



The fully automatic Wiggpod welding cell is characterized by high dynamics, exceptional path accuracy and high rigidity.

Innovative hexapod welding cell is ready for series production with PC-based control technology

## TwinCAT CNC software controls 6-axis parallel kinematics with absolute precision

The high-precision WIG (Wolfram Inert Gas) welding of thin sheet metal or exact circumferential seams is a complicated process, which to-date could not be performed to satisfaction either using conventional machines or by hand. To solve this puzzle, the Augsburg, Germany-based machine builder Castro GmbH has developed an innovative welding cell based on parallel kinematics. With the support of system integrator Böckstiegel Automation in Penzberg, the new machine has quickly entered series production with the help of PC-based control technology and TwinCAT 3 CNC.

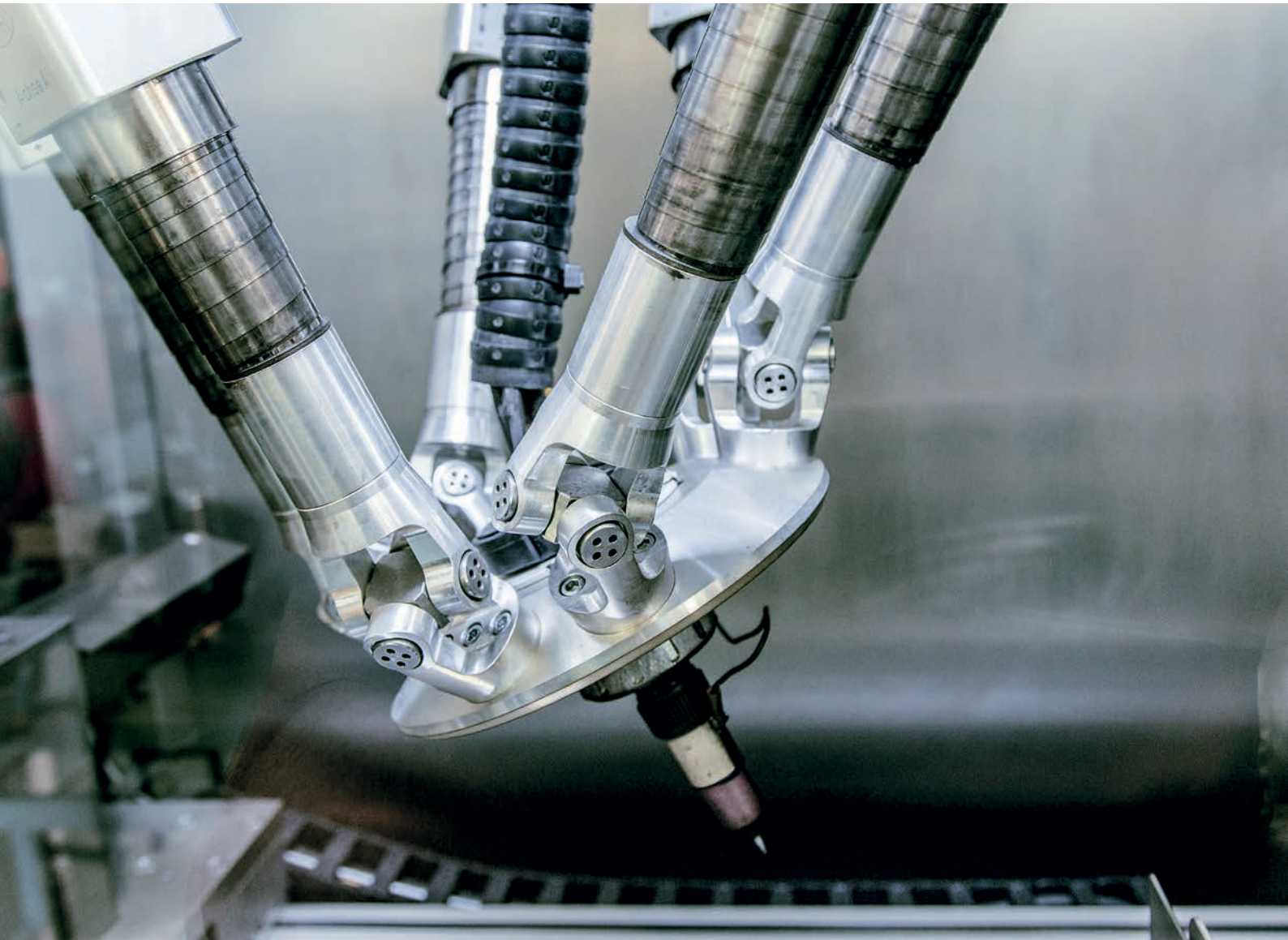


Udo Massari, Managing Director of Castro, and Peter Böckstiegel, Managing Director of Böckstiegel Automation, at the CP6942 Control Panel developed by Beckhoff specifically for use on machine tools (from left to right)

The weld seam demonstrated by Udo Massari, Managing Director of Castro, on a titanium catalytic converter for luxury cars looks much like a top-quality silicone seam. "The beading produced is completely uniform. We offer the only solution in the industry that can deliver this level of weld quality. Not even a robot can accomplish this." The secret to this success lies in what is known as the Wigpod, an automated Wolfram inert gas welding cell that operates on the basis of parallel kinematics. The six axes arranged in parallel can change their length and move in all three translational and rotational degrees of freedom. By utilizing the latest automation and drive technology from Beckhoff, the machine is now ready for series production.

The switch from the previously used control technology to PC-based control was surprisingly quick and simple for Udo Massari. "We revamped the complete control system and completed the transformation activities and HMI programming in just four months. As early as the first visit, Sales Manager Raphik Shahmirian from the Beckhoff Munich office was able to recommend potential solutions, with work commencing just a short while later on the actual implementation." Peter Böckstiegel, Managing Director of Böckstiegel Automation, the company supporting the integration, had the same experience: "I received the best possible support in all projects to-date, which has allowed us as a small company to fulfill challenging customer implementations and accomplish even highly specialized tasks with exceptional reliability, such as in the case of Castro."





The Wigpod welding process is performed in a hermetically sealed cell, since a pure inert gas atmosphere is required.

### High precision and repeatability

Castro has developed systems based on hexapod technology since the 1990s. Initially the company specialized in surgical tables for medical treatment, such as in laser eye treatment and kidney stone disintegration. Working for many years on an implementation of the hexapod technology in industrial machinery, Castro launched the first basic model under the name of Caspod onto the market in 2009. Udo Massari explains: "The main challenge we face when developing a new solution is to implement parallel kinematics in CNC-based control technology. A new era has now dawned, however, because PC-based control helps us reduce complexities and meet the demanding requirements of precision engineering in an ideal way."

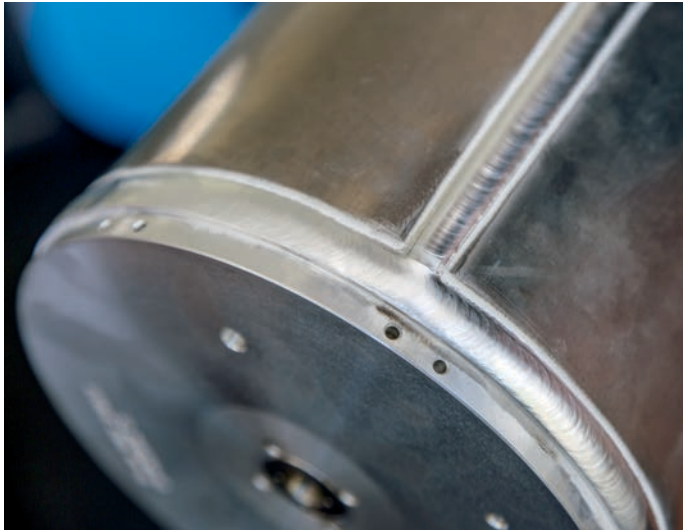
The Caspod series includes 6-axis machining cells with parallel kinematics that can be designed for the most varied applications, such as welding, deburring,

milling, polishing or laser cutting. The compact CE-compliant welding cell is characterized by high dynamics, path accuracy and high rigidity. The new Wigpod welding cell can position the 0.5 kg WIG welding torch with the highest level of accuracy even at a feed rate of 60 m/min – and using a fraction of the power input required by conventional machines.

According to Udo Massari, this has been made possible by the parallel arrangement of the six axes whose movable net weight is very low: "What's special about this is that the movement is executed in an axial direction of six drives rather than only one drive. Conventional systems with a serial arrangement, on the other hand, have to move several units of 100 kg net weight for the same tasks and thus quickly reach power consumption levels of several kW. In a comparable workspace, the Wigpod operates with much more energy efficiency at a power consumption level of just 0.8 kW. This means that com-



Udo Massari, Managing Director of Castro, holds a stainless steel catalytic converter for clean-room technology



A perfect welded seam on an aluminum high-pressure fire extinguisher

ponents for the trade, industry, aerospace and automotive sectors – especially those made of titanium, aluminum and stainless steel – are welded fully automatically without tempering colors in an energy-efficient and environmentally friendly way, reducing hazards for operators at the same time.”

### Powerful kinematic transformation capabilities

The transformation of complex hexapod kinematics to CNC machine technology was a particular challenge in the project. Specifically, the Stewart transformation forms the centerpiece of the underlying mathematical model. It ensures that the servomotors of the six axes can be controlled in a coordinated manner and precisely generate flowing movements. The Stewart platform gets the set points of all motion sequences from the overlying TwinCAT 3 CNC software, calculates the required axis positions and returns the information to the drive control system.

Peter Böckstiegel explains: “The perfect interaction of the CNC with the Stewart transformation ensures the smooth and simultaneous movement of the six axes. Beckhoff provides the corresponding mathematical translation tools and kinematic transformations for this purpose in the TwinCAT 3 CNC. This allows especially simple and flexible operation and programming.” TwinCAT 3 CNC offers comprehensive CNC functionality and covers the entire range of classic CNC path controls up to highly complex motion and kinematics requirements. With regards to the Wigpod implementation, Dieter Auer, specialist in application software from the Beckhoff Munich office, explains: “With the control and transformation capabilities provided by TwinCAT, it is now also possible to rotate around an additional axis, which was a limitation of the predecessor system. This is especially significant when the weld head must be rotated around the seam being welded.”

As a highly scalable automation system, PC-based control represents a flexible hardware platform that can suit the needs of every application. Raphik Shahmirian: “The hard real-time of the TwinCAT kernel and the ultra-fast drive system communication over EtherCAT offer ideal conditions for high-precision motion control. The C6920 control cabinet PC is the best-suited hardware to accommodate the Wigpod’s requirements. Operation is based on the application-specific 15-inch CP6942 Control Panel for machine tools with CNC push-button extensions.” Peter Böckstiegel adds: “The innovative TwinCAT CNC HMI serves as the user interface. It can be programmed with ease on the basis of Microsoft .NET standards, and due to its open and modular concept, it enables customized application designs.”

### Safety in motion control

The welding cell’s six main axes are driven by dynamic servomotors in the AM8000 series from Beckhoff. There are also two auxiliary axes for linear part feeding and rotary positioning of components. Four compact, 2-channel AX5203 Servo Drives are used for a total of eight CNC axes. In particular, they support fast and highly dynamic positioning, optimally fulfilling the requirements of the welding cell according to Peter Böckstiegel. “Yet another advantage of drive technology from Beckhoff is One Cable Technology (OCT), which dramatically reduces wiring overhead and results in significantly lower material and commissioning costs.”

The AX5203 Servo Drives are fitted with the TwinSAFE AX5805 option card to protect machine operators from potential danger in the application. Peter Böckstiegel explains: “A crucial factor, with trial runs of new products in particular or when configuring a machine, is that the operator can also intervene in the workflow manually. With TwinSAFE, the welding cell can also operate if necessary when the door is open or at a reduced speed without introducing any risks to the operator.”

Further information:

[www.boeckstiegel-automation.de/1](http://www.boeckstiegel-automation.de/1)

[www.castro-online.com](http://www.castro-online.com)

[www.beckhoff.com/cnc](http://www.beckhoff.com/cnc)