Clear path – software CNC controls movements

Woodworking machines are defined by a high degree of functionality. "Faster, higher, further," is the general motto in machine construction and engineering. Accordingly, a powerful control is expected to deal with all machine functions, while at the same time allowing easy upgrade for future requirements thus keeping cost low while improving machine performance. In order to achieve this, the company Weeke Bohrsysteme GmbH in Herzebrock-Clarholz, Germany, ventured to implement a fully PC-based CNC machine control.

Automatic high-performance drilling machine BST 500

The strong competition in the furniture sector is characterized by increasing demands in terms of production costs, production speed, processing quality and flexibility. These demands are pushing machine suppliers to use state of the art technologies such as PC-based control, in order to meet market requirements. Weeke Bohrsysteme GmbH has been producing powerful woodworking machines for many years. The company specializes in the production of machines for processing wood panels. The product portfolio includes automatic high-performance drilling machines (BST) and CNC machining centers (BHC) for machining the workpieces in one chucking. Quite often, mixed versions are used, i. e. machines that deal with both CNC processing and drilling. The weighting may differ de-
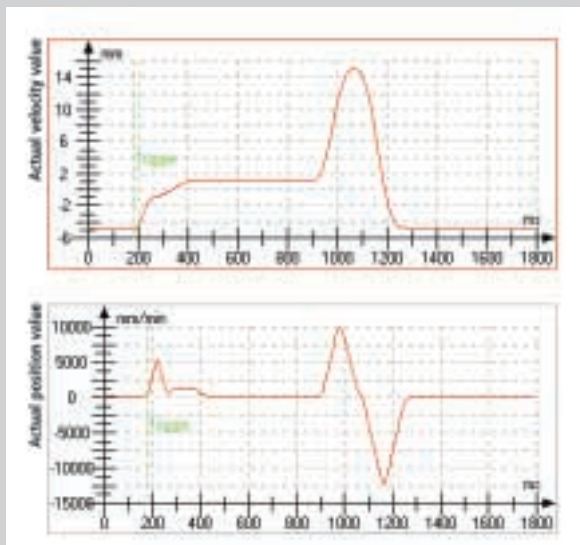
pending on the requirements. The consistent orientation towards advanced technology and optimum customer benefits recently prompted Weeke to implement a new control generation. "Of crucial significance was the availability of a unified platform for all machine types," said Werner Birwe, manager of electrical design. "This means that a control system has to combine a large number of different functions." This obviously requires a powerful system. The requirements of openness, good price/performance ratio, progress and investment protection inevitably led to a PC-based control system. The advantages offered by TwinCAT, the universal control platform from Beckhoff, made Weeke choose this system.

Based on a hard real-time environment that forms the TwinCAT foundation, each machine has access to the PLC functionality contained within TwinCAT as standard. Up-to-date programming uses one of the programming languages consolidated under the IEC 61131-3 standard. The integrated PTP control deals with simple PTP positioning tasks and coupled movements. More complex movements in the form of interpolating axes are either solved under TwinCAT NC I (interpolation) or under TwinCAT CNC, depending on the requirements.

A CNC for any application

The variety of Weeke machines place very different demands on the control system. On the one hand we have the highly dynamic drilling center with many I/Os and up to 100 positioning axes, on the other hand we have the processing center with relatively little sensor and actuator technology, but complex motion processes. In both cases, the options and characteristics of the CNC functions integrated in TwinCAT are the crucial factor for the quality and speed of the machining process.

Automatic high-performance drilling machine BST

Weeke builds two drilling machine variants: the BST 500, with up to 2 horizontal and 20 vertical fixed drill heads, and the BST 100, with usually up to 8 horizontal and 8 vertical drill heads with individually selectable spindles. The latter may justifiable be identified as the "high end" of drilling machine technology.

A drill head is a complete drilling unit with room for up to 40 individual drills that either replicate the motion of the drill head (BST 100) or can perform different individual motions in each cycle (BST 500). During machining, the drill head does not perform simple PTP movements, since the drilling process consists of a range of process-dependent, clearly defined individual movements. To name but one example, the drill head (z-axis) approaches the workpiece with as high as possible velocity, the surface is drilled with reduced velocity, the drill head moves through the material with higher velocity, the velocity is reduced again before the rear of the workpiece is penetrated, and the drill head is retracted after the drilling process. During the movement of the z-axis, individual drill spindles, provided
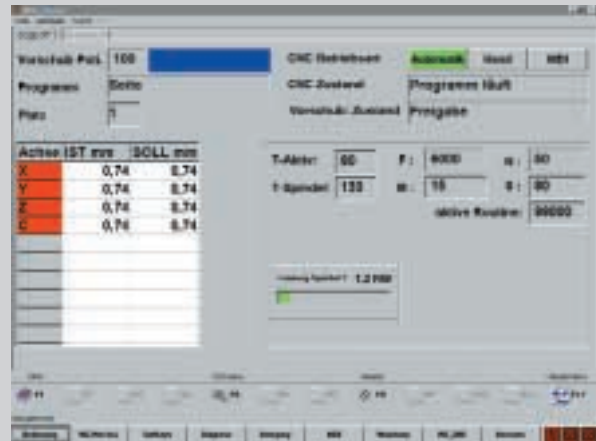
Functional variety through boundless openness

During the processing of wooden parts, the machines from Weeke perform a large number of axis movements that were controlled by a range of special hardware platforms. Proprietary PLC systems, positioning controls, classic CNCs, various drive and fieldbus systems offer a heterogeneous picture of the control world within the machines. Together with the existing operating PC, this hotchpotch of components was not only complicated, but also expensive. All this will now be a thing of the past; on the hardware side, the system consolidated to a single Industrial PC, and all control functions are dealt with by the TwinCAT software modules.

they can be selected individually, can be withdrawn, e. g. for drilling a blind hole, depending on the part being processed. Parts can thus be processed flexibly with variable drilling patterns and with extremely short cycle times.

In short: The TwinCAT NC I control package runs on an Industrial PC equipped with a Pentium 4 CPU. The user-friendly visualization application called "Top Drill" enables the selection of the drilling programs, tool data management, diagnostics etc. From this interface, the program "Wood WOP" for graphic part programming and drill optimization can be accessed. The interfaces were created in Visual Basic or Visual C. With ADS OCX they use a standard Microsoft technology for accessing all the data of the TwinCAT PLC and NC/CNC world.

TwinCAT receives its data essentially from Wood WOP. The result of the graphic part programming is made up of the data about hole positions (surface data X, Y), drilling depths (Z), bore diameter and drilling speed (depending on the material) of the individual holes. Due to the large number of bore holes, a significant amount of data may be generated, which is transferred to the PLC via the ADS OCX. The data are then processed in TwinCAT PLC and distributed to the NC or NC I as required. The planar positioning movements of the drill heads (X, Y) are

PTP movements, which are dealt with by the PTP control integrated in TwinCAT. There is no restriction on axis coupling. The more complex drilling processes (z-axis) are carried out in individual NC I channels for each drill head to ensure optimum velocity for each motion. In the most recent machine built by Weeke, type BST 100, 10 z-axes are controlled in individual NC I channels, plus approximately a further 40 PTP axes.

Since TwinCAT NC I enables the interpolation of up to 3 axes and a further 5 auxiliary axes per channel, the intention is to run typical CNC-based functions, such as corner rounding, notching and grooves on the same machine in further NC I channels. No structural changes of the control system are required, neither on the software side nor on the hardware side and, even more importantly: no changes are expected to be required in future either.

The suitable fieldbus for every function

TwinCAT supports all market-relevant fieldbus systems as standard. In this concrete case, the complete drive technology (Indramat DKC) is operated via a SERCOS interface. Approximately 500 digital inputs and outputs and a few ana-
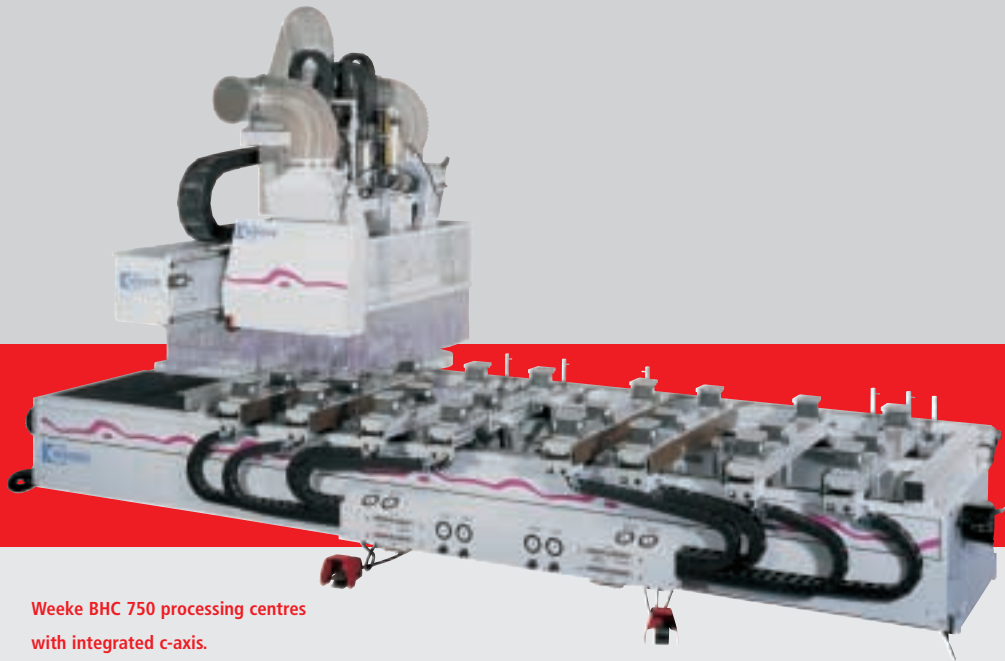
Weeke BHC 750 processing centres with integrated c-axis.

log channels for the spindle drives are simultaneously controlled via Profibus. The Beckhoff Bus Terminal System is used as an I/O module. It is available for a large number of bus systems. At a later stage, the additional use of CANopen is envisaged, perhaps for special field devices.

In the PC, appropriate master interfaces are required, both for SERCOS (FC750x) and for Profibus (FC310x). Here too, Beckhoff offers suitable single-channel or twin-channel PCI cards.

BHC processing center

Different variants of the processing centers are available. The main differences are in the size of the processing space in the three spatial co-ordinates or in the number of axes, which have an immediate effect on the variety, but also on the speed of the machining.

In terms of the control, the distinction with regard to the processing options and, often related, the number of axes, is relevant. They range from small 3-axis processing centers with interpolation in the Cartesian space (BHC 250/350) via classic processing centers with integrated c-axis (BHC 550/750) to large centers with interpolation of 8 or 9 path axes and co-ordinate and kinematic transformation (BHC650/850). So-called throughfeed processing centers (BHT) round off the range.

The main feature is that not much changes in terms of control or hardware. Due to the more comprehensive demands on the CNC, such as spindle functions, interpolation of more than 3 path axes per channel, transformations with different kinematics, the variant TwinCAT CNC is used instead of TwinCAT NC I. Apart from the CNC part, both systems are identical; TwinCAT CNC includes all the typical elements of a classic CNC mentioned above.

The control configuration can be explained quickly: Everything more or less corresponds to the control technology for drilling machines. For graphical part programming, Wood Wop can be called up from the MCC operating environment, which is programmed in Visual Basic/Visual C like for the drilling machines. After completion, the post-processor (PP) integrated in Wood Wop generates a CNC program according to the familiar DIN 66025. This CNC program in ASCII format

is loaded from the PLC into the actual CNC and started. Like under TwinCAT, the usual communication routes between PLC and CNC are simple and standardized.

SERCOS is again used as a fast drive bus. Due to the relatively small number of digital and analog inputs/outputs (100-200), in addition to the drives it additionally operates a SERCOS Bus Coupler BK7500 with an associated number of I/O terminals.

Hardware-independent control

"Hardware independence is a big topic for us," said Ralph Kottmann, software development manager at Weeke. "We thus open up the otherwise not obvious option of being able to purchase the best components required at the time on the world market without restriction."

Weeke can offer its customers real added value in terms of plant availability and investment protection through simple diagnostics and service options – even deep down in the control – and through simple methods for control networking and master computer interfacing and automatic homogeneous further development of the PC-based control platform. In addition, the integration of the CNC functionality within the TwinCAT software package makes the control hardware attractively clear and inexpensively. Who would want to challenge the role of the Industrial PC as the spearhead of industrial control technology?

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