Special Machine Construction from IWM Automation

IWM Automation is globally active as a system integrator in special machine construction. The company has four specific competence fields in which it also works as a general contractor to implement equipment designs. In addition to system services such as engineering, plant construction and assembly, commissioning and after-sales services (teleservice), the company's activities also include assembly and welding technology as well as glue and proportioning technology. Test engineering effectively developed as an intersection of these various competence fields.

IWM Automation most recently achieved sales of about 20 million EUR. It has 95 employees, of whom more than half work in engineering, project management and similar areas.

CX1020 controls 15 active axes on a tube-end forming machine

PC controller unites hydraulic and electric drives

A PC-based automation solution, with the Embedded PC CX1020 at its heart, controls 15 NC axes in a complex machine for tube-end forming at IWM Automation. With the innovative control concept that integrates PLC and Motion Control at the software level, IWM Automation offers its customers significant advantages over traditional PLC approaches.

The NC controller on DIN rail: an Embedded PC controls both electrically driven and hydraulic servo axes on the tube-end forming machines.

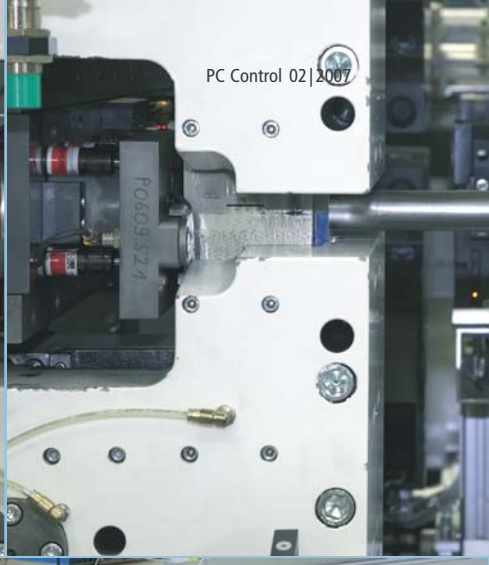
The tube-end forming machines are used by suppliers to the automotive industry for machining and shaping the ends of tubes. This includes, for instance, tube stamping as a preliminary process, as well as swaging and pressing for the fabrication of assemblies. The tube ends are cold formed in up to four steps in which they are hydraulically swaged on both sides and, in some cases, calibrated. The end product is a subassembly incorporated in a unit for the motor vehicle industry. The machine that IWM Automation has developed implements the machining process through thirteen motor-driven and two hydraulic NC servo axes.

Optimum automation for highly complex Motion Control

IWM Automation, based in Porta Westfalica, Germany, was awarded the "tube end forming" project in mid-2006. The job involved the implementation of a type of hydraulic press that, in a simplified form, was already being used by the customer. The customer has greatly tightened the requirements profile in respect of cycle time and machine output.

A requirements profile of this kind was entirely new for IWM Automation. "In our initial approach to the design, we looked for ways in which the complex machine process could be implemented efficiently and economically," explains Olaf Klink, Marketing and Project Development Manager at IWM Automation. "Instead of taking the approach of adding supplementary hydraulic control to a conventional PLC, we decided in favor of PC-based control from Beckhoff."

The tube-end forming machine has a modular structure with three main and two auxiliary stations. The nature of the product requires the machining process to be sequential; a specific working sequence must be followed. From the point of view of the machine, however, all the machining stations are continuously in operation. Altogether, up to two swaging movements and up to four forming movements are executed, which means that four tools can be used in the main station. Loading and discharge actions, as well as adjustment movements, must also be carried out. The parts are advanced through the machining stations by a servo motor-driven handling device. The cycle time for an assembly needing three swaging processes amounts to about 8.5 seconds per assembly.



In the tube end forming machine both tube ends are hydraulically upset through cold forming. The end product is a subassembly incorporated in a unit for the motor vehicle industry.

Compact control solution

An Embedded-PC CX1020 is used for controlling the equipment and machines. A classic CNC controller was originally planned in the performance specification. However, an additional, special controller would also have been necessary in order to control the servo-hydraulic axes. Olaf Klink comments: "We would have needed two controllers, and these would have had to be coupled together. For this reason, Beckhoff's software modules, which handle both motor-driven and hydraulic NC axes, are the better alternative."

Windows XP Embedded provided the operating system for the CX1020, while TwinCAT PLC was used as the run-time system. All the peripheral devices, including all sensors, command units, displays and actuators – except for a small part handled via PROFIBUS – are connected to the Embedded PC via the EtherCAT fieldbus system. The PROFIBUS coupling is made through a modular master module plugged onto the CX1020.

Visual display is provided by the Zenon software system; a 15-inch touch screen panel from Beckhoff displays the progress of the machine. The visual display program runs on the Embedded PC – the HMI unit is used to display and parameterize the equipment. TwinCAT interacts with the visual display program through TwinCAT ADS, which as an open interface, permits well-organized exchange of data with other Windows programs.

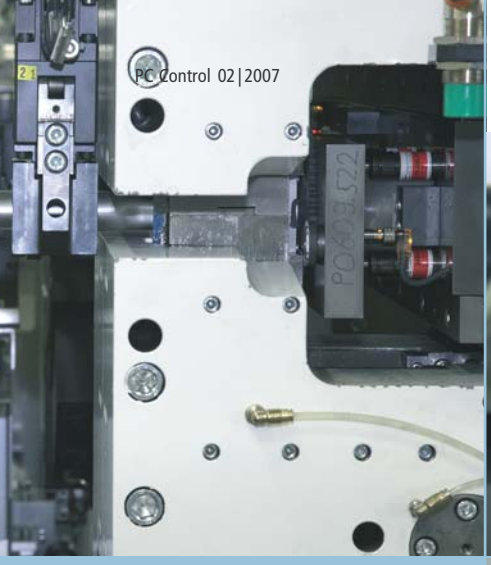
Software-based Motion Control solution

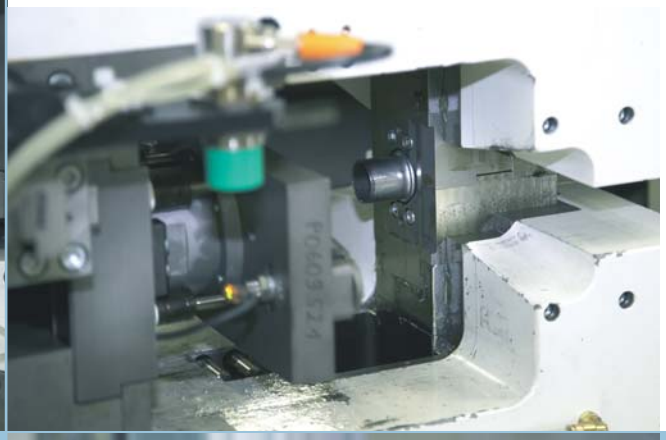
A total of 15 NC axes are used for machining, of which 13 axes use AX2000 Servo Drives and appropriate servomotors from Beckhoff; 2 NC axes are driven by servo hydraulic units. All the axes are simple point-to-point (PTP) single axes. In other words, none of the axes have continuous-path control.

The TwinCAT PLC Hydraulic Positioning library is used to program the positioning processes. This library is one of several Motion Control libraries standardized in accordance with PLCopen. "This software tool allows the programming of both hydraulic servo axes and servo motor axes," explains Stefan Sieber from the marketing department at Beckhoff's headquarters. Although a hydraulic axis behaves, in terms of control engineering, quite differently from a motor-driven axis, all the axes can be programmed with this software tool, without the need for special NC control components. Olaf Klink adds: "We drive the hydraulic axes following a defined speed profile that is specified by the end customer. This is an important component in the total cycle time." The highly dynamic axes achieve a speed of 2,000 mm/s. The hydraulic axes – used to swage the pipe ends – have a total of up to 45 tons of feed force.

Sensors detect the actual progress of the positioning. The analog resistance displacement transducers (0…10 V DC) on the hydraulic axes are directly coupled via EtherCAT Terminals. In the case of the electrical axes, the encoder signals are directly connected to the AX2000 axis amplifiers. These, in turn, are connected to the Embedded PC CX1020 via EtherCAT. The CX1020 generates the profiles for all the axes and carries out their control. The set values for the proportional valves in the servo hydraulic system are output as an analog signal (0…10 V DC) through an EtherCAT Terminal.

Pressure measuring cells are another type of sensor; they are used to acquire the pressure generated by the equipment. The maximum operating pressure of the production equipment is 310 bar; the operating pressure in use at present is





The machine has a modular structure with three main and two auxiliary stations. The parts are advanced through the machining stations by a servomotor-driven handling device. The cycle time for an assembly needing three swaging processes amounts to about 8.5 seconds per assembly.

Automatic material feed to the machine

EtherCAT-based automation: AX2000 Servo Drive with EtherCAT interface (left) and EtherCAT I/O Terminals

230 bar. Olaf Klink points out: "It is particularly important to monitor the hydraulic temperature. A complete temperature module is coupled to the Embedded PC via EtherCAT for this purpose."

EtherCAT: a faster bus for faster cycles… even for hydraulics

Generally speaking, hydraulic systems are significantly slower than actuators driven by electric motors. This naturally raises the question of why EtherCAT, a high-speed fieldbus, is being used. For Olaf Klink the pre-conceived notion regarding hydraulics does not hold water: "Hydraulic equipment can be just as fast as electrical drive equipment. Use of a fast Ethernet fieldbus system like EtherCAT is necessary for the sake of the total process control, as we are not controlling the movements by autonomous, distributed regulators, but centrally, in one controller. This can only be done if data is exchanged at high speed. This means that the hydraulics can be operated not only quickly, but with a positional accuracy that is better than 0.01 mm." Stefan Sieber supports the argument: "The extremely short cycle time demands that signals are also quickly available. EtherCAT's high transmission speed is therefore necessary."
The EtherCAT wiring is based on CAT5 copper cables. They are, however, laid with great care, as the machine, after all, is a production machine involving hydraulics and additional applied oil; as Olaf Klink says, an additional oil mist is sprayed on to the tube ends during the forming process, both in order to reduce tool wear and to support the forming.

A convincing solution

IWM Automation is a very experienced company in the field of control technology. Olaf Klink has this to say about the company's experience to date with the PC-based automation solution from Beckhoff: "We were able to convince the machine operator that he will work more effectively with a PC-based automation solution, and will also have more potential available. And we are confident that we are on the right path with the Embedded PC solution from Beckhoff, as we were not only able to meet the customer's production engineering requirements, but were even able to offer cycle times that are shorter than specified. There is no doubt that we will continue in this way."
IWM Automation has set itself high targets for precision and quality, customer service and efficiency, a highly professional approach and the maximum possible success for both sides – for the manufacturer as well as the operator of production equipment. Olaf Klink is convinced that solutions such as the production plant realized for tube-end forming will contribute to reaching those targets and even going beyond them. His summary is that "the solution gave the customer better performance than was asked for. This generates trust and satisfaction!"

→ IWM Automation **www.iwm-automation.de**