



PC-Based Control Technology
for Woodworking Machines

Beckhoff Pass Saw Test at Koch

As a manufacturer of woodworking machines based in the German town of Leopoldshöhe, Koch Maschinenbau don't have a minute to spare if 1800 wooden drawers are to be made every hour. The changeover from classical PLCs to PC technology was just as brisk. The company are now fitting Beckhoff automation equipment to its machines.

What do the provincial German towns of Verl and Leopoldshöhe in Westphalia have in common? Neither town is exactly part of Germany's industrial heartland. Nevertheless, both towns are home to companies with world-wide influence. While Beckhoff fit modern automation technology to machines in use across the globe, many of the woodworking machines in use around the world bear the name of Koch. The two companies have now developed an optimal solution for a new series of machines for the production of folded drawers in the furniture sector. It is centred on PC-based controller technology, the fast Lightbus and the multifunctional Bus Terminals from Beckhoff.

Koch had found themselves in a position

typical of many companies. It is only with great difficulty that the machines – fitted with classical PLC systems – can be made to offer facilities such as operation under Windows, simulation of commissioning on a PC, or remote maintenance and diagnosis. Werner Reinhard, an electrician at Koch, remembers: "Whenever that kind of thing was needed, or whenever there was anything unusual about the drives, we always had to fix up some complicated special solution." This gave rise to a range of isolated solutions, which were indeed capable of satisfying customers' needs on individual machines. What, however, was missing from these solutions was any overall plan for integration, in the sense of a unified automation strategy.

For Werner Reinhard, the application of standardised automation technology based on PCs offered the promise of an escape from this dilemma. Two factors were critical for the choice of Beckhoff, the IPC pioneers. One was the improved connection with controller technology, while the other factor which spoke in favour of the decision was the years of experience – now more than 10 – in the field of PC-based controller technology.

The initial design for the new woodworking machine envisaged the use of an industrial PC running the TwinCAT real-time PLC and NC software. This PC takes charge of operation and monitoring as well as the configuration of the physical units at the machine and the real-time control of the actuators and drives.

At the machine manufacturer Koch in Leopoldshöhe the PLCs have retired, since the company are fitting PC-based controller equipment to the whole of their range of woodworking machines.



Classical PLC Technology Could no Longer Guarantee Success

The two engineers involved in developing the automation solution for this application, Werner Reinhard and Matthias Köster from Beckhoff, oriented themselves right from the start towards the machining processes on the plant. In the first part of the machine, the clad wood is cut to length. The saws, angled at 45°, cut two V-grooves precisely down as far as the lower foil. When this is then folded at right-angles, a drawer is created, from which only the front panel is missing. For this purpose, the second part of the machine performs all the drilling and gluing processes, together with insertion of the dowels with which the front will be fastened. The installation consists of eight processing stations. Individually, these are:

- top and side drilling stations,
- turning station,
- further drilling stations,
- cold gluing station,
- station for insertion of the wooden dowels.

A chain conveyor transports the workpieces through the stations. The wooden parts are held pneumatically for the various processing steps. The transport motor is controlled by a frequency converter, which guides the wooden parts dynamically to the clamping equipment.

“That sounds all easy enough” says Koch’s automation engineer about these process phases, “but it gets very complex when 1800 drawers have to be processed each hour.” Some figures give a picture of the dynamic processes

The Machine

The woodworking equipment incorporates a trimming and mitre sawing machine for cutting to length, sawing of V-grooves, drilling, glue injection and dowel insertion. Its range of applications includes the full fabrication of folded drawers and folded plinth components. The workpieces may be between 800 mm and 2500 mm long. Also included in the specification are magazine feeding or transfer from a prior machine, and transport of the workpieces through the processing stations by means of a cam chain. Added to this are the sawing station, the horizontal drilling station, the glue application and dowel insertion stations, and, as a special feature, the Koch KLC glue valves with the sealed, air-tight glue system. The main advantage is the almost complete freedom from maintenance. Other features include the digital adjustment of glue quantity and the high pressure glue pump for any viscosity. Additionally, a vertical drilling station, longitudinal drilling unit, the patented ELC glue monitoring system and a separate gluing and dowel station can be selected as options.

All the process signals are brought to the 20 distributed bus stations in the 15 x 4 metre woodworking machine. They pass from the electronic Bus Terminals via three Lightbus rings for further processing in the PC.



in the machine. Up to 30 drawers can be made each minute using simple drilling procedures. This involves control of 44 axes. The units are 700 mm apart, so that there are always between eight and ten units in the machine.

"The industrial PC and the TwinCAT automation software are the central pillars of our solution nowadays" said Werner Reinhard of the approach. The details begin with a 400 MHz Pentium PC with a separate keyboard and screen. Three optical fibre rings for the Beckhoff Lightbus distribute the computing power quickly and safely to the sawing and drilling process stations. Strict real-time response from the PC is achieved through TwinCAT running under the Windows NT operating system, without the need for additional hardware. The software functionality includes the PLC, which is programmable in accordance with IEC 61131-3 and has 10 ms cycle time (adjustable from 50 µs), a wide range of axis and position controllers, diagnostic facilities using the standard methods of the PC world, and data connections with Microsoft standards. The user interface at Koch was created using Visual Basic via the TwinCAT ADS Windows interface for the purposes of visualisation.

Optimal control of 44 axes

In the Koch application, TwinCAT and its NC functionality commands 44 axes, divided into ten servo-axes and 34 high/low speed axes. The fast/slow axes take care of the positioning of the workpieces through easy-running linear guides, the

servo-axes perform the processing steps. Installation components include three-phase motors and frequency converters for the variable speeds as well as economically controllable DC motors.

All the process signals are brought to 20 distributed bus stations in the 15 x 4 metre woodworking machine that has been described. Here the Beckhoff Bus Terminals, familiar as electronic terminal blocks, transfer the machine data onwards. „With these components“, said Beckhoff project engineer Köster, „our customer can use any mixture of signal types at each station.“ The fine granularity, two channels per signal type, allows for the optimum combination of the necessary I/O channels. The advantage: it saves space, since there are no unused channels, which in any case increase the costs. The bus couplers, which are the coupling stations between Bus Terminal and fieldbus, give the system flexibility and open it to all common fieldbus systems such as Profibus, CANopen, DeviceNet, Interbus, ControlNet, Modbus, Ethernet TCP/IP, USB, RS232, RS485 or the Beckhoff Lightbus. Altogether the Koch technicians used about 180 Bus Terminals, the great majority of which were digital input/output terminals. The servo-axes, servo-actuators and the frequency converters, which are responsible for the drives of the drill spindles, are controlled through analogue Bus Terminals.

Dynamic Adaptation Saves Production Time

The Koch automation engineer is parti-

cularly proud of the possibility of controlling the NC advance of the servo-axes using TwinCAT. This creates a multi-level depth profile. In other words, the software functions implement a program in which a number of depths and speeds, deburring and intermediate withdrawal are saved as a data set for a drilled hole. This controller option not only saves processing time, but also improves the hole quality through the adjustable speeds.

The decision in favour of TwinCAT also brought competitive advantages to the users: the machine setter now only needs to transfer the dimensional data from the customer's drawing through the PC to the individual axes in the machine. Customer-specific data is also entered here, such as, for example, manual operation of the 44 axes, machine data input, the entry of message texts, log-book functions for fault analysis, and user management. Everything possible is done in advance in order to leave only the entry of the drawer dimensions to the user. In practice this automatic mechanism has meant fault-free commencement of drawer production - manufacturing tolerances of less than 0.1 mm are achieved without secondary adjustment.

Both Koch and Beckhoff are equally happy to have implemented such an advanced automation design on the woodworking machine within only two months – not least because the software resource, TwinCAT, allowed progress to be made in several areas. "There were the Windows interface, the input routi-

Thanks to the approach of using PC controllers on the Koch woodworking machines, the machine setter only needs to enter the dimensions from the customer's drawing via the PC to the individual axes in the machine. Customer-specific data is also entered here, such as, for example, manual operation of the 44 axes, machine data input, the entry of message texts, log-book functions for fault analysis, and user management.



nes and the error messages with graphics that all made the project design so much easier", explained Reinhard.

In the early days, all the drill holes were adjusted manually

This comment becomes all the more understandable when we picture how the procedures used to be carried out. To begin with, all the holes were set up manually. "PLCs and positional controllers then made things easier", Werner Reinhard remembers, "but as the number of machines being made went up, these proprietary solutions for just one machine type became simply too expensive." It was only through a detour to DOS computers fitted with supplementary external hardware and expensive axis cards that the Koch automation engineers came into contact with the advanced Beckhoff "New Automation Technology". Nowadays, the PLCs at Leopoldshöhe have retired, and Koch are fitting PC-based controller equipment to the whole of their machine range, regardless of whether it will cost DM 80,000 or DM 800,000.

Beckhoff TwinCAT: PLC and NC on the PC

The TwinCAT software system ("The Windows Control and Automation Technology") transforms every compatible PC into a real time controller with multi-PLC, NC axis control, programming environment and operating station. TwinCAT replaces conventional PLC and NC controllers as well as operating devices with:

- embedding of Software-PLC and software-NC in Windows 2000/NT, Windows NT Embedded, Windows CE
- efficient multi-PLC with 4 PLC run-time systems per PC and cycle times from 50 μ s. The programming environment offers all languages of the IEC 61131-3 standard
- axis control for point-to-point positioning and interpolated path movement. Up to 256 axes can be positioned, dependent only on the efficiency of the PC processor. Special functions such as "cam plate" or "flying saw" are supported
- connection to all common fieldbuses and PC interfaces for I/O signals: Profibus, CANopen, DeviceNet, Interbus, Sercos, Beckhoff Lightbus and PC-Hardware
- data sharing with user interfaces and other programs by means of open Microsoft standards (OLE, OCX, ActiveX, DCOM+, OPC etc.)