Tailor-made solutions

STRONG, UNIQUE PRODUCTS CAN BE MADE WHEN THE NEEDS OF THE CUSTOMER ARE PUT FIRST AND THE TEAMS INVOLVED WORK TO PRODUCE INNOVATIVE, PRACTICAL AND PERSONALIZED FEATURES

When Italian forklift manufacturer Carer of Cotignola set out to design a heavy-duty alternating current (AC) forklift truck to compete with internal combustion (IC) vehicles, the company knew the vehicle's performance capabilities would have to include high speed, rapid acceleration, heavy lift capacity, suitability for outdoor all-weather operations and excellent operator ergonomics. But there was one major technical obstacle still to overcome.

"Normally an AC forklift of this size would have only three to three-and-a-half hours of autonomy," says company owner Luca Spreafico. "It's easy to refuel an IC forklift, but not so easy to change a battery or recharge quickly. So the biggest challenge we had to solve when we designed this product was to guarantee that the operator could complete an eight-hour shift on a single battery charge."

Carer accomplished that goal by reducing power consumption through several mechanical design choices and improving power management through the programmable CANopen-compliant motor and speed controllers provided and customized by Curtis Instruments Italy.

Carer's new A-series forklift trucks, the A80X, A80/900X and A100X, are the company's first vehicles whose braking relies solely on electronic regenerative brakes, which reduce energy consumption by recovering some of the energy used to stop the vehicle. The braking system can stop 25 metric tons moving at 20km/h (12mph) in only 8.5m (28ft) – all accomplished electronically through the Curtis speed controller.

Another first for Carer in the A-series vehicles is the distributor, or main control valve, which manages hydraulic functions of the mast, with a servo motor actuating lift, lower, tilt and side-shift.

The new front axle consists of a unique block of two independent units: right and left gearboxes and motors. Designed to optimize power consumption, the dual 15kW traction motors work at up to 5,400rpm, providing high torque and gear reduction, enabling the trucks to reach top speeds of 19km/h laden and 20km/h unladen. Depending on model and load, they can reach those speeds in 5.1 to 7 seconds. The 52kW pump motor provides the power to lift 8-10 metric tons at 0.38-0.50m per

ABOVE: **The Carer forklift model A80**

OPPOSITE: **Tiziano Penazzi, Carer's manager of electrical design, with Pasquale D'Orlando, Curtis Italy's director of sales**

second. All these design choices enabled Carer to deliver a high-efficiency system.

"It was important that we create a vehicle that would use less energy to do the same work. So this was a big improvement," said Spreafico.

Into the great outdoors

Since Carer intends the A-series AC forklift trucks to win converts from IC, the company developed these vehicles specifically to be operated outside in all environmental conditions.

Carer's highly advanced manufacturing technique ensures that the motors remain reliable and durable, even under stress. The motors meet the IP54 enclosure rating for protection against dust and water. All Curtis electronic control devices are environmentally sealed as well, so that the trucks can be operated in all types of weather.

Capabilities in the CAN

To make the A-series trucks even more attractive to potential customers, Carer has enhanced the operator experience with high-end appointments – all controlled through the CANbus system – that increase comfort, safety and visibility.

The luxury ergonomic heated seat features automatic weight adjustment, air suspension and lumbar support. The intelligently designed armrest includes integrated mini-levers and command buttons affording fingertip control, and the pedal system can be configured to specific customer needs. Although the physical design of the mast provides the operator with maximum visibility, the A-series trucks also include front and back cameras that are integrated with the Curtis enGage VII display, which automatically shows the appropriate image when the truck is moving forward, in reverse, or when the lift is operating.

Even the electronic brakes demonstrate the attention that Carer paid when elevating the driving experience in the A-series, according to Pasquale D'Orlando, general manager for Curtis Instruments Italy. "Most manufacturers focus on the drive, not the brake," he says. "Normally with an electric truck, as long as you are in drive, the feeling is fantastic. For the brakes, they simply choose a standard mechanical system." Such brakes can require uneven pressure to stop the vehicle, according to D'Orlando. The braking system in the A-series trucks, on the other hand, features an electronic pedal linked to a Curtis motor speed controller that increases or decreases braking torque in direct proportion to how much current the operator is requesting. This contributes to safer and more predictable braking. "If you push 10%, you know it's 10%," D'Orlando says.

"Carer paid the same attention to drive and brakes, so you have the same feeling when you drive as when you brake," adds D'Orlando. "Carer's goal was to have a very drivable vehicle. They did a great job on that; they know what the customer wants."

LEFT: **The Curtis enGage vehicle display instrument used as a reverse safety camera**

"In the past, this type of machine was more spartan than today. They had a very poor level of accessories," says Carer design engineer Tiziano Penazzi. "Now, modern servo systems allow more features, better ergonomics and higher safety. Without CANbus it would be impossible."

Turning the potential of CANopen technology into actual performance advantages is the job of 20,000 lines of customized code written in the powerful, yet easy-to-use Curtis vehicle control language (VCL). Including CAN communications control, I/O functions, feedback loop process blocks and software development tools, VCL enables virtually limitless customization of component functions and vehicle performance. VCL also enables software to be edited directly on the vehicle without having to open the firmware.

Working from Carer's initial specifications and performance objectives, Curtis proposed a control network using: three model 1238E motor speed controllers (one master for all system functions and right side traction, one slave for left side traction and another for the hydraulic pump); a model 1232E as the steering pump controller; and a model 1353 eXM I/O CANbus expansion module to provide additional input/output capabilities for the system. The Curtis enGage VII LCD display was chosen as the operator-vehicle interface.

As deployed in the A-series trucks, this 5.7in (14cm) advanced multifunctional LCD display enables end users to adjust the settings of the truck depending on their specific needs and applications. The enGage VII can display operating parameters such as vehicle speed, driving direction, battery state of charge, drive instantaneous consumption, battery voltage and working hours. Warning lights can show parking brake status, brake failure, seat switch status, headlights and reverse direction.

Carer chose to work with Curtis on the A-series trucks because it knew from experience that Curtis does more than simply supply devices – it also provides the software development necessary to turn the selected components into a fully integrated, fully customized vehicle control solution.

According to D'Orlando, software development for the A-series required customer support engineer Antonio D'Amore to work on-site at Carer one day a week for six months and to communicate with Spreafico or Penazzi almost every day.

A partnership-driven approach

While some large vehicle manufacturers may have software development and VCL programming capability in-house, Spreafico says that Carer appreciated being able to receive that support from Curtis. "Even though they are a very big company, they have the flexibility to work locally with a customer to develop new products," he says. "That is fantastic for us as we are a small company that wants to have the best components, but big companies sometimes don't want to work with us because the volume will not be very big. With Curtis we have a partner that gives us an amount of attention that is unusual for a big company."

Penazzi says, "Curtis was the perfect partner to help us improve the performance and efficiency of an electric forklift truck. The partnership with Curtis allowed our engineering department to bring to reality the idea of delivering the drive experience and productivity of a high capacity ICE truck in an electric forklift. The A-series is the last and most advanced expression of this joint research. Fast responses from Curtis allowed us to complete a lot of vehicle specialization in a short time." In fact, while the development of trucks such as the A-series might typically require up to two years, Carer and Curtis worked together to deliver the A-series in under one year.

Carer pushed its production schedule to take advantage of the rapid change in the IC-to-electric conversion market. According to Spreafico, Carer expects to quadruple its vehicle sales by 2020. **iVT**

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