**RICHARD CARR**, iVT INTERNATIONAL

DECIDING THAT THE ORDINARY BACKHOE LOADER JUST COULDN'T CUT IT, DIVERTO WENT ONE FURTHER – OR TWO FURTHER, IN FACT. BY ADDING TRACTOR AND BOOM MOWER FUNCTIONS TO THE USUAL EXCAVATING AND LOADING, AND THE ABILITY TO OPERATE 200 ATTACHMENTS, THE RESULT IS ONE OF THE MOST MULTIPURPOSE MACHINES AROUND

# DUTCH ARMY KNIFE

MAIN IMAGE: **The industrial vehicle equivalent of a shotgun shack: two doors either side of a spacious, flat floor provide superb and speedy access to and egress from the cab**


You can't beat a good double-take to pique the interest at an exhibition, and this was exactly what happened to me at Intermat this April. Passing through Hall 5A, I clocked an unusual, yet beautiful, machine on the stand of Diverto, a name that had promised much when it first came to public attention with Sunward, before abruptly falling off the radar a couple of years later. Yet the vehicle in question was nothing like those original SWEL concepts that were rather like a squat compact crawler excavator.

So what was going on, I asked Diverto managing director Leonard Huissoon? "We got to know Sunward in 2006, and there was a good 'click'," he explains. "But it later began a public offering on the Chinese stock exchange and things became more difficult in terms of priorities, etc. It was also very hard to persuade them of the need for a European finish and quality level in terms of ergonomics,


The QS 100 boasts three patents on the folding boom alone

finishing and using the most suitable materials for corrosion resistance.

"Then, after Bauma 2007 where we presented the prototype, the financial crisis happened and Sunward refocused its attention on China, where the market was still booming. So then I made a Plan B, where we designed and patented a three-point hitch and PTO function on a machine as a rough concept and, rather than just elaborating on the compact excavator platform, we created a new concept where all functions would deliver a much higher performance. So it all ended amicably – it just didn't work out quite the way we planned."

The result was the four-wheeled QS 100, with Q standing for 'quattro' due to the four main functions – tractor, mobile excavator, wheeled loader and boom mower (although approximately 200 attachments are suitable for use) – and S for 'synchro', or the synchronisation of those. Dubbed 'a superfunctional tool carrier' and boasting a higher power to weight ratio than an equivalent-

# Call me a cab

## A COLLABORATIVE DESIGN APPROACH SPEAKS VOLUMES, AS CHIEF DESIGNER FOR BSI, **DAVID BOWLER** EXPLAINS

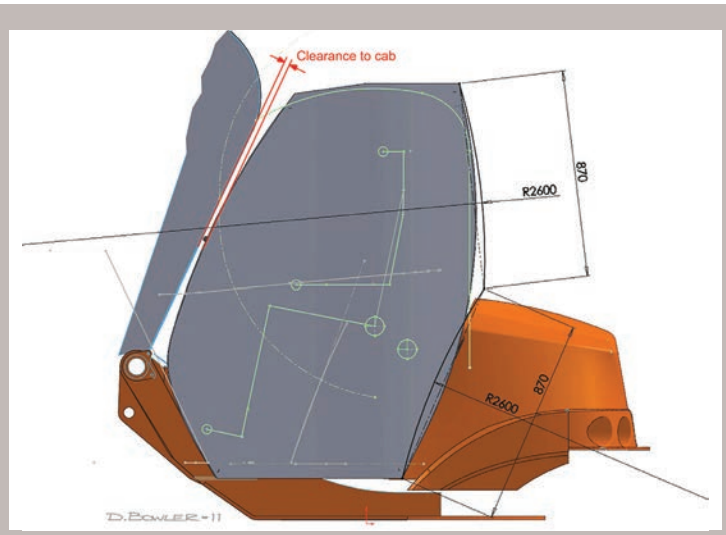
At the Bosal-Sekura Industries (BSI) production facility in Randers, Denmark, no two cab lines look the same. This is normal, because the company is a specialist in designing and producing bespoke safety cabs. BSI's cabs are designed to meet the unique functional requirements of its customers' needs. That said, however, there are sometimes similarities between cab revisions, as customers often see a certain value in keeping some DNA from the old model, whether functional, technical or visual. That is, of course, product evolution over time.

Evolution is one thing, but what about a completely new machine concept? These are particularly exciting projects for the designers at BSI as they form the basis of a new line of evolution. One such project came with the forming of a working partnership with the Dutch company Diverto Technologies BV, when BSI was asked to design, develop and manufacture the cabs of its radical and completely new Diverto QS machines.

The Diverto QS has many worldwide patents and model rights granted, including the cabin. Diverto also has many patents pending, so what's so special about the QS?

"There are four main factors we're very proud of," says Leonard Huissoon, the company's founder. "Firstly, the super tool carrier concept, with its 'synchronous tool' operations, has been designed and engineered to be a zero-compromise solution, using the features of the four functions – tractor, mobile excavator, wheeled loader (both sides) and boom mower – to strengthen the other functions.

"For instance, the power-to-weight ratio and road speed are exceptionally high for an excavator and a loader. The full boom and cabin rotation offer






Early 3D concept sketches exploring the cab geometry and construction

size wheeled loader, it is even possible to simultaneously dig with the boom while running a wood chipper from the 65hp rear PTO.

"Diverto means being different, very versatile, and as it all ends in 'o' it sounds very nice!" Huissoon adds. "People think we're Italian but we're actually Dutch!"

## Making the switch

There are certain resemblances between the Diverto QS 100 and the SWEL models, however – the main one being the unusual folding boom that enables a rapid transition from excavating (extending to just under 6m, and 3m deep) to loading (1,800kg capacity to a height of 2.9m). From a distance it might look identical to the boom on the SWEL models, but improvements have since been made, resulting in three exclusive patents on the boom alone.

Switching from excavator mode to loader mode is incredibly simple. Not to mention very quick – in the prototype's manual operation, it takes just 60 seconds to disconnect the work tool, move the stick inwards, folding it against the middle section of the arm to form a mechanical connection, which then folds against the first boom section and is again mechanically linked. "So the forces taken up by the quick coupler can be withstood by not just one boom section but by all three," Huissoon explains. "On the production models the procedure will be automatic, but with low-speed operation due to safety regulations, so will probably require 90 seconds."

That surprisingly straightforward procedure notwithstanding, surely an operator must find it tricky or counter-intuitive when attempting to lift a load or start mowing right after a few hours of intensive digging?

"It has taken us from our first prototype in 2005 up to now, after adding tractor and mowing boom functions, to discover how to design the best HMI," he admits. "Those four functions in one machine took us two years to find the right design of the cab and controls. But now the joystick movements and the buttons for the tilt rotator, etc, are the same as for a traditional excavator.

"If you're in wheeled loader mode, you move the right joystick and those operations are equally the same. If you're used to operating a normal tractor, it feels just like moving the three-point hitch and PTO – we use the same colours, and the same positions for your fingers.

"Then comes the most difficult part – a professional boom mower operator will want all the mowing functions on the right joystick while he steers with the left. We couldn't find many options available, but we found elobau's joysticks ideal as they have a lot of functions, so we don't have to use the same button for two

RIGHT: **Final cab design (patent pending) by Diverto**

significant advantages in, tractor, loader and mower operation with respect to operator visibility to attach tools; faster load-up and dumping actions; and four-side visibility for safety."

The second factor is that the boom, the superstructure and the undercarriage – complete with three-point hitch and PTO – have been engineered to place the operator at the best possible angle for all diverse operations. This design facilitates the space to be able to offer an exceptionally wide and comfortable cab. Other machine standards and product segments (e.g. excavator, boom mower) do not allow for such design freedom. Diverto has therefore made the cab design one of the highest priorities in the total vehicle design, and has included a certified secondary seat.

A further benefit is the folding boom system, which allows for a much lower weight than, for instance, a backhoe loader with two boom systems. The Diverto concept has been able to keep the GVW low because it always rotates the counterweight with engine opposite the load, offering a compact low weight for all applications with tools and materials hanging on the boom. This agile, compact and low-weight design offers a clear advantage in the market.

Finally, the automotive-style, tough and super-comfortable interior positively reflects both the on- and off-highway characteristics of the machine.

## Detailed brief

The brief given to BSI was to propose a cab geometry that fitted the QS's unique architecture. The frame and the glazing forms needed to achieve maximum interior space within the available envelope on the machine and provide maximum operator visibility to work zones. While offering great access into the cab, there had to be a stylish and dynamic form – yet it also had to be cost-effective to tool and produce in the required quantities.

Initially, several cab styles and structures were proposed by the BSI design team and supplied in 3D CAD, enabling both camps to evaluate the pros and cons of these cab forms in context. Diverto was then able to select its preferred solution based on advice offered by BSI and added requests for further features based on these concept discussions. Once the basic silhouette of the cab and machine took shape, the focus switched to adding detail and developing the systems for both the

functions. So the operator doesn't have to think in a different way when he presses a button; it's exclusively for one function, very straightforward and intuitive. This is really only possible with a CANbus system."

## Open-door policy

Of course, I wasn't the only one to get excited about the QS 100. Having immediately earmarked it as an ideal candidate for our September issue, I then had my thunder stolen slightly when industrial designer David Bowler submitted an article on behalf of cab supplier Bosal-Sekura last month, covering its involvement in the project. So I've taken the unusual step of incorporating that into my own feature (see *Call me a cab*, page 44) as the QS 100 is so innovative that there's still plenty left to talk about – even on that cab.

Take the two-door arrangement that enables the operator to enter and leave it from either side, for example. This is something that few excavator operators will be familiar with, but when the cab rotates 360°, just how necessary is that really?

"The idea was that because we're looking at the landscaping and tractor markets, we should incorporate it as it's what they're used to," Huissoon explains. "But say, for instance, you are using it as an excavator or boom mower, and you're working on a busy highway. You might have to stop in a certain position, and not be able to rotate fully, so you would have to climb out of the side next to the traffic. That caused quite a packaging challenge, but now when you want to get out, you just tilt the right console upwards – it's very comfortable to exit from either side."

## A glass act

Sitting in the prototype at Intermat, I had admired the almost entirely glass (Lexan) doors and the superb visibility they provided, but Huissoon says the production version has done away with the central metal strut – even though the obstruction it caused wasn't a patch on that created by the traditional excavator boom.

**A fish-eye view through the steering wheel highlights the console's portals, which provide views of the wheels, as well as the bucket when digging right up to the machine**

"We don't have that problem as our boom is at the front [being offset-mounted on the chassis, there is a clear, unimpeded view to the bucket directly ahead of the operator] but we knew the doors had to be clear all the way to the bottom, so that it gives a safe feeling to operators. Despite them being ROPS and FOPS, we also kept the A- and B-posts really minimal, and


cabin and the machine. This was done simultaneously by both Diverto and BSI's in-house teams, sharing data and technical information on a daily basis in order to ensure that the product met all target criteria and meshed together to form a seamless and stylish design. Supportive assistance from potential component and subsystem suppliers also helped keep momentum in the project.

The cab was required to pivot upwards around its front iso-mounts, thereby providing fantastic service access to many areas on the machine in one simple action. The engine, hydraulic pump and associated holding tank are designed close-in to the rear bulkhead and floor areas of the cab as part of the mass centralisation and compact nature of the machine. This highlighted the need for optimal acoustic and thermal isolation properties over the floor and rear bulkhead areas. Double-density PU mouldings were therefore proposed for those areas of the interior, giving designers the opportunity to incorporate the shape of the buddy seat and some useful 'rattle free' storage areas in a 'one-shot' operation, rather than the usual combination of ABS and foam-backed fabric. The interior trim package could therefore be offered as a suitable solution for both canopy-style and full comfort-cab machine options.

## Surprise package

The cab floor and bulkhead areas needed to mesh with the complex geometry of the chassis structure in order to give the best possible driver ergonomics and keep the overall height of the machine to a minimum.

In short, this was a very challenging packaging exercise. Every component had to be considered for its shape, size and positioning, in addition to its function, quality and performance.

A collaborative design team is essential to resolve such tricky packaging and performance issues. The QS has many applications, so the operator cab needs to accommodate all these aspects. Regular brainstorming sessions enabled these complex requirements to be met. A mix of hardworking, fresh-thinking, young design engineers, working closely together with much more experienced engineering and design personnel, has yielded great results.

As the bond and respect strengthened between the two companies during the early stages of the project, Diverto expanded the project with BSI to include the overall styling of the machine, as well as detail design of body parts such as the engine hood and side skirts.

The result of that decision was very beneficial, because the core design team was kept to an optimum level, enabling fast design iterations and keeping the focus on both the technical aspect and the product styling.

It needed to be done this way because many of the core components and subassemblies have been developed with modularity in mind. The cab is just one of the modular subsystems that will be integrated on a number of different-sized models in the revolutionary QS range.

This machine just could not have been created successfully through a 'boardroom-led, design-by-committee' approach. A close-knit team of specialists was needed for a product as radical and feature-packed as this, because it is important that designers are able to relay important aspects in the most direct and quickest way possible, in order to enable key decisions to be made quickly – and for the right reasons.

Thanks to such a successful and close collaboration between BSI and Diverto, the unique DNA of this machine is now firmly established in line with the vision originally set out by Leonard Huissoon and his team. Bosal-Sekura is pleased to have played a key part in bringing the QS to life. Let the revolution begin!

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ABOVE: **The innovative cab and engine hood tilting is a patented feature by Diverto. No additional counterweight is required, helping to maintain a low ground pressure**

because you're sitting in the middle of the cab and are further away from the posts than in a normal excavator, the dead corners on both sides are equal, while the blocked angle of view is also less than with a smaller, narrower cab.

"Then the steering console has an opening so that when you look through the top of the wheel you can look straight down to where you are working, which is vital as you can dig right up to the machine on all sides."

Mounted on the right console, the Parker IQAN colour display provides a clear view of all machine data, with no joystick etc obstructing any part of it. This LCD screen is in line with the A-post, as is the mounting point for a tablet computer. Although the latter would currently only be for personal use or perhaps for scrolling through machine manuals, rather than downloading data, Huissoon is waiting for new developments that could offer some exciting possibilities: "We don't use it to steer or control the machine at this stage, but there is definitely potential for that."

In the upper right corner of the cab is the radio which, if the double-DIN option from Pioneer is taken, comes with a GPS system. A rear-view camera comes as standard with this option, so the radio/GPS doubles up as the video screen for extra safety.

## Light on its feet

With municipalities and landscapers a primary target market, weight saving was a major priority. Market research had revealed that an abundance of machine features were welcome – as long as this did not negatively impact on ground pressure.

"Therefore, we don't use castings as a counterweight," Huissoon says. "We've chosen a 4.5-litre engine [a 100bhp Tier 4i John Deere] that's relatively heavy compared to its power but that makes it possible to avoid adding a casting while still having good balance in the machine. Locating the DOC/DPF in one of the stacks behind the driver helped keep the hood short too, so the tailswing is just 25-40cm, depending on tyre choice. We expect gross vehicle weight will be 5.6 to 5.7 tonnes."

With low ground pressure so desirable then, why was a wheeled machine produced – especially given Diverto's tracked origins? "There's always a possibility to go back to crawlers, whether the standard kind or quad-track," he claims. "However, our market research showed that the use of excavator and loader functions, with three-point hitch and PTO, requires higher speeds and more mobility, so we chose to go with wheels first."

As a result, the hydrostatic transmission means that trailers can be towed at up to 40km/h, speeding the time to the job site and yet again reducing the need for an additional machine. "We've limited space in the chassis, so one of the main reasons we chose Linde Hydraulics' pumps and motors was because of their smaller build-in space. The quality's also very high and they were very willing to help us to tune the components."

These are linked to Dana axles, which Huissoon says were chosen on the grounds of some attractive features that the supplier has yet to announce. The 4WD vehicle has just one steering mode – front-wheel steer – though this effectively becomes rear-wheel steer when, for example, in wheeled loader configuration the load is more suited to the rear fixed axle rather than the oscillating front axle.

## Share magic

There are four Parker hydraulic pumps, operating the transmission, boom, PTO, and cooling and steering. And while Huissoon rather casually mentions its load-sensing abilities, the flowsharing that was so vital for a 'superfunctional tool carrier' with 130 l/min auxiliary flow was rather more difficult to achieve.

"We needed a CANbus-controlled valve block with flow-sharing, and it took us about six months to evaluate the different blocks available. We chose Parker for the main valve block, and because it was also very compact, it fulfilled all our requirements. We also tested the IQAN system, and found that it's very comfortable to work with as engineers due to its tuneability. It's very robust too.

"Hydac is really strong in proprietary customised designs, so we used its smaller valve blocks on other features. Again, they're very compact, which was necessary in both the lower and upper chassis. They've given us very good support – in fact, all these companies have really jumped into this project!"

Manufacturing of the QS series – bigger and smaller versions of the modular machine are planned – will take place on a new assembly line set up at the VDL Steelweld facility in Breda, following the announcement of a close co-operation between the two Dutch companies.

Production is scheduled to begin imminently, with several orders having been received from four dealers of A-class-equipment based in the Netherlands, Switzerland and Germany. It is hoped that more dealers will be found to cover most of north-western Europe by 2013. **iVT**