiser would also carry a five-passenger Beechcraft aircraft – winched up a ramp on its back – which would be used for aerial photography and surveying. In addition to its control cabin, the cruiser had a machine shop and a combination darkroom/kitchen. In the rear was storage space for fuel, food, and two huge spare tires.

The interior looked comfortable and above all warm, mainly because the engine coolant circulated through interior radiators, heating the living quarters with any excess heat venting to the outside. Excess electrical energy could be stored in batteries and used for lighting and powering some of the equipment when the engines were not in use.

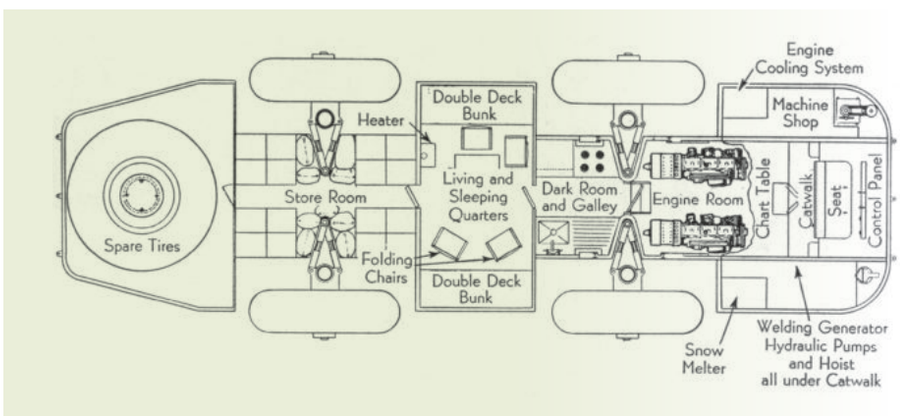
At 17m long, nearly 6m wide and 4.7m high, the completed vehicle was enormous. Fully loaded, it weighed in at more than 34,000kg – much of that being taken up by the storage of the huge quantities of fuel necessary for the journey to the Pole. In all, 9,463 liters of diesel were stored under the floor and 3,785 liters of gasoline, for the airplane, on the roof.

Driveline solves space problem

Power and driveline was supplied as part of the first engineering alliance between GE and Cummins. Despite the huge size of the Snow Cruiser and its predicted range over the ice, it was clear from the start that the driveline and engine installation had to occupy as small a space as possible, maximizing the operating area.

Using a conventional engine and driveline mounted along the centerline of the vehicle driving gearboxes and shafts to conventional axles would present a major installation problem. So the design team, along with Cummins and GE engineers, came up with the novel idea of a diesel-electric drive system, which seemed to offer the best solution to the space problem. The engines could be smaller than otherwise needed, requiring less fuel, while the electrical motors could be connected by cables instead of solid drives, for much greater flexibility. Application of this system would establish the viability of diesel-electric propulsion on large vehicles – making the Snow Cruiser the forerunner of today's diesel-electric mining trucks.

The system seems to have been an adaptation of GE propulsion technology previously used on rail locomotives. The installation on the Snow Cruiser consisted of two 112kW six-cylinder diesel engines (called 'oil engines' at the time) with a 124mm bore and 152mm stroke. Both were attached to a pair of GE generators, which then powered the 56kW series wound traction motors mounted in all four wheel hubs. Each naturally aspirated engine incorporated a highly advanced fuel distribution and injection system that included fuel preheaters – essential to combat temperatures as low as -50ºC.



Maintaining a comfortable temperature inside the Snow Cruiser was a priority, and this was achieved by using the engine coolant circulating through internal radiators

Retractable wheels

On the subject of low temperatures, Poulter came up with an innovation designed to preserve the tires. Natural rubber starts to lose its flexibility in extreme cold, so when the vehicle

ABOVE: **Sightseers take a look. The Snow Cruiser traveled over 1,000 miles to Boston harbor**

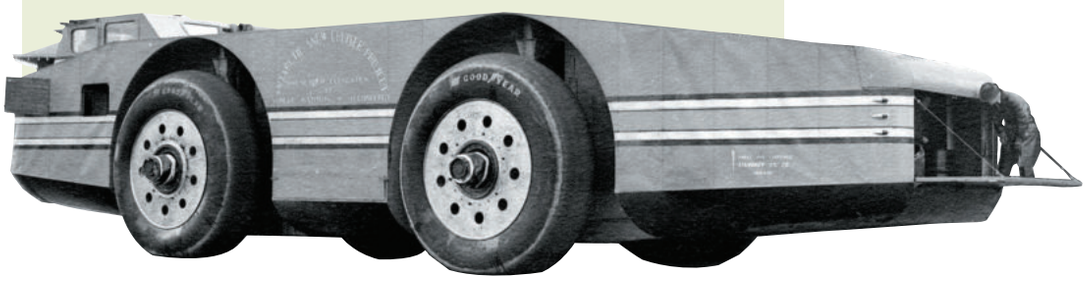
DIESEL-ELECTRIC DRIVE EVOLVES

The euphoria generated by the Snow Cruiser died away as quickly as it had started, as the machine slowly disappeared under the deep snow. Yet the Snow Cruiser did establish a unique place in off-highway vehicles, as probably the first off-rail adaption of a diesel-electric system. It may also have been the first utilization of 'wheel motor' technology on a vehicle of this type.

While the Antarctic may not have been the best place to trial a new drive system, it proved to be a successful combination matched to the Cummins engines – only held back by the inability of the huge tires to work on the snow and ice. And of course, the vehicle completed a 1,020-mile journey to Boston harbor before heading to the Antarctic. This fact was not lost on GE, which maintained a keen interest in the technology after the memory of the Snow Cruiser had faded away.

Attaching an internal combustion engine to a generator and powering the vehicle directly through electric motors attached to the drive wheels provided several significant advantages. Engines didn't need to be directly connected to the drivetrain, and electric cables rather than solid driveshafts transferred the power to the road wheels.

In 1947, experimenting with underground mining vehicles, GE converted a small road truck to run on electric motors taking power from overhead lines. But it would be another 10 years before Unit Rig built the first diesel-electric mine truck, fitted with a Cummins engine. The truck incorporated a newly designed direct drive (DC) wheel motor unit developed by General Electric, which went on to dominate the electric drive market for mining vehicles. The success of the 65-ton articulated truck led to the establishment of a new generation of diesel-electric vehicles for mining – huge haul trucks, wheeled loaders and excavators – many of them equipped with Cummins engines.



was stationary, each wheel would retract into its housing and then be heated by the engine exhaust gases.

Poulter's daring solution for safely traversing crevasses consisted of four immense wheels, complete with 3m tires, set close to the vehicle center and producing an overhang of more than 5m, front and back. The wheels could be retracted vertically until they were flush with the Cruiser's body – upon reaching a crevasse, Poulter proposed to retract the front wheels and push the front half of the vehicle across until it rested on the other side of the chasm. Then he would retract the back wheels, extend the front ones, and pull the Cruiser the rest of the way across.

With today's advanced hydraulics and computer controls, the process would have been easy to complete. But to accomplish this manually required some dexterity, with many separate operations involving the closing and opening of 20 separate valves, making the process hugely complicated and time consuming. Unknown to Poulter, it was to prove a fatal flaw.

Shipping off to Boston

When the last component was in place – and without any prior testing – the Cummins engines fired up first time and the Cruiser edged its way out of the Pullman Company's gates on the first leg of its 1,020 mile cross-country odyssey to Boston, followed by a huge entourage of police and press vehicles. After a few problems with damaged steering and broken oil lines caused by a detour into a stream, the machine continued its journey at up to 30mph.

Finally, Poulter drove it aboard the North Star at the Boston Army Wharf. Optimism was high, and on November 15, the ship set sail.

Once it reached the Ross Ice Shelf in January 1940, preparations were made to unload the machine. At one point a ramp beam gave way and the front wheels broke through, but with a surge of power the Cruiser lurched forward on to the ice sheet.

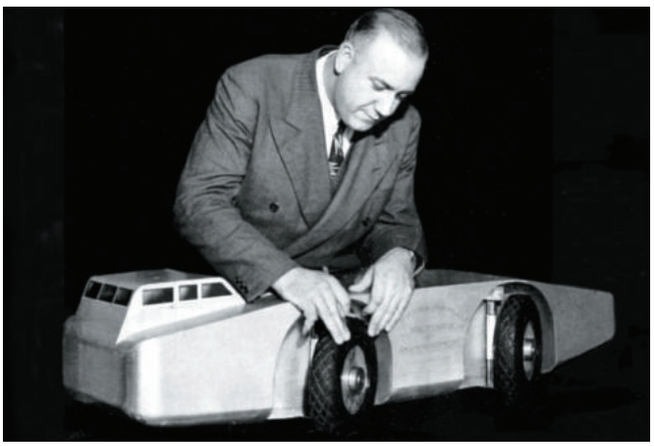
However, the initial cheers faded as Poulter tried to move it through the snow. It quickly became clear

that the designers' assumptions about traction had been inaccurate. The huge tires, originally conceived for a large swamp vehicle, just spun ineffectively a great deal of the time, providing little forward speed.

Some weeks later, they tried to attach the additional tires originally carried as spares. These were fixed to the front wheels to gain more grip, with chains placed over the rears, but it still couldn't achieve good speed. Although the engines and the drive system met expectations, Poulter recognized that the treadless tires would never work effectively and headed home.

Finally, after several months of frustration, the remaining expedition members covered the vehicle with timbers, making a fine bivouac. The Cruiser could be heated so effectively that the crew were able to sleep under only the lightest of covers. Scientific members of the expedition could therefore continue their research.

Then, as America braced itself for possible entry into World War II, the US Antarctic Service lost its funding. It became clear that the expedition would never be able to finish its planned multiyear tour.



Poulter demonstrates how the wheels could retract into their housings. The tires had an independent vertical travel of 4ft

Although Poulter talked about modifications that might make the Cruiser operational, Wade, his second in command, began to realize that the machine would never work, and wrote, "I'm rather dejected tonight when I think of the many long hours of planning, the days of hurried construction, the hopes and ambitions of Tom Poulter that are now gone with the wind and snow."

Whatever happened to...

In 1958, an international team discovered the Snow Cruiser by digging down several feet with a dozer, where a pole identified its position. Inside they found a litter of magazines, papers and cigarettes – just how the crew had left it.

Later expeditions, however, found no trace, leaving a real mystery to be solved. One intriguing notion is that during the Cold War the Soviets took it – but they would surely have had the same difficulties moving it as the Americans.

A more plausible explanation is that it slowly floated out on the ice, broke off and sank without a trace. Although perhaps it would be much more intriguing to visualize the Snow Cruiser sitting in the Russian equivalent of the secret US military Area 51, somewhere in deepest Siberia… **iVT**

JON LAWSON, iVT INTERNATIONAL

NORTHERN EXPOSURE

IF YOU THOUGHT THE CHILLIEST CONDITIONS ELECTRIC DRIVES EVER FACED WAS IN COLD-STORE APPLICATIONS, THINK AGAIN. A FEW OF THEM ARE OPERATING IN SOME OF THE HARSHEST CONDITIONS ON THE PLANET

Diesel may still be king in the minds of many, but tightening emissions requirements mean that, despite concerns over battery power, electric vehicles are now being taken evermore seriously – even in the harshest of environments.

Perhaps the most extreme example of a working cold-weather EV resides at the Summit Station scientific research base high on the Jakobshavn Glacier in Greenland. The area is 10,000ft above sea level, with average winter temperatures plummeting to -34°C. As many of the samples taken by the scientists are in the 'Clean Air Zone' sector, conventional IC vehicles are not permitted, as their emissions could contaminate readings.

The vehicle of choice (dubbed Edison by the operators) is made by Mogile Technologies, whose president, Simon Ouellette, explains

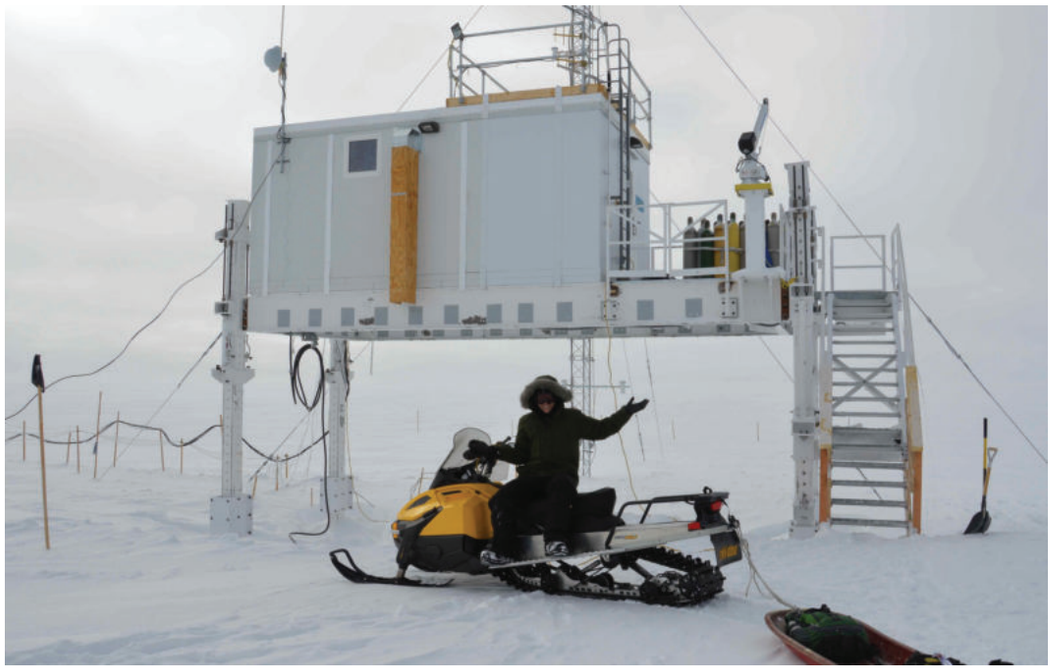
MAIN IMAGE: **Most often used in temperatures around -15°C, Mogile's Edison snowmobile maintains peace and quiet in the Arctic through the use of AC induction motors**

RIGHT: **High torque and no jolting on start-up make towing heavy loads with Edison highly efficient**


REVXU

the origins: "As a student, around 10 years ago I entered a US competition – the Clean Snowmobile Challenge. It was mostly concerned with trying to clean up regular combustion engines, but because I am from Quebec, where 96% of our power is hydroelectric, I thought we should design something that was electrically powered. Although the competition wasn't ready for us, we were welcomed and the concept received quite a lot of attention." As interest grew, the competition developed a standalone electric vehicle class.

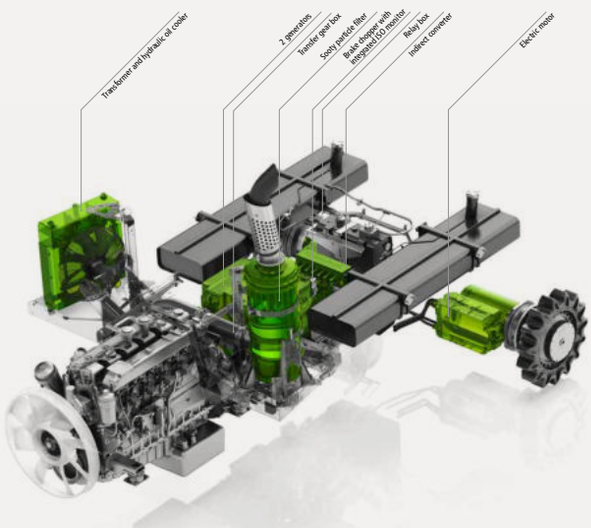
From time to time, the Summit Station researchers would borrow the snowmobiles from the students, but eventually realized that greater reliability was required. So, two years ago, the US government contracted Mogile to build something a little more durable.

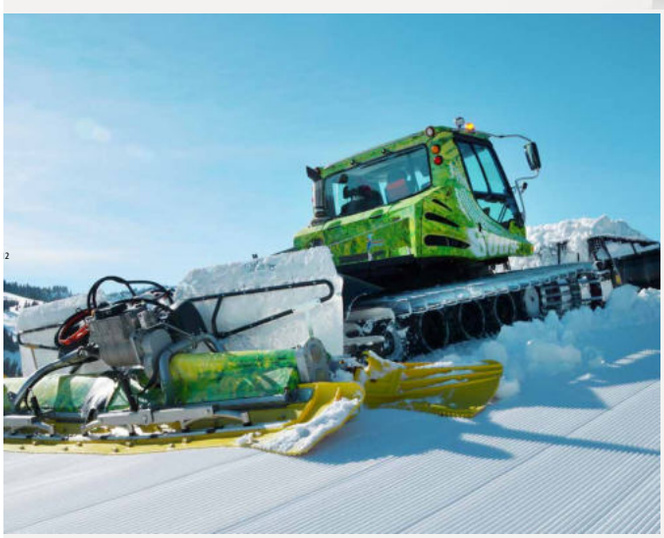


COMBINED EFFORT

Perhaps one way of avoiding the range issue common to EVs is to combine the best of both worlds with a hybrid. PistenBully's 600 E+ snow groomer features a 400hp-rated six-cylinder Mercedes-Benz diesel engine, coupled to two generators, two drive motors and a tiller motor (each 140kW/650V).

Michael Hemscheidt, PistenBully's head of technical marketing, explains the development process: "Our customers are primarily interested in reducing fuel consumption, more than emissions. We always strive to provide the latest technology; in fact, we actually started researching hybrid technology in the early 1990s. However, at that time the components were just too large and expensive. Nowadays, they may not be cheaper, but at least they are smaller."





The design goal was to get the IC engine to achieve the optimum torque at lower revs, and PistenBully proudly claims a 20% reduction in fuel consumption over a comparable conventional machine. "We know the customers really appreciate this," elaborates Hemscheidt. "It is also a different driving experience. With just a standard diesel engine, there needs to be lots of throttle use to get it to deliver the power. With a hybrid, the torque comes in much earlier, so the driver does not need to be revving it up. Also, this makes it much quieter so, at St Moritz for example, the operators use the hybrids when working close to the hotels."

Looking ahead, Hemscheidt sees further gradual refinement, with no great leaps forward expected for standalone electric power. "Hybrid designs are the future, I see no way a machine this size could rely on a battery alone to power it. Even a small groomer in a snowdome will need improvements in battery technology to really work well."

Edison gets most of its use in the summer, when the days are long and almost 'balmy' at -15°C. This winter, the machine is coming back to Ouellette as lessons have been learned in the field that will require some upgrades.

The specifics have not yet been decided, but he can make general comments about the technology: "From the design perspective, the forklift guys have made great strides with motors and controllers as used in refrigerated warehouses. So the area with the room for the most improvement is battery technology. To be more precise, it is not just an issue of battery performance, but one of price."

The solution, Ouellette believes, lies with economies of scale, and he cites Tesla's expansion as an indication that this is already underway.

EV lover

The operator experience is very different with Edison. According to Ouellette, the high torque that is instantly generated means that towing the heavy research materials is easily achieved, and with no IC engine engaging a CVT belt-driven clutch, there is no jolting when starting out. The quietness means it is more pleasant for the driver, with walkie-talkies able to be heard over the hum, unlike with petrol engines.

However, there are downsides, and safety features were designed in to counter these. Ouellette says, "When it is turned on, it is dead silent so it is easy to forget that it is running. As the slightest touch on the thumb actuator will make it move, we installed a 'screen saver' type function, meaning it will power down if left unattended."

Range is also tricky to calculate accurately, and at the moment it appears as if the only real solution to this is operator training. "It is not like a forklift in a warehouse or a car, which drives on a similar surface all the time," explains Ouellette.

"A change in traction on the snow can happen rapidly due to the environmental conditions, drastically affecting the range, so just fitting a charge gauge is not really enough. It's actually a really nice engineering optimization puzzle – the bigger the range buffer, the bigger and more expensive the battery."

Better batteries?

However, battery design for cold-store use is not an area where great technological leaps forward are being made – at least, not according to Jason Osadac, manager at Westrock Battery. "In the 20 years I've been in the battery business, and in the 20 years prior to that, there has been very little change to the lead-acid unit," he notes.

"The major difference between a cold-store forklift battery and a regular-use battery remains in the construction. It's a bit heavier with slightly thicker plates, so it can hold up to the cold better. I don't expect any significant changes in design or electrolyte in the near future."

BELOW: **The Legacy Arctic Battery features special electrolyte solution, a five-fold plate insulation system and a thermal tray insulator that improves the performance of the outer cells, which are most affected by cold applications**

BELOW: **Defence R&D Canada sponsored this Mogile Technologies research project, dubbed Loki (pronounced 'low key'). It can run with a conventional petrol engine and switch to electric when required. Simon Ouellette says, "The military were primarily interested in the acoustics of the vehicle, and with a quiet drivetrain, this was easier to study"**

GOING FOR COLD

Mark Ankers, VP of product management at Curtis Instruments, spells out a few of the technology challenges for designing EVs for use in cold climates.

How can condensation and moisture ingress be managed?

For controllers, the typical construction is an alloy heatsinking baseplate and a moulded plastic cover, with a perimeter gasket for sealing the interface between, O-rings or some other method to seal around the high-current bus bar connectors for the motor and battery, and a sealed connector for the low-current harness such as an AMPseal. The typical IP rating is IP65 with the mating low-current connector fitted.

However in reality, due to changes in ambient temperature and/or atmospheric pressure, it's economically impossible to maintain absolute sealing. To counter this, the state-of-the art solution is to include a Gore-Tex breather into the controller's cover so that pressure is always equalized and moisture can exit, but its entry is minimized.

Furthermore, controllers themselves will generate considerable heat during operation. On a typical 48V, 1.5-ton counterbalance truck, the pump and traction controllers are outputting 300-500A, and as a result each controller is generating a few hundred watts of heat. Coupled with the breather, this means that operation in cold areas isn't such a problem – it's actually the transition from hot to cold areas that can cause condensation.

Older controller designs – say 12 years ago – didn't have the Gore-Tex or sealed connectors and attempted to combat condensation with conformal coatings on the PCBs, or complete encapsulation. The issue with both these methods is that they are not suited to series electronic manufacturing. It's extremely difficult to ensure such coatings/encapsulants have been correctly applied to each and every production unit, and the big problem here is that a partial coating, or an encapsulant that hasn't correctly adhered, does not form a complete barrier against the ingress of moisture. Instead, it can often 'trap' it, increasing the chance of localized corrosion or contamination.

How will the technology develop?

In the future, I'd expect to see increased use of autonomous or semi-autonomous trucks to reduce the need for operators to work inside the cold rooms.

With outdoor cold climates, I don't think there is such a thing as a typical electrical forklift destined for a cold climate. Today a diesel truck is more cost-effective when talking about solely outdoor use. Emission legislation may become a factor, but if you think about where in the world the really cold climates are, there are not many countries that will be strictly enforcing emissions rules, and it's typically a remote frontier mentality where it will be far easier to service diesel/gas trucks than sophisticated electrical trucks.

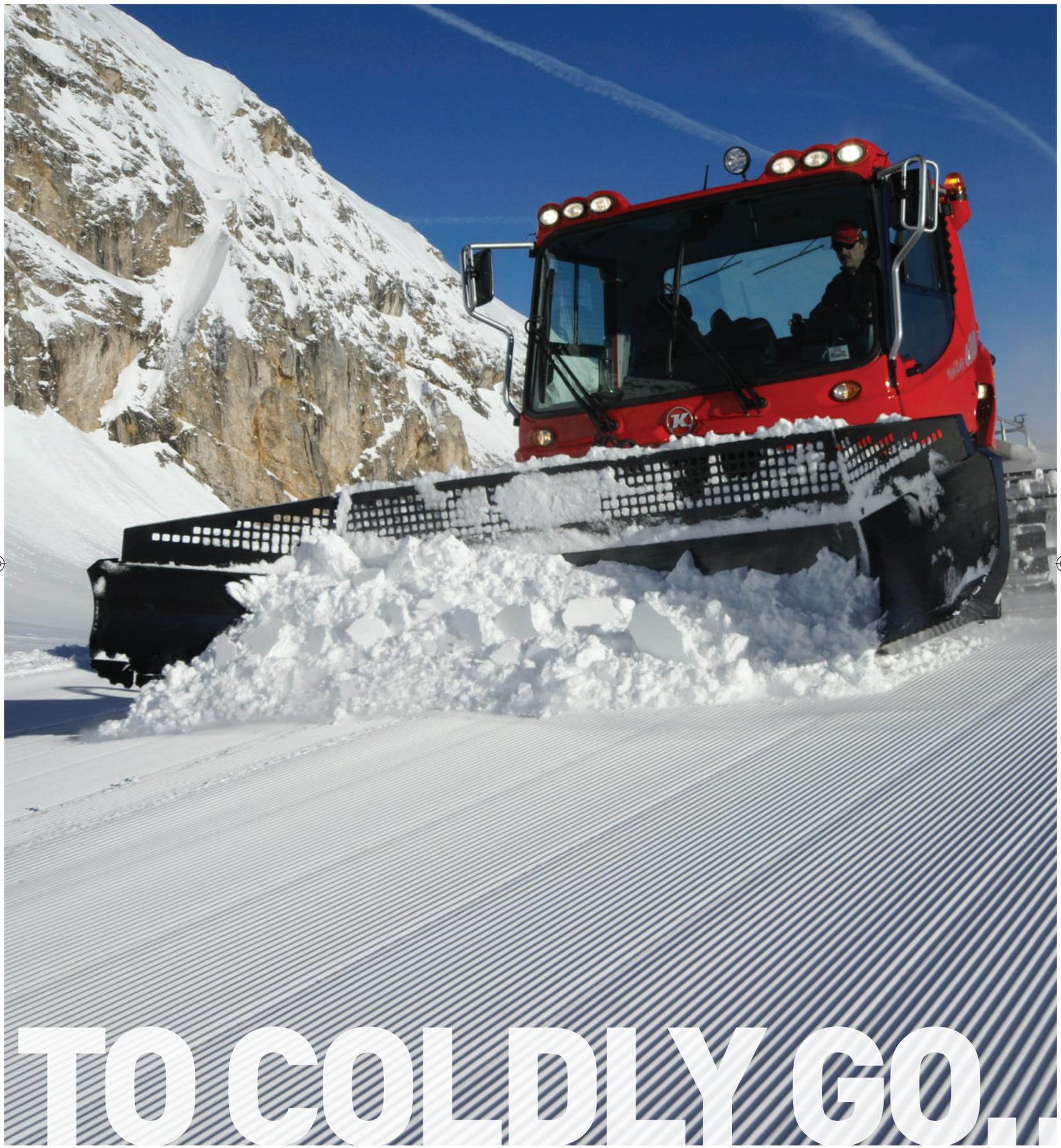
So could construction machinery use electric drives in cold conditions?

The cost of making large diesels compliant with the ever-tighter emissions regulations is already fueling the adoption of diesel-electric hybrid systems in construction vehicles. For the colder regions of the world, the solution today is to simply control the ambient temperature around the key components so that they never get exposed to really cold or hot temperatures.

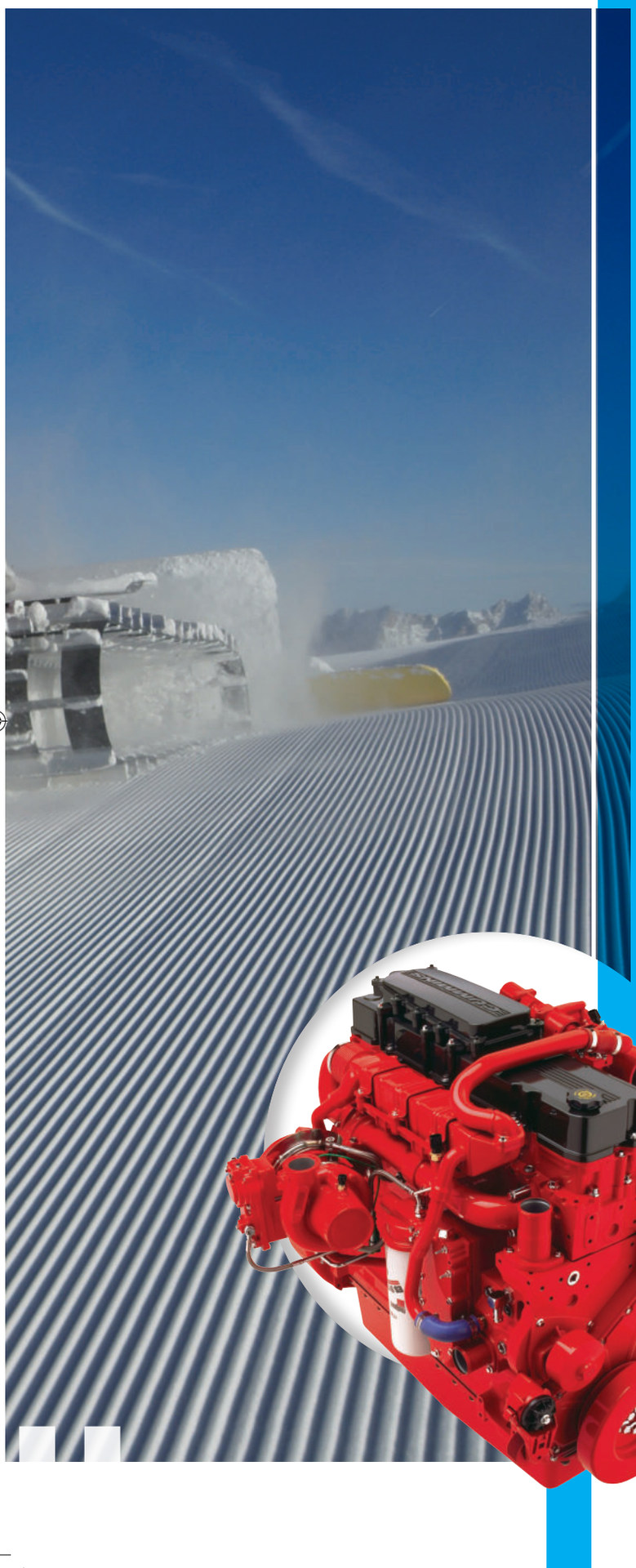
Osadac is keeping an eye on the high-cranking lithium batteries, but sees no scope for their industrial use. "It's not just the cost – some of these batteries are US$1,500 – but lithium just isn't good enough in cold environments."

However, more progress seems to be happening with battery charger design, Osadac concludes. "We have definitely seen improvements here, with smart boards that can tell the charger what the battery needs, so it can adjust itself accordingly. This can make these systems more economical to run." **iVT**

JON LAWSON, iVT INTERNATIONAL



TOO COLD TO GO...



AS INDUSTRIAL VEHICLES BEGIN TO GO WHERE NO OTHER VEHICLE HAS GONE BEFORE, WHAT DEMANDS ARE PLACED ON THEIR ENGINES, AND HOW ARE THEY ADAPTED TO COPE?

As the quest for harvesting natural resources continues, more and more industrial vehicles are beginning to pitch up in cold and inhospitable environments. Fortunately, technology seems to be quite capable of keeping pace with these demanding conditions.

Mercedes-Benz supplies power plants to a variety of excavators, wheeled loaders, trucks and the like across the globe. Director, classic engines and aftertreatment systems, Hans-Otto Herrmann, says, "The most important thing about the design of an engine for use in a cold climate is that initially the intake air must be heated, usually with a flame heater or a grid heater. We design based on the outside temperature, and this is ideal for -15º to -20ºC. When the temperature is lower than that – say, -30ºC or colder – then we also recommend an externally powered block heater."

There are other subtle material differences, depending on where the vehicle is destined to go. "Take the oil pan," Herrmann notes with a chuckle. "Plastic is perfectly safe to use down to about -40ºC, but not in Siberia. That's because there, if the engine doesn't start, they light a fire under it…"

From a design perspective, where altitude is concerned, Mercedes-Benz places great emphasis on the turbocharger. Carefully optimized up to a specific altitude, power reduction is inevitable should this be breached. Herrmann adds, "Altitude also makes emission control slightly more challenging. Currently the legislation stops at -7ºC and above 1,700m. AdBlue freezes at -11ºC, so we use coolant-based heat exchangers to enable us to inject it again. It does not make a huge difference, but less oxygen in the intake charge does cause NOx and particulates to creep up."

As far as any future emissions legislation is concerned, Herrmann is adamant that this must proceed hand in hand with fuel quality, and he cites sulfur content in particular. "Also, there has been quite a lot of discussion about biofuels recently. Diversity in fuel is all well and good, but it seems to me the only reason to use it in the cost-driven commercial vehicle business is as a tax incentive. This will go away, and interest will wane. Diesel will still be the main fuel of choice in 20 years.

"Improvements will come with higher-pressure injection systems, and incremental efficiency increases, like with lubricants. Ultimately we need to learn how to make better use of an engine's waste heat."

Taking to the piste

Cummins Engines provides Kässbohrer Geländefahrzeug with QSL9 engines for the PistenBully 400. Made in Darlington, UK, the 8.9-liter turbocharged six-cylinder

MAIN IMAGE: **The PistenBully 400 relies on the 8.9-liter Cummins QSL9 to deliver 370hp and maximum torque of 1,519Nm**

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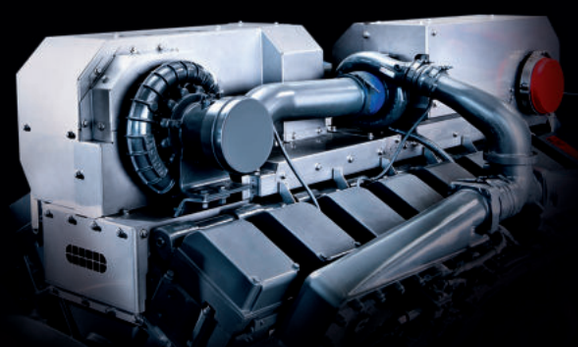
Steffen Cronauer – Director Technical Sales Thermamax



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units produce 370hp, with a torque of 1,519Nm at 1,500rpm. As Steve Nendick, Cummins communications director, observes, "These engines differ from our normal engines as they have been specially adapted for the cold climate. As well as a block heater and a fuel heater, we specify low viscosity oils, such as 5W 30, instead of 15W 40."

Also unique is the control software, Nendick elaborates: "This includes several cold-start parameter changes, such as pre-heat time and fueling table changes. It's not only cold start, but cold start at high altitude."

Kässbohrer adds a few features to its machine as well; for example, during cranking there is alternator decoupling and pressure-relief valves in the hydraulics. For those vehicles destined for Antarctica, an oil pan heater is installed. Here, sometimes operators need to start up at -40ºC but, once the engine is running, it usually won't be shut down again.

The PistenBully unit is compliant with Stage IIIA/Tier 3, but Nendick notes: "For Tier 4 Final, the use of SCR and AdBlue aftertreatment systems means additional components will be required to keep it working at low temperatures. There needs to be capable heating of the AdBlue. Electrical heaters on the lines as well as a coolant-based heater in the tank are the solution here."

In fact, Cummins has a long and interesting history when it comes to cold-weather innovation. It supplied a pair of its renowned H-6 units to the Antarctic Snow Cruiser, built in 1939, which featured an unusual twin engine and electric drive combination – as the feature on page 54 reveals.

The cold hard facts

Perkins also features cold-weather options for the majority of its range. Martin Parker, technical manager, notes, "Challenges not only include starting the engine, but thermal management of the aftertreatment; providing sufficient heat to the operator [the cab heater draws its heat from the engine] and the time it takes for the engine to warm up.

"Also we would mandate fluid changes – notably oil to cope with the viscosity change – and would advise heating various systems such as the DEF tank lines and breather. A cold-weather pack is also available, including ether start and cylinder block heaters."

A Mercedes-Benz Actros (still in camouflage) undergoing winter testing to -40°C in Rovaniemi, Finland. The company tests many of its industrial engines in trucks like this

While the control software stays the same, mechanical components such as batteries, starters, power cables and alternators are selected dependent on the application, as the machine's parasitic load will change with temperature.

Parker continues, "We design our engines with differing fuel qualities in mind, but not for additives. Looking forward, developments in the way we integrate the engine and the powertrain are likely."

SPARK OF INNOVATION

Diesel may be king in the industrial world, but petrol still has its place. Rotax has been installing its engines in snowmobiles since 1962, and currently the company makes 2- and 4-stroke engines for a variety of uses, including BRP's Ski-Doo and Lynx ranges, industrial ATVs and even the Sea-Doo wet bike.

Thomas Uhr, general manager at BRP-Powertrain, observes, "Designing engines for cold weather poses specific challenges. For snowmobiles, we design down to -40°C, so tolerances are smaller due to the different elongation factor of the materials, such as an aluminum crankcase versus a main bearing and crankshaft made out of steel. So if the calculations and matching of those components is not properly done and extremely accurate, it could lead to a seizure at low temperature."

Uhr points out that the machines must also be able to start at low temperatures without a battery if necessary, stressing the importance of using oil with an appropriate viscosity, especially on the 4-stroke units.

There are further design differences between the cold-weather engines and their ambient-temperature counterparts. Uhr continues, "One of the main differences between Ski-Doo engines versus, for example, the Can-Am ATV engine, is the coolant system.

"With the ATV radiators, as with car engines, ambient air passes through to cool the liquid. On the Ski-Doo, the aluminum body frame is used instead – the snow does the cooling."

Rotax has created a custom ECU to cope with the changes in altitude. Again in common with cars, both the 2- and 4-stroke systems use sensors measuring temperature, air density, throttle position, RPM, and so on, to govern what the injectors do.

Over the years, Rotax has tested various biofuels. Uhr notes, "With ethanol, there are problems due to the affinity of alcohol to water. This may lead to reduced performance in the short term, and excessive corrosion of fuel system components in the long term.

"We remain open minded, but in the short term the best way of handling emissions is by good design. For example, the modern Rotax 2-stroke snowmobile engines have been equipped with the state-of-the-art E-Tech direct fuel-injection system, which allows the engine to operate as lean as possible under all conditions."

Testing times

Part of Volvo CE's development process for new engine technology involves testing prototype machines in the far north of Sweden, where temperatures drop well below -30°C. The engine technology for its latest generation of machines was tested in the deepest point of winter at the Kiruna mine – perhaps the largest and most modern underground iron ore mine in the world.

Here, a Volvo customer who operates at the production site incorporated the prototype articulated haulers into his fleet. This meant that not only could Volvo engineers collect data and monitor performance in a real-life situation, but they were also able to understand how the new technology felt from the operator's point of view. Other tests included repeating standard working cycles and cold-start optimization.

Each winter-testing expedition involves around 100 engine and machine engineers, who together carry out hundreds of tests over the month-long expedition. The expeditions and tests are repeated twice – the first time during the development phase and again later on in the process, for verification.

Taking it to the other extreme, these tests are also carried out in demanding applications in the punishing heat as well as at high altitudes. Testing is carried out in climate chambers and test rigs at Volvo facilities.

MAIN IMAGE: **Testing the latest generation of Volvo articulated trucks involved repeating standard working cycles and cold-start optimization at the Kiruna iron ore mine in Sweden**

ABOVE: **Henrik Amann, director engine and auxiliaries at Volvo CE: "Stored electrical power... could be used to help start the machine in freezing conditions"**

When asked about the differences between cold and ambient engine specs, Henrik Amann, director engine and auxiliaries at Volvo CE, notes, "As much as is possible, the engines are the same. However, there are some differences between cold and ambient engine specs, such as electric block heaters.

"The Siberian Kit option for Volvo's articulated haulers has been designed to allow machines to work in extremely low ambient temperatures, down to -40°C. The kit contains a variety of modifications to crucial sub-systems, including electrical equipment, batteries, the hood, fuel supply and the radiator."

Amann also sees securing engine startability in cold climates as an important design challenge to overcome, as well as material specification so that parts don't crack. "The latest generation of our machines equipped with Tier 4 Final/ Stage IV engines now incorporate SCR, so in cold climates the tank and hoses containing the liquid are heated so that dosing can start as soon as possible after a cold start, and so that the reduction agent remains in liquid form. This is one of the key design features for Volvo machines that was tested during the winter expeditions."

As a key part of the testing and validation process, prototypes are also tested at high altitudes. The latest generation of machines was tested 3,500m above sea level in Les Deux Alpes, France.

For fuel, Amann advises, "For operation in cold climates, it is essential to use fuel with a low cloud point. It is usually the case that the fuel sold in Arctic climates has these properties. Volvo CE does not recommend the use of aftermarket fuel additives; instead we advise the machine operator to speak with the fuel supplier to ensure they use the correct fuel for cold climate operation."

Building prototype machines commits a lot of time and resources, so the manufacturer is developing new methods to increase the amount of virtual testing and simulation that can be conducted. The aim of this is to shorten the development cycle and also ensure that when the prototypes are built, they are of a higher quality and much closer to the final product. In the future, Amann believes the company will be able to skip early prototypes and build a more mature model with a higher level of accuracy that's much closer to the final machine – saving both time and money.

He concludes, "Looking further ahead, I think we will see more electric hybrids on the market. The stored electrical power in these could be used to help start the machine in freezing conditions." **iVT**

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PETER CAPPELLUCCI

Test the water

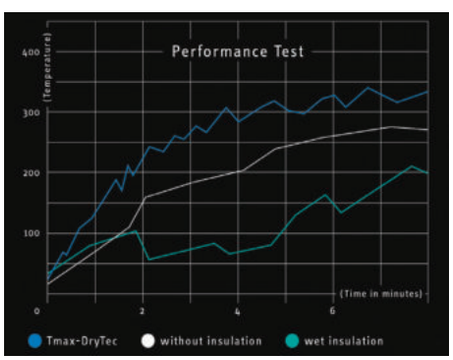
IN COMPARISON WITH CONVENTIONAL HIGH-TEMPERATURE INSULATION THAT CAN QUICKLY BECOME SATURATED, THE MARKET'S FIRST WATER-REPELLENT TECHNOLOGY HAS PERFORMED REMARKABLY WELL IN TRIALS

Thermamax has developed what it claims to be the world's first hydrophobic insulation fiber for high-temperature applications in the on-highway, off-highway and automotive market sectors. In wet weather or during engine washing, the porous fiber material used in traditional insulation systems quickly becomes saturated, particularly in vehicle underfloor installations. This has several negative consequences, such as delayed light-off performance, and the reduced durability and effectiveness of the insulation system. But thanks to the newly developed Tmax-DryTec technology, the insulation fiber is water-repellent and the high-temperature insulation lasts longer and has a better performance.

With conventional thermal and thermoacoustic insulation systems, liquids mixed with dirt particles such as salt can penetrate the insulation, particularly during engine washing or through condensation or spray in poor weather conditions. Porous insulation material can easily become saturated as a result.

The consequence is a delayed light-off performance in the exhaust aftertreatment system, as this loses valuable heat which is needed to dry the fiber. Fuel consumption and exhaust emissions will also be correspondingly higher during this phase.

The durability of the insulation system is also adversely affected due to the dirt deposits and water accumulating in the fiber. These deposits can also reduce the effectiveness of the system and, in the long term, even lead to failure. Insulation systems installed on a vehicle underfloor – such as DPF and SCR modules, silencers or thermoacoustic systems – can be particularly affected. The latter type often feature a perforated outer shell with a design at risk of damage or reduced effectiveness.



Test cycle with a 3-liter diesel passenger car

ABOVE: **Exploded view of an SCR module employing a 3D fiber-formed component with Tmax-DryTec**

Watertight system

One effective measure to protect insulation systems from the ingress of water is to employ water-repellent insulation fiber. Tmax-DryTec uses hydrophobic fiber elements to improve the performance and durability of high-temperature insulation systems. Compliance with future emission regulations is made simpler and fuel consumption reduced.

Trials on a test vehicle have demonstrated that an insulation system using the Tmax-DryTec technology ensures a faster warm-up phase and improves the performance of the exhaust aftertreatment system. The hydrophobic fiber elements repel the salt, dirt and dust particles along with the water and prevent deposits being formed. The fiber therefore stays clean, increasing durability and the optimum degree of insulation.

Comparative salt spray tests (3x72 hours) between conventional insulation systems and the hydrophobic Tmax-DryTec technology have demonstrated that salt deposits were less than 2.5g/m² using 7mm-thick Tmax-DryTec fibers, whereas deposits of 50g/m² crystallized salt were present in the insulating material of the conventional system. Further tests to determine the level of water ingress to the insulating material have shown that Tmax-DryTec insulating fiber absorbs 400 times less water than traditional fibers. **iVT**

BELOW: **Salt-spray tests in accordance with DIN EN ISO 9227**

Based in Mannheim, Germany, Peter Cappellucci is research & development manager at Thermamax

ROBERT LANG

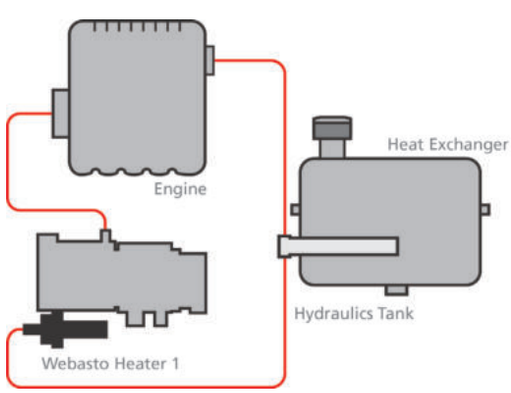
The cold war

SUBZERO CONDITIONS DON'T JUST MAKE LIFE UNCOMFORTABLE FOR THE OPERATOR – MANY OF THE MACHINE'S FUNCTIONS CAN SUFFER TOO. BUT INNOVATIVE SOLUTIONS ARE AT HAND TO AVOID ENGINE IDLING, REDUCE OPERATING COST AND INCREASE WORKPLACE EFFICIENCY

Low winter temperatures often present huge challenges at construction sites – for both the people who work on them and the machines they operate. Clammy fingers and a chilly cab can affect concentration, which may become more than a safety issue as the performance of construction machinery also declines. The battery no longer holds a charge, the viscosity of lubricants and liquids drops, and until the engine and hydraulic fluids reach their operating temperatures, vehicles cannot be operated efficiently. This applies for the initial start of the machine and for subsequent downtimes and breaks.

When construction machinery is shut down, the engine and the cab quickly cool off. That is why idling the engine continues to be a widespread practice at construction sites. The downside is that idling, which comprises up to 50% of operating hours, is a key cost factor of construction machinery that can substantially lower the value of the capital goods. The greater wear also increases maintenance frequency, reducing the warranty claim period accordingly, and thereby lowering the resale value. In addition, it results in an unnecessary increase in fuel costs and environmental impact due to higher pollutant emissions.

The engine-independent Webasto water heaters mitigate this problem. Because they are integrated into the engine's coolant circuit, they preheat the engine, enhance the driver's comfort and can be intuitively operated via user-friendly control units.



The tank for the hydraulic fluid can be easily integrated into the water circuit

ABOVE: **The heating solutions by Webasto could make the widely prevalent idling of construction equipment a thing of the past**

LEFT: **The Webasto Thermo 90 ST is ideally suited for use in construction equipment**

Preheated hydraulic fluids

This technology also benefits machines equipped with hydrostatic drives, such as excavators and small and midsize wheel loaders. The Webasto water heaters can be easily combined with heaters for hydraulic fluids, preheating them before the engine is started.

At the American company Pacific Rail Services, for example, engine preheating of its wheeled loaders was typically performed by idling the engine for half an hour, and subsequently running it for another 30 minutes at maximum speed with a fully depressed accelerator. The intent was to accelerate heating up the engine, cab and hydraulic system.

But after cooperation with one of its distributors, Cummins Northwest, Webasto installed a Thermo 90 ST water heater with 9kW heating power and an Arctic Fox Hydraliner into a Pacific Rail Services wheeled loader, where the tank for the hydraulic fluid was integrated into the water circuit. This produces tangible benefits for the company: the operator of the vehicle can now produce an extra hour of work in the morning – the time previously required to preheat the wheeled loaders. This saves fuel and operating hours and considerably reduces maintenance expenditures.

No need for engine idling

In addition, Webasto has developed its Engine-Off technology specifically for construction equipment. One ingenious feature is that during work breaks, the temperature inside the driver's cab is automatically maintained at the desired level. With the engine off, the residual heat is optimally used by having the still-warm coolant continue to flow through the vehicle's circuit. Only when the sensor detects temperature falling below a pre-defined set point will the parking heater automatically switch on again.

The Engine-Off technology is also very easy to use: when starting work, the operator merely has to push a button to activate the system. The heating system is now available as original equipment, but can be easily retrofitted with a few additional components. **iVT**

Robert Lang is director product market management heavy duty, Webasto Thermo & Comfort SE

MIKE CULLEN

Get on with it!

AFTERTREATMENT MAY DECREASE REGULATED EMISSIONS BUT IT CAN ALSO PENALIZE OPERATOR PRODUCTIVITY – UNLESS YOU'RE USING AN ENGINE SYSTEM THAT ENABLES SEAMLESS OPERATING, THAT IS...

Nothing provokes more debate than the issue of productivity. Defining it, delivering it and measuring it are exercises that have taxed the best brains in the off-highway machine business, yet to those at the sharp end – the machine operators – it is probably true to say 'they know it when they see it'.

For them, productivity is as much a function of their experience doing the job as it is to do with the machinery they are operating. The expectation is already there that the machine will dig, load or haul, but it is the application of knowledge and skill that boosts productivity – i.e. getting the job done quickly, efficiently and at minimum cost. Time is money!

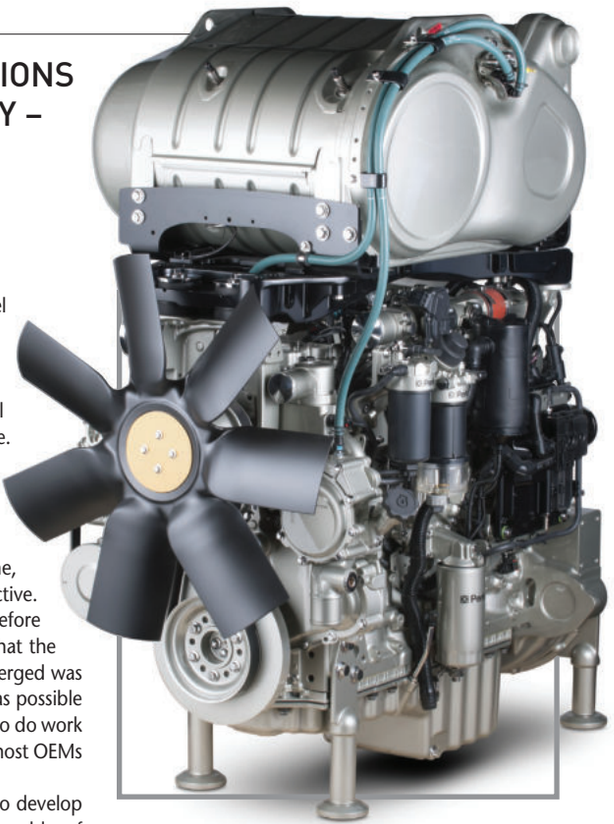
Whether it is digging in layers when trenching, selecting the right operating mode, or selecting the right gear to avoid spinning wheels and achieving optimum rim pull, it is essentially the operator's technique and know-how that delivers productivity.

And, of course, the assumption is that productivity is primarily based on machine uptime. However, in the new era of US EPA Tier 4 Final/EU Stage IV emission standards, that assumption could well be challenged. The addition of aftertreatments – namely diesel oxidation catalysts (DOC), diesel particulate filters (DPF), and latterly selective catalytic reduction (SCR) – have posed new challenges for manufacturers of industrial vehicles in terms of operational continuity and the impact on the duty cycle.

With any SCR-equipped machine, optimal temperatures are required to ensure the SCR system works in terms of meeting the emission standards, as well as keeping it robust for the life of the machine, while ensuring the machine remains productive.

As an engine manufacturer, Perkins therefore talked to its OEM customers to find out what the best approach might be. The view that emerged was that as little intervention of the duty cycle as possible was required. Machines sell on their ability to do work – and in the competitive markets in which most OEMs operate, any advantage is highly prized.

The company's response was therefore to develop a robust thermal management system capable of meeting the tight operating parameters of SCR, while offering full machine availability.



ABOVE: **Perkins 1200 Series engines use passive DPF regeneration, which does away with the need to perform any kind of forced regeneration**

Perkins has developed its aftertreatment system to operate seamlessly at high altitudes as well as in cold environments

Perkins has developed its aftertreatment system to operate seamlessly at both high altitudes and in cold environments, testing and validating a number of machines in the most arduous of climactic conditions to ensure effective SCR at every stage of the duty cycle.

Similarly, the company has employed the same seamless operating approach to the DPF. Perkins 1200 Series engines, equipped with a DPF, use passive regeneration, which is totally transparent to the operator and does away with the need to perform any kind of forced regeneration.

Overall, the benefits are clear. Both aftertreatment strategies enable operators to get on with what they are good at – making the machine as productive as possible. With no lights or dial needed in the cab for aftertreatment maintenance, they can concentrate fully on the job without the distractions of warning lights or checking dials. In addition, no specialist training is required, so that cost is removed, leaving operators to get on with what they do best – extracting maximum productivity from their machine. **iVT**

Mike Cullen is a Tier 4 marketing specialist at Perkins

PATRICK THIL

Swept to power

WITH AN INNOVATIVE MODULAR DESIGN, FAUN'S VIAJET ROAD SWEEPERS APPEAL WORLDWIDE – NOT LEAST FOR THE CHOICE OF AN ENGINE THAT ENABLES PLENTY OF POWER AT LOW RPM

BELOW RIGHT: **Awista keeps Düsseldorf roads clean using ViaJet sweepers from Faun Viatec, all of them powered by JDPS engines such as the PWX 4.5L (left)**

BELOW LEFT: **This ViaJet is fitted with Faun's eco-friendly Aquatherm hot water system to remove oil spillage without detergents**

Faun road sweepers are in action around the globe, through urban streets, on construction sites, industrial areas and even airfields. A recent order for multiple ViaJet roadsweeper units from a customer in the Middle East clearly demonstrates that this German manufacturer is doing something right, and helping to make the world a cleaner place.

"The key factors for our success are smart design, green technologies, and personal support worldwide," explains Helmut Schmeh, managing director of Faun Viatec. "The modular design lets us build units that match the specific needs of each customer – whether a municipality, construction company, or industrial contractor – quickly and efficiently, using standardized components. With our proven air-recirculation system, the internal airflow generates energy that accelerates the sweeping in the suction mouth. The sweeping process is quicker and cuts down on air pollution. And finally, Faun customers can rely on a trained support network wherever they are, with expert advice and spare parts readily available."

The ViaJet 7 Expert is one of Faun's sweeper models that has been specifically designed for specialized sweeping applications in challenging environments such as road construction or industrial cleaning. The truck-mounted sweepers, with a hopper capacity of 7m^3 (247ft^3), have high-pressure washing systems that can be arranged in a variety of ways, and a large water supply from the 2,100-liter (554 US gal) tank. They can also be customized with fine surface cleaners or Faun's eco-friendly Aquatherm hot water system, which removes oil spillage without detergents – a boon in urban areas where road accidents are common.

Picking up savings

But their appeal goes far beyond power: they rely on engines that keep fuel consumption, as well as noise, down. And each ViaJet 7 Expert sweeper is fitted with an 86kW (115hp) JDPS PowerTech E 4.5L engine.

"The price is right, the engine fits nicely, and the PTO is easy to adjust," explains Schmeh. What's more, the engines contribute to keeping production costs down: "By giving the sweepers enough driving power at a low rpm, we can reduce the noise insulation material to a minimum. And by driving the engines at optimal torque, we can restrict fuel consumption to under 5 liters (1 US gal) per hour."

John Deere engines – the PowerTech PWX 4.5L in this case – also drive the ViaJet 6 Professional model – the best seller in Faun's range. This highly versatile unit can be used in urban, construction and industrial applications, and comes with a broad selection of attachments. The sweeping body can be demounted from the chassis in under 20 minutes – a useful option for operators with varied and changing applications.

With the support of local John Deere distributor DGS, Faun recently integrated the auxiliary PowerTech PWX 4.5L engine in order to meet the Interim Tier 4/ Stage IIIB European emission regulations. "DGS has been very helpful in supplying information on the new Interim Tier 4/Stage IIIB engine design, and how to integrate it in our new-generation sweepers," says Schmeh. "I appreciate how they're always quick to respond to our questions." **iVT**

Patrick Thil is manager OEM engine sales EAME Asia Australia for John Deere Power Systems

MATTHEW DELZELL

Power trip

USED STAGE IIIB MACHINERY IS ALREADY MAKING ITS WAY TO LESSER-REGULATED, AND OFTEN WARMER, CLIMES. WITH A WELL-THOUGHT-OUT MIGRATION STRATEGY, CATERPILLAR'S SIMPLIFIED SOLUTIONS HAVE BEEN DESIGNED WITH THE CUSTOMER IN MIND

For decades, Caterpillar has sold – and will continue to sell – new, purpose-built engines and equipment that meets the needs of customers operating in all regions of the world. Complex issues crop up, however, when used Stage IIIB products that were originally manufactured for operation in highly regulated countries (HRCs) migrate to those with less stringent – or even no – non-road emissions standards.

To avoid any problems arising from issues such as widely varying fuel quality and fuel sulfur content, Caterpillar has followed an aggressive migration strategy ever since the day development began on its popular Stage IIIB products, introduced in 2011. Thanks to this strategy, Cat dealers are well prepared to help new owners enjoy peak productivity from their used Stage IIIB products.

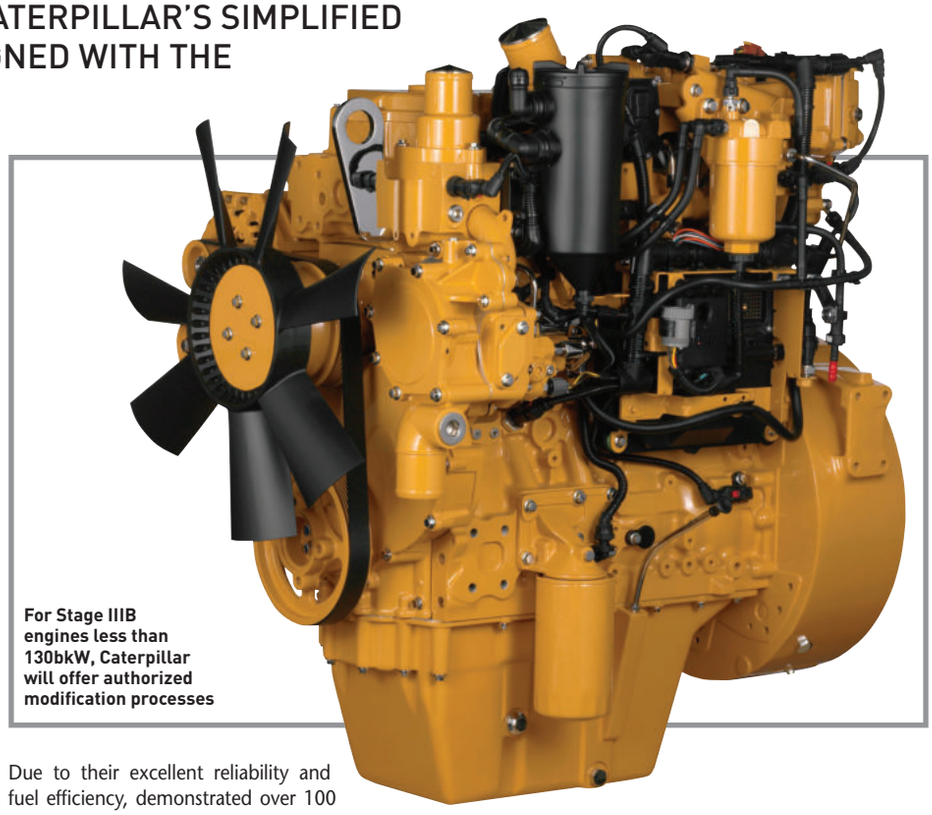
All diesel engine manufacturers marketing products in HRCs, including the USA, the European Union and Japan, must abide by the stringent standards that have been established in those areas to decrease exhaust emissions. To enable Caterpillar and other OEMs to meet the emissions standards, HRCs have also regulated the allowable fuel sulfur levels. Phased in since 1996 in the USA and since 1999 in the EU, the standards first went into effect as Tier 1 or Stage I. With each phase that followed, regulations required increasing reductions in particulate matter (PM) and in oxides of nitrogen (NOx).

Today the Stage IIIB and Stage IV standards are in effect, requiring engine manufacturers to achieve the ultimate goal – near-zero emissions of PM and NOx in non-road diesel engines.

Tailored by power range

To meet the increasing demands of the emissions standards, Caterpillar recognized early on that no 'one size fits all' solution exists for the range of products it manufactures for different environments. Hence, it tailors its emissions solutions by engine power range, using a selection of building-block technologies such as reliable air-management systems, advanced fuel systems, durable aftertreatment solutions and new electronic controls. This tailored approach gives it the flexibility to develop the optimal solution for specific machines and applications.

The Cat Stage IIIB field population has grown rapidly to over 100,000 products operating in HRCs.



For Stage IIIB engines less than 130bkW, Caterpillar will offer authorized modification processes

Due to their excellent reliability and fuel efficiency, demonstrated over 100 million operating hours, customers from all over the world, including those from lesser-regulated and non-regulated countries, have bought or shown increasing interest in purchasing used Cat Stage IIIB products. Without question, these desirable products are on the move.

This movement, however, creates complexities in terms of purchase and support decisions for customers in countries that have never had to consider the implications of operating Stage IIIB products.

Caterpillar has determined that used Cat Stage IIIB engine systems between 130bkW and 895bkW (7-32 liter engines) will not require any modification for operation in lesser-regulated countries. For Cat Stage IIIB engines less than 130bkW, Caterpillar will offer authorized modification processes that safely remove aftertreatment from machine and commercial engine configurations to enable operation in lesser-regulated countries. These modification processes, which include decertification, will be made available to customers in certain lesser- and non-regulated countries through their local Cat dealers beginning in December 2014.

Happy to help

Due to the successful execution of this migration strategy, local Cat dealers are ready for the arrival of used Stage IIIB products in their territories. Through extensive training, dealers know which products will or will not require modifications to overcome location-related issues, such as fuel quality, to operate at optimal levels. They also have parts in stock, service tooling and product information available, including details about specific product availability.

Those interested in purchasing used Stage IIIB Cat products in non-HRC locations should work with their local Cat dealer to ensure compatibility with local fuel supplies as well as to verify that the importation and modification of the engine configuration, when required, does not violate local emission regulations or import restrictions. **iVT**

Marketing and sales support supervisor Matthew Delzell is an expert on Tier 4 engine and aftertreatment systems and has worked for Caterpillar for 10 years

MARK WASS

About turn

WHEN YOU'RE OPERATING AN 80-TON REACH STACKER, IT'S NICE TO KNOW IT WILL GO EXACTLY WHERE YOU POINT IT. A NEW SAFETY CONTROLLER IS KEEPING LINDE'S MODELS SAFELY STEERING IN THE RIGHT DIRECTION

Linde Material Handling, a member of the Kion Group, ranks among the world's foremost manufacturers of material handling, forklift and warehouse trucks, and is the market leader in Europe. In addition, the company now offers its extensive know-how, gained during decades of developing and manufacturing hydrostatic and electric drive systems, to external customers for a wide variety of applications.

Manufactured by the company's Heavy Truck division, its reach stacker is a key piece of machinery for loading and unloading ISO containers at ports, together with road and rail freight. Linde's customers often operate these reach stackers in small port authorities, resulting in their drivers frequently having to tackle tight turning circles throughout their normal working day.

However, the operator can steer these 80-ton reach stackers with ease using just a single joystick. Offered as an option, the joystick provides a simple and ergonomic solution to this application. Due to the new European safety legislation EN13894 that relates to electrical systems, and is referenced in the Machinery Directive, it was critical that Linde implemented a system that would meet the requirements specified in the EN15000 standard.

Safety controller

The ifm CR7021 safety controller, certified by TÜV to PL d and SIL 2, was designed into the heart of the machines' control systems. As the CR7021 safety controller is a fully programmable device, this meant that the FDS (functional description of software) application was translated and programmed by the Linde engineers, using CoDeSys software, without requiring any external assistance. Any adjustments or modifications required during development were therefore carried out efficiently.

The impressive 80-ton reach stacker picking up an ISO container with ease, making it at home in ports around the world

Driver's view of steering in tight spaces with the optional single joystick

The IP67 housing meant that the CR7021 safety controller could be mounted directly onto the truck chassis, thereby aiding installation. The control system harness was connected with the CR7021 safety controller via the single 55-way AMP connector, ensuring the high sealing rating.

The monitoring of the various input signals, together with controlling the outputs for the steering system, was achieved through the 40 configurable I/O channels of the CR7021 controller, with a choice of digital, analog and high-frequency inputs matched with digital, PWM and current-controlled outputs.

PWM valves were chosen to precisely control the steering mechanism proportionally, this being a fundamental aspect of the design when steering such a large machine.

Dual redundant signals were taken from both the transmission over CAN (J1939 protocol) and via a pulse pick-up sensor on the driveshaft to allow the control system to dynamically adjust the joystick's sensitivity in relation to speed, going from 'lock to lock' with a single movement at slow speeds.

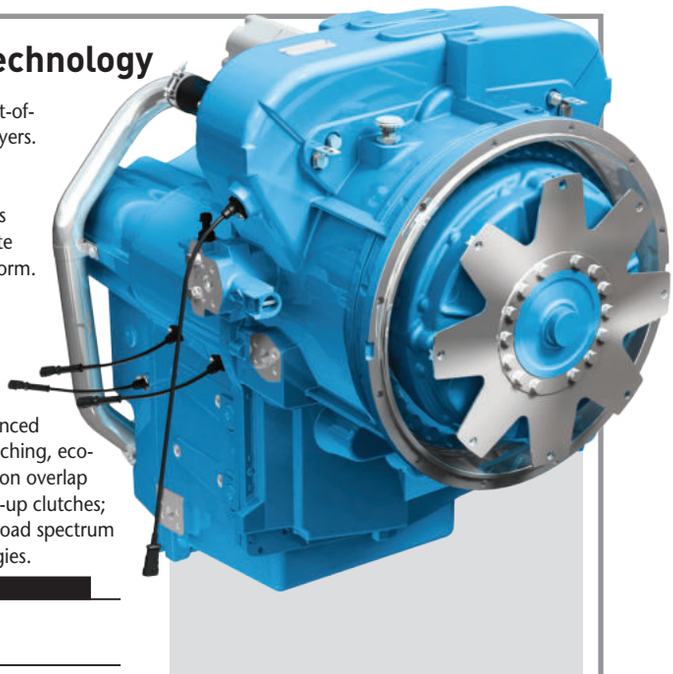
The ifm fully programmable CR0451 color display acts as a multifunctional operator interface, mounted in the cab, and provides the driver with several dynamic views. An accurate graphical position of the rear steering wheels, crucial when changing between the two steering modes, together with vital diagnostic information on the steering system, allows for quick and effective problem solving, if required.

With this project, ifm was therefore able to ensure that Linde's customers were steering safely in the right direction. **iVT**

Mark Wass works as UK mobile industry sales manager for ifm electronic

BULLETIN BOARD

Something for everyone with four-tier forklift technology



Dana Holding Corporation currently offers a four-tier technology platform of powershift transmissions customized to meet regional requirements and preferences for forklift trucks and other material handling vehicles.

The company will continue to offer a wide range of capabilities across these four tiers by building on a common transmission platform that is suitable for all markets. This strategy allows OEM machine designers to configure a series of vehicles in the same power range with a wide selection of features that require minimal alterations to the packaging envelope.

The tiers include a full range of options, from basic transmission configurations for emerging markets supplying proven performance and long-term durability, up to high-feature transmissions for developed markets incorporating cutting-edge technologies for maximizing fuel efficiency and productivity.

Dana has thoroughly tested these features to determine the efficiency gains of these options and help OEMs quantify the total cost-of-ownership benefits for equipment buyers.

Spicer T30 and TE30 powershift transmissions for reach stackers and heavy-duty forklift trucks with engines ranging from 225-300kW demonstrate the versatility of Dana's four-tier platform.

Available features will include optimized clutch capacity; intelligent lubrication and cooling; high contact-ratio helical gears for reducing noise; upgraded software and enhanced hardware that enable advanced control capabilities, such as precise inching, eco-drive, power drive, and next-generation overlap control; converter freewheel and lock-up clutches; and streamlined integration with a broad spectrum of advanced parallel hybrid technologies.

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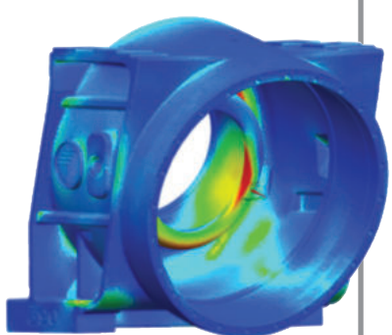
Quote Ref: **507**

Drum drives mix with the best

Bonfiglioli's Trasmital 500 Series of drum drives for transit mixers has been extended with a new model designed for drum capacity up to 18m^3 and enhanced with an electric version to meet the specific requirements of hybrid truck applications.

The new model will benefit from a major redesign, including a new oil-lubricated oscillating system integrated in the gearbox to meet demanding applications and a modular design approach that allows the configuration of several features and options, such as in-line or offset input for a flexible motor installation, integrated PTO for water pump drive, integrated speed sensor and a wide ratio availability.

The new 590 has been designed in Italy, leveraging the experience of the 250,000 units produced so far – in Italy, Slovakia, India and China – and the most advanced simulation and design verification techniques. These include a specific laboratory test stand capable of reproducing the duty cycle of the real application and includes continuous and intermittent torque application along with the radial loading due to the drum weight, while a hydraulically actuated four-bar linkage system is also capable of reproducing the oscillation and dynamic forces of the truck.



As a result, the new design has been proven to be extremely robust and capable of handling even higher degrees of oscillation between the drum and its support – this is now becoming more aggressive due to the higher elasticity typical of modern truck frames when driving both on- and off-highway.

The 590 is also being offered in an electric version for hybrid truck applications, where the mechanical construction includes a helical parallel gear input reduction that features a 60kW liquid-cooled AC motor and an optional emergency motor with quick mechanical disconnect.

This version is not only attractive due to its proven higher efficiency and reduced fuel consumption during the loading/unloading phase, when the drum can be powered by the truck's batteries alone, but also for the reduced exhaust emission and low noise levels, which reduce its environmental impact and make it much more desirable for use in built-up areas or for night-time work.

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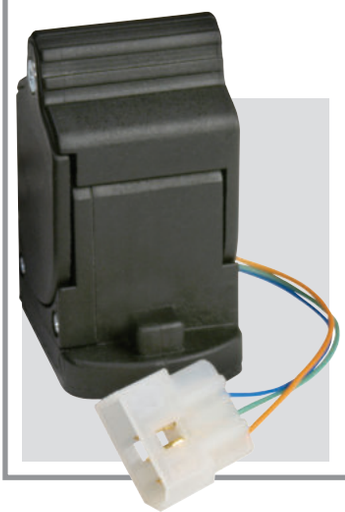
Quote Ref: **508**

Put your finger on it

JR Merritt's FS1 ultra-compact, Hall-effect, finger-operated joystick controller features a compact, lightweight and robust design that makes it ideal for a variety of applications, including in-cab control panels, portable radio control boxes and pendants.

This single-axis, Hall-effect joystick features a 2.2in (55mm) actuator height and glass-filled Zytel housing.



Moisture-resistant, non-ferrous components and conformal-coated electronics provide exceptional durability and ruggedness for use in industrial vehicles, mobile machinery, on- and off-highway applications, and for in-plant process control where dependability and long life are paramount. The non-contacting, Hall-effect sensors provide long life and reliable control for harsh environments. The extension-style spring return offers smooth and precise operations.

Sealed to IP55 specification, the FS1 joystick meets or exceeds CE EMC requirements.

An optional boot sealed to IP66 is available, making this device suitable for application in corrosive and hostile environments. Other options include a 2.6in actuator height, friction brake, step detent, 7-30V input, redundant output and low power consumption.

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Quote Ref: **509**

Faster gets into oil and gas

Constantly focusing on continuous improvement activities and new product development, the R&D department at Faster has recently developed a new range of couplers for oil and gas application ranges.

The new HNVFR and OGVFR series was specifically tested and certified (third-party certification provided by Lloyd's Register) to fully comply with BOP (blowout preventer) applications in the oil and gas industry.

Certification by Lloyd's verifies full compliance with API 16D standards, with five minutes of fire exposure at 700°C, at full operating pressure without leakage or pressure loss. This ensures that the product will maintain pressure during a short time to prevent leakages from fuel sources.

HNVFR and OGVFR couplings are pictured below, and can be easily identified by the red paintwork on the female sleeve and on the male body.

Technical features include:

- Maximum working pressure connected from 21MPa to 34.5MPa;
- Outstanding impulse pressure resistance;
- Excellent internal flow rate;
- High resistance to severe conditions and dirt environment;
- Mate500 CrIII coating treatment;
- Available sizes: 08 (½in), 12 (¾in), 16(1in) and 20 (1-1¼in).

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Quote Ref: **510**

So major projects
don't bite the dust:
www.tougher-whatever-the-conditions.com

Off-highway champions

TOUGHER WHATEVER THE CONDITIONS: THE NEW MTU SERIES 1000 TO 1500

MTU presents its Series 1000, 1100, 1300 and 1500 engines to meet the requirements of EU Stage IV and EPA Tier 4 Final. Based on Mercedes-Benz technology, these diesel engines cover a power range of 100-460kW, and are extremely robust, reliable and fuel efficient. For manufacturers of off-highway machinery and the end-users, this all boils down to trusted quality, as designed by MTU.

The company's newly developed Series 1000 to 1500 engines complement the established Mercedes-Benz OM 924, 926, 460, 501 and 502 engines. Like their predecessors, they find use in performance-hungry construction and industrial applications such as haul trucks, wheeled loaders, rotary snow ploughs, mobile cranes, telescopic handlers, excavators and underground mining vehicles.

Reliable, durable drive concepts offering a high degree of operational availability are the solution of choice for these machines – and the 4R 1000, 6R 1000, 6R 1100, 6R 1300 and 6R 1500 engines satisfy these demands. They are based on tried-and-tested Mercedes-Benz utility engines and have been developed specifically for use out in the field.

The new engines meet EU Stage IV and EPA Tier 4 Final off-highway emissions standards by means of exhaust gas recirculation (EGR) and a straightforward system of selective catalytic reduction (SCR) – and all this without the need for an additional diesel particulate filter and the active regeneration this would entail. This eliminates unnecessary additional fuel piping and the potentially dangerous temperatures involved in regeneration, and also saves the fuel otherwise needed to restore the filters to optimum performance.

Tougher whatever the conditions: the new MTU Series 1000 to 1500

The basic idea behind the development of the exhaust gas aftertreatment system was to provide off-highway equipment manufacturers with a sturdy, space-saving system. From the outset, MTU regarded engine and exhaust aftertreatment as one integrated system: engine components, including the control system, harmonize perfectly to satisfy the demands of the EU Stage IV and EPA Tier 4 Final standards.

Despite stricter emission requirements, MTU Series 1000 to 1500 engines consume less fuel and AdBlue than their forerunners, which meet EU Stage IIIB and EPA Tier 4i. Compact design and standard mechanical and electrical interfaces minimize integration costs as well. And the new engines really pack a punch in day-to-day operation: their rugged design enables them to deal with the sudden, hard load changes associated with constantly changing operating states. They develop plenty of low-end torque and maintain it over a wide speed range. The use of lightweight materials, such as cast aluminum and synthetics, also lends them an excellent power-to-weight ratio. This makes the new Series safe and reliable in operation without compromising economy – so major projects don't bite the dust.

The 260kW MTU 6R 1000 is used in Bomag BM 1000/35 cold planers

Wirtgen's cold recycler/soil stabilizer WR 200i, powered by an MTU Series 1100 six-cylinder in-line engine

In its new type 457 wheeled loaders, JCB relies on MTU 6R 1000 engines with an output of 197kW

INDEX TO ADVERTISERS

AS THE INSIDER COMES IN FROM THE COLD AND WARMS UP WITH ONE HOT TODDY TOO MANY, COMMUNITY SERVICE VEHICLES ARE THE FOCUS OF HIS WRATH. SHOULDN'T THEY BE A BIT LESS, ERM, OFF-HIGHWAY?

Surprisingly, there was actually life before Facebook, laptops and even cell phones – sad to say that I remember those days all too well. The lack of these distractions enabled me to use my 'surplus' time when on business trips to explore the regions in which my customers were located, simply because I was in the area.

As at that time, the majority of our clients were based in Europe, I used to find myself regularly skirting what was then known as the Iron Curtain, the border of the West and the Eastern Bloc countries. One customer, who manufactured road rollers, was based in a German town so near to the border that, with time on my hands one evening, I drove out that way just for curiosity's sake.

AS I WIPED THE SLUSH FROM MY JACKET AND THE SALT FROM MY EYES, I SAW A YELLOW AND BLACK SIGN AND THE PENNY DROPPED

You can probably imagine that this turned out to be an anticlimax and eventually I struck a road block with plenty of signs warning me to go no further. Around about 2km prior to the final roadblock though, there were signs aimed particularly at serving militia, as well as another bizarrely claiming that beyond that point there would be no *Winterdienst*.

This floored me! Even my trusty dictionary had no reference, so I had no idea what it meant. Being something of a linguist, I was able to translate the 'winter' bit myself, and also recognized 'dienst' as 'service'. Was it a military reference? Was it a special road surface? Was it a secret area that I should not have entered? On that mild summer evening in Germany, I could not imagine to what it referred.

Some months later, however, I experienced my first true snowfall in this area and was passed on the street by a huge orange vehicle with a snowplow blade mounted at the front, then another with a huge hopper and revolving salt spreader. As I wiped the slush from my jacket and the salt from my eyes, I made out the yellow and black sign proclaiming *Winterdienst* on the back of the hindmost vehicle and the penny dropped. The duet of vehicles I had just seen were part of the fleet of community service (*Kommunalfahrzeuge*) vehicles that Germany – and I guess many other central European countries – offers to the inhabitants of its various communities.

Illustration: Julie Welby

The provision of these vehicles is, it seems, big business in these areas. When the machines are not busy plowing snow over pedestrians and parked cars or blinding them with salt spray, they are refitted with curious implements to scrub the streets or wash road signs (no, I'm not kidding) – in fact, all the services that should rightfully be provided to good citizens of one of the cleanest countries in Europe.

Now, it may be that this demand offers a huge sales opportunity (this opinion is clearly shared by most of the tractor manufacturers that are operational in these markets). Indeed there are also companies producing forestry machines that view this market avariciously.

However, if you take a look at the format of *Kommunalfahrzeuge*, they are surely crying out to be based on a conventional road-going chassis and not on a standard or modified off-highway vehicle like a tractor. To be effective, these vehicles need the equal front/rear axle loading of a road transport machine, the ability to house the load near to the center of gravity of the machine and, most importantly, a forward-mounted cab, as it will spend much of its life on the road network.

Despite this, the marketing organizations of most of the big OEMs insist on hanging salt hoppers and load cages off the back of their products, painting them orange, and investing huge amounts of time and money trying to convince various municipalities to accept what is clearly an agricultural tractor as a suitable product for this application.

It isn't. The weight distribution of an ag tractor has a natural bias to the rear, so it cannot take a large-capacity hopper behind the cab. It has two or three million forward gears and several thousand reverse gears, and while it probably does a good job of plowing snow, it has rubbish forward visibility on road and is a liability to other road users when fitted with a snowplow blade. They are not suitable – period.

My opinion, for what it's worth, is that tractor OEMs lose sight of the focus when local influences entice them to attack this market. They should just sit back and ask whether the effort is really worth it, decide that it's not, and spend the money elsewhere. Actually, like a lot of the marginal sectors of the market, these applications should be left to OEMs who class themselves as 'special vehicle manufacturers'.

For the big guys, it makes no more sense to dabble in this now than it did 30 years ago, or to expect 2km of unplowed snow to halt a Soviet invasion… or do I misunderstand? **iVT**

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