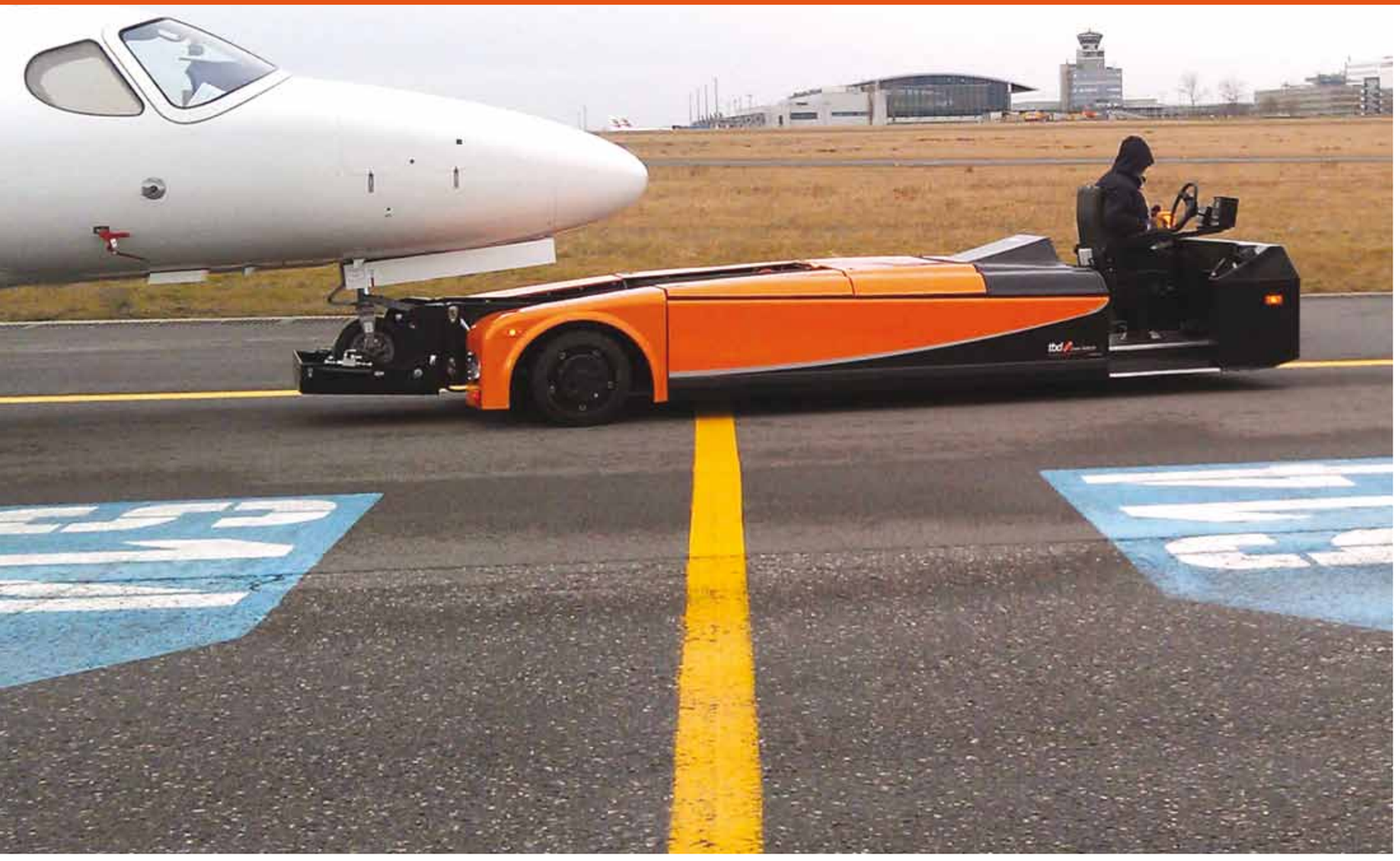
TUG OF PHWOAR...

EYES WERE OUT ON STALKS AT INTER AIRPORT WHEN TBDUK UNVEILED THE JET TUG. IT MIGHT LOOK MORE LIKE A SEXY SPORTS CAR, BUT THE EYE-CATCHING DESIGN OF THIS NEW ELECTRIC AIRCRAFT TUG HIDES SOME TECHNOLOGY THAT ENGINEERS WILL DROOL OVER



LEFT: **One of TBDUK's first designs for the open-cab version of the Jet Tug 35-50**

Words like 'sleek' and 'stylish' have rarely been synonymous with aircraft tugs, but the Jet Tug 35-50, TBDUK's new offering that pulled in the crowds at Inter Airport last month, may be set to change that.

The project started in late 2011, as Phil Summers, technical director, explains: "This is our first tug, as well as our first venture into electric vehicle production. The company has historically specialised in towed and chassis-mounted equipment using commercial vehicles chassis for toilet trucks, potable water trucks, scissor-lift maintenance trucks and the like. However, we saw a gap in the market for a general aviation electric tug."

TBDUK therefore examined the market carefully so as to identify exactly who the end product should be aimed at.

Summers explains: "We are entering a market where there is a lot of money and some customers are very image-conscious, so they are quite comfortable spending a lot of money on their private aircraft. So it was clear that we had to differentiate ourselves from our competitors; just performing the task was not enough.

"We wanted a visual impact, with a vehicle that even looks great beside a multimillion-pound business jet. It is not a sports car, but it does look a bit like one – and that's what we are aiming for!"

Autodesk Inventor 3D CAD was used for the concept work. A series of scale models was then produced and refined, and some trial mouldings created in GRP. The general structure of the new machine was set in stone quite early on in the process.

"We wanted to use a combination of steel for the chassis and GRP for the upper body," explains Summers. "For the body, we considered other materials, but we ruled out Kevlar as it was not required from the strength point of view, and we felt aluminium would not give us the lines we were looking for."

As well as the focus on aesthetics, careful consideration was also given to operational practicality. During TBDUK's assessment of the daily working lives of these vehicles, it was observed that items such as strops and chocks are frequently tossed onto any flat surfaces that fall to hand. To accommodate this practice, a chequer-plate aluminium deck was designed to slot into the front section, with a pair of easily accessible steel side lockers built into the chassis.

A cab has been designed and the necessary fixings are in place, should one be specified by the client. This could be a fully enclosed unit or even just a roof section, depending on the prevailing local weather conditions. "But we don't have a convertible yet," jokes Summers.

The chassis itself is in effect a large steel box, divided into sections that are welded together. TBDUK is a specialist fabricator, so it is able to manufacture this item in-house.

Back and forth

Another issue for the design team that needed to be resolved very early on in the process was the driving

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MAIN IMAGE: **Some admiring glances for the Jet Tug following its unveiling in Munich**

INSET: **The striking display was customised to include data regarding runtime, state of charge and position of the steering wheels**

position. The very nature of aircraft tow tractors means they spend just as much time going backwards as going forwards, and Summers did not like how other manufacturers tackled the problem.

"Historically, when reversing, tug drivers have had to lean over to look behind," he explains. "Sometimes, these vehicles have two completely separate driving positions, facing in opposite directions. We rejected both of these ideas."

The company opted instead for a single rotating driving position, designed with ease of operation in mind. When a change of direction is required, everything spins through 180°, including the controls.

"We did also consider using joystick steering," reveals Summers. "However, after much discussion, we felt the industry wasn't quite ready for that yet. It would've actually been easier to design, but we settled instead for a more conventional steering wheel and a joystick drive control, with the system built into the right-hand-side seat arm. The system is fully proportional, and forward means forward, whichever way the driver is facing."

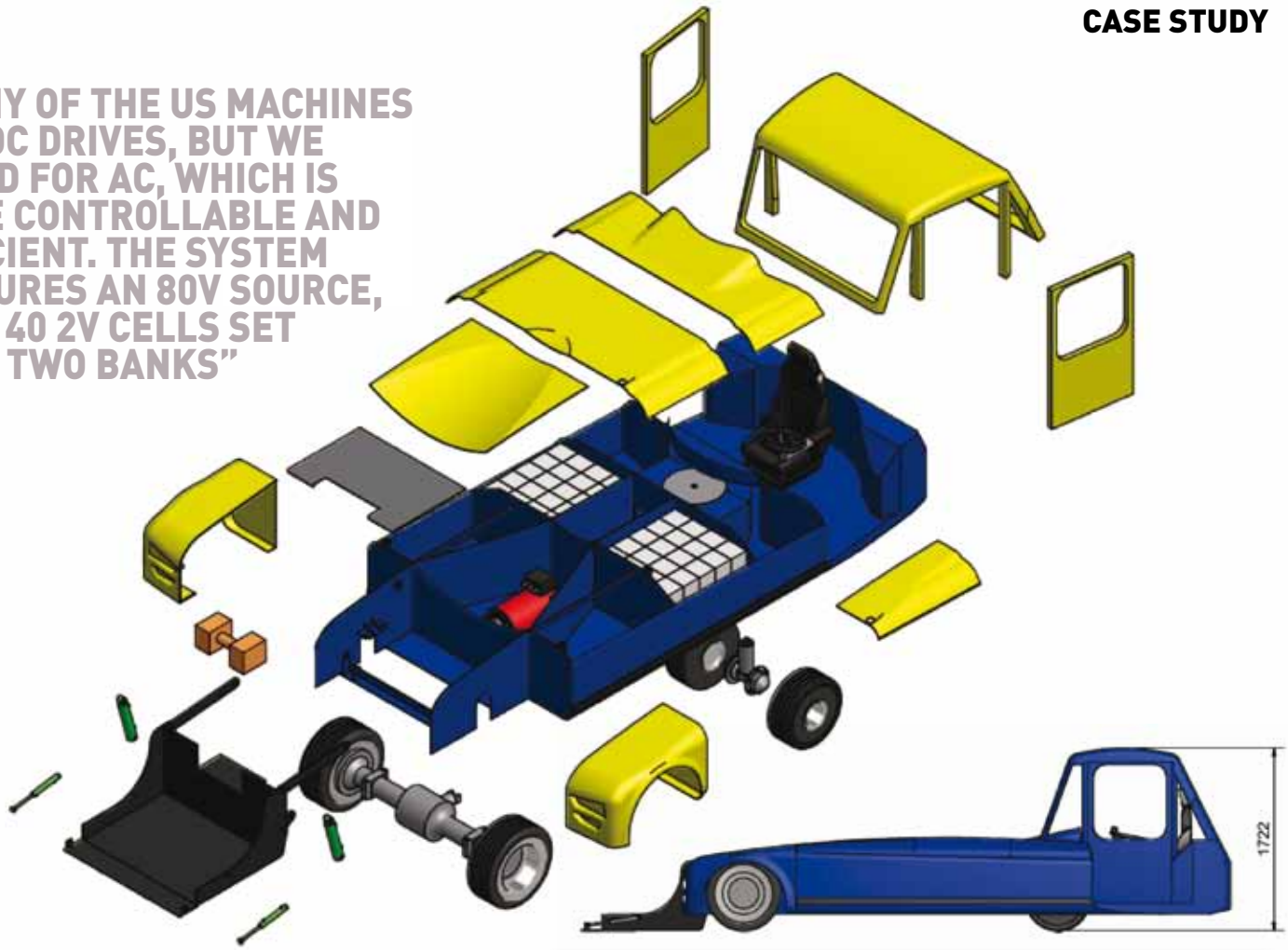
A CANbus system supplied by Curtis Instruments was developed to control all functions. "It had to be tailored to our requirements, as there was nothing available off-the-shelf," states Summers.

"We also wanted a bespoke display that featured speed, battery condition and steering wheel position, which is vital because the operator won't be able to see the steering wheels – this is particularly important when starting off."

In addition to these fundamentals, there are system warnings to indicate whether the bucket is up or down, whether it is loaded, and displays for lights and indicators. Everything associated with driving rotates with the driver's seat; the only immovable controls on the bulkhead are those for raising the nose wheel bucket, and the on/off switch.

Specifying the tyres was easy – they are simply stock press-on band Trelleborg items. On the other hand, specifying the wheels was not quite so straightforward, because of the limited production runs.

"MANY OF THE US MACHINES USE DC DRIVES, BUT WE OPTED FOR AC, WHICH IS MORE CONTROLLABLE AND EFFICIENT. THE SYSTEM FEATURES AN 80V SOURCE, WITH 40 2V CELLS SET UP IN TWO BANKS"



MAIN IMAGE: **An exploded view of TBDUK's design for an 80/100-tonne tug with cab. Parts in yellow will be manufactured from GRP; those in blue from steel; and those in grey from aluminium. The steel bucket is highlighted in black**

INSET: **Some passengers might be affronted by seeing an ugly tractor on the walk between their Bentley and executive jet – hence the beautiful styling of the Jet Tug 35-50**

Summers notes, "It is not cost-effective to have an axle made to your exact requirements when you are building only a handful a year, so we had to use an off-the-shelf item from JCB Drivetrain Systems. To get the load ratings we needed, we ended up with a particular hub size, so we had to source a custom wheel to fit our desired load-bearing figure. Ideally, we would have liked a smaller hub – and I think in the future these will become available."

Range finding

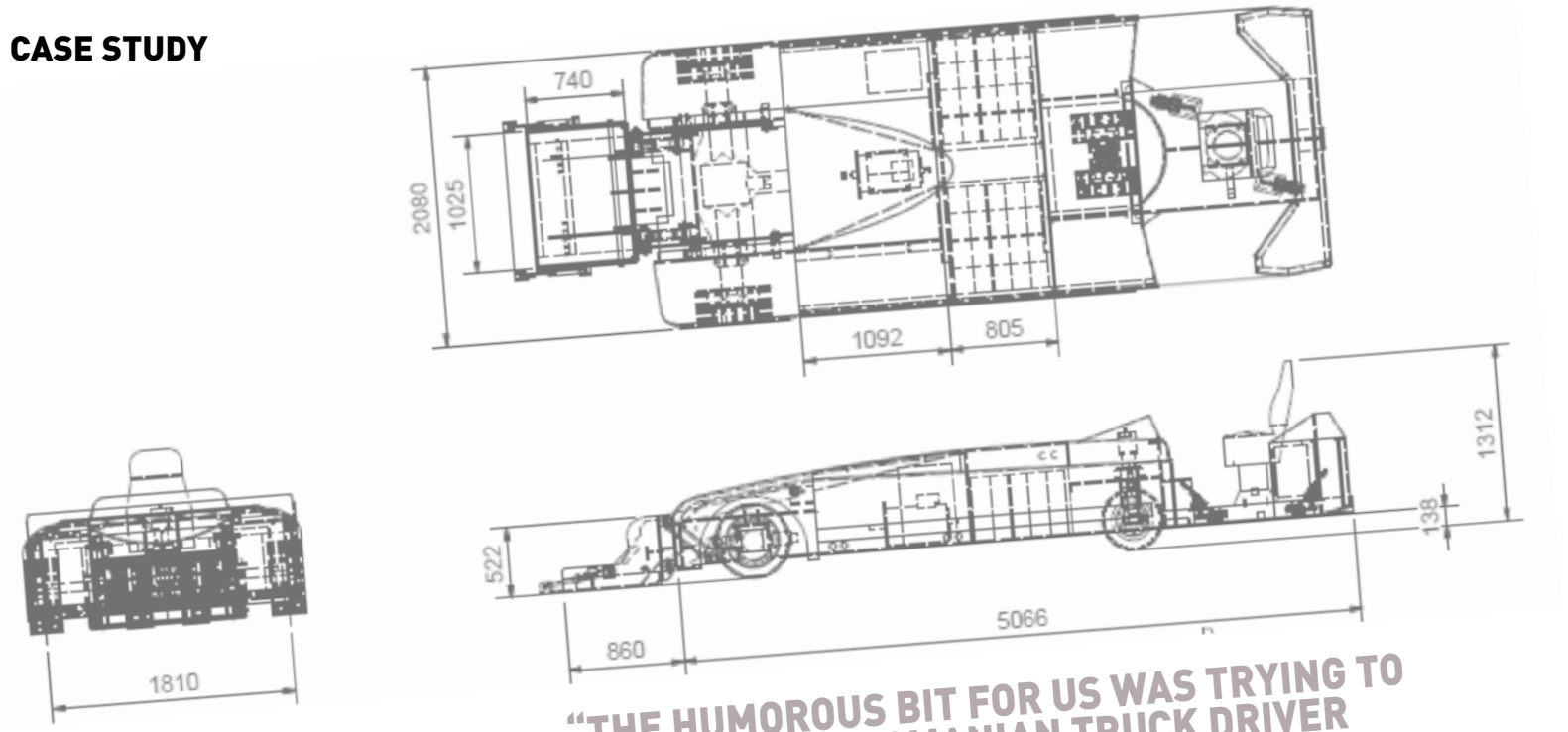
TBDUK plans to eventually build several variants; currently it offers two options: a so-called medium-sized one for aircraft up to 30/50 tonnes and a larger one for aircraft up to 80 tonnes. Prototypes are out in the field and working hard, though Summers cannot yet reveal who the customers are.

"What I can say is that we have had continuous feedback and it has been interesting! One thing that we thought initially might be a major selling point was onboard charging, but it now seems this may not be the case – it could be preferable to have the charger off the machine. This could enable us to use a larger unit with a quicker charge cycle.

"So rather than trying to make a selling feature out of having an onboard charger, we will be offering it as an option in the future. My suspicion is that more customers may opt for static charging."

Pondering the reasoning behind this, Summers concludes that it is all about vehicle size. Smaller vehicles can be easily charged in a variety of locations using a standard power socket, but larger machinery tends to be brought back to the same place due to the size and type of power supply required.

Curtis Instruments was also a partner in the development of the Jet Tug propulsion system. Summers explains the philosophy behind it: "Many of the US machines use DC drives, but we opted for AC, which is more controllable and efficient. The system features an 80V source, with 40 2V cells set up in two banks. The steering works on 48V, and there are various 24V auxiliary systems. The technology behind the motors is developing rapidly, so over time I can see these changing."



"THE HUMOROUS BIT FOR US WAS TRYING TO CONVINCE THE ROMANIAN TRUCK DRIVER WHO CAME TO COLLECT THE TUG THAT IT WAS A TRACTOR AND NOT A SPORTS CAR"

Electric may dominate the field at the moment, but Summers can see a time in the future when some form of hybrid system could be used, such as a small diesel charge engine.

Regarding future evolution of the driveline, Summers hopes to see improvements across the vehicle. "We would like to bring the loaded centre of gravity back, which will enable us to make it lighter and more efficient. We are aiming to get more distance between charges as well as eventually using smaller motors. The options are changing the axle configuration or going for integral wheel/hub motors. When we looked at the motors in 2011, there wasn't the load-carrying capacity, but that is changing all the time."

The current design uses a central single motor, with a conventional heavy power transmission axle and an electric parking brake. There is also an emergency hydraulic system incorporated in the axle disc brakes, although the joystick is designed to electrically brake and control speed in normal use. Built into this is a dead man's grip safety feature which automatically applies the handbrake when it is released.

ABOVE: **The chequer-plate aluminium deck above the bucket provides operators with a place to toss chocks without damaging the GRP shell of the Jet Tug**

In terms of range, the ability to successfully opportunity charge is an important feature of this type of vehicle. It is designed for intermittent use, and although it is difficult to gauge precise figures due to different aircraft weights and distances driven, TBDUK claims the tugs should last a shift without needing a charge.

Summers is full of praise for what Curtis did with the drivetrain: "One of the great things about the drive control system is the way it can be configured. Getting the theory right is one thing, but once in use it may need fine-tuning.

"Take basic speed control for instance: depending on the bucket position and load, we've set a normal drive mode and a creep mode. These are pre-selectable, so if we start with 4km/h for slow and 12km/h for fast, and then find we need to adjust these parameters, the control software can be easily reprogrammed. This has formed part of the customer trial, so during the commissioning process we can precisely adjust these things for each customer."

The design certainly seems to have raised a few eyebrows anyway. One unexpected problem occurred when trying to ship the tug over to Munich for Inter Airport Europe. Matt Hill, business development manager, says, "The humorous bit for us was trying to convince the Romanian truck driver who came to collect the tug that it was a tractor and not a sports car. It took over an hour on the phone, with company data sheets and photos being sent to his head office before he was happy…" **iVT**