The robust design of Beckhoff Control Panels makes them ideally suited for harsh industrial environments. The modular Control Panel series encompasses a wide range of variants, including standard displays with touchscreens and complete CNC control panels for machine tools. The combination of Control Panels, Industrial PCs and TwinCAT automation software is ideal for PC-based CNC control systems.

The new PC-based control concept used at MDC Max Daetwyler AG, a Swiss company producing printing plates for gravure and flexographic printing, has far-reaching strategic significance. As a result of this upgrade, machine performance has increased significantly and development, maintenance and staff training have become much simpler.

The Motion Control Bus Terminals of the versatile I/O system from Beckhoff offer a cost-effective alternative to more sophisticated drive systems. They enable control of stepper motors, DC motors or hydraulic valves, for example. The motors or valves can easily be integrated into the control system via TwinCAT automation software.
Openness – who do you trust?

The market is calling for open technologies – and rightly so! After all, no-one wants to be fully dependent on a particular supplier. Accordingly, all new technologies claim to be “open.” Naturally, users can – and should – verify the openness of technologies based on common criteria. These criteria include free access to specifications, standardization, interoperability, vendor diversity and costs for utilization and implementation of the technology.

Ultimately, the crucial aspect is the trust one has in the company acting as the driving force behind the technology. If this company has a tradition of openness, technology from this company deserves a certain level of trust. It is quite amusing to observe how companies who traditionally offered closed system solutions are currently trying to portray themselves as particularly open. Until recently, some of these companies didn’t support any open fieldbus systems at all (or perhaps only a single system), while they now see themselves as champions of open solutions, as if they had a "Road to Damascus experience". For one particular industrial Ethernet solution, the key technology is hidden in the highly complex optimization algorithm of the configuration tool – which happens to be excluded from the specification and is not disclosed or made available to third-party manufacturers. A representative for a different technology recently told a baffled member of its user organization that a particular feature cannot be made accessible for competitive reasons. The configuration tools offered by some other companies only support their own devices and often have a range of undocumented features. Apparently, one supplier even pronounced his proprietary implementation, which is incompatible with the rest of the world, as version 1 of
the new standard and for the last two years has been refusing to support version 2 (which was developed by the user organization), because it would mean competition for his devices from the partner companies. Shame on him who thinks evil of it! Particularly remarkable is the fact that time and again renowned suppliers will enter into strategic partnerships with such companies and start waving their banners. There are several examples of arch-enemies from the fieldbus wars suddenly becoming partners making friendly overtures – it will be interesting to see how these “marriages” develop.

The name Beckhoff has been regarded as the quintessence of open control engineering for many years. Beckhoff has been using PC-based controllers since 1986, when others were still bogged down in court cases trying to deny competitors access to their backplane buses. TwinCAT, the control software from Beckhoff, runs on all standard PCs, not just on Beckhoff devices (which incidentally do not lose their warranty simply because a card from another supplier is inserted). TwinCAT is programmed in the languages of the IEC 61131-3 standard, not in a proprietary dialect. Naturally, TwinCAT also features all common, open software interfaces and it can be integrated and configured in devices from other manufacturers. Beckhoff makes all documentation available for download from the Internet, free of charge and without a password.

The Beckhoff Bus Terminal has been on the market since 1995. It is the I/O system that supports the largest number of fieldbus systems (and also the largest number of I/O interfaces). EtherCAT, the real-time Ethernet technology originally developed by Beckhoff, is made available to interested partners, effectively free of charge. Another aspect is that Beckhoff is in constant and open dialogue with competitors, as anyone who has ever visited a Beckhoff booth at a trade show will have experienced.

Beckhoff is committed to open control technology. Don’t just take our word for it – see for yourself.

Martin Rostan
EtherCAT Technology Product Manager
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The Motion Control Bus Terminals of the versatile Beckhoff I/O system offer a cost-effective alternative to more sophisticated drive systems. Stepper motors, DC motors, hydraulic valves and other devices can be controlled via associated Bus Terminals. The motors or valves can be easily integrated into the control system via TwinCAT automation software.

Motion Control in miniature format

Control systems for machines are becoming more and more complex and challenging for the user. For this reason, generic tools and simple interfaces are becoming increasingly important. With sophisticated drive control systems, synchronous and short controller cycle times are desirable from an application point of view. Notwithstanding all the benefits of decentralization, a central, high-performance computing unit that can deal with all processes in parallel, is ideal for this purpose. PC hardware can meet these demanding requirements. With the EtherCAT real-time Ethernet system, capacity isn’t an issue when it comes to data transfer. Almost any conceivable application can be controlled without overloading the system.

The new drive solutions from Beckhoff, ranging from the compact Bus Terminal to Servo Drive, enable handling of motors with different operating principles in a unified form. The TwinCAT System Manager reduces familiarization effort to a minimum, and users can be bold enough to use a DC motor, a stepper motor and a servomotor in the same application. The interfaces are almost identical, and parameterization is quite straightforward. In terms of software TwinCAT enables equal treatment of all motors. With a single mouse click, a stepper motor can be synchronized with a DC motor, for example – an input field is available for entering a coupling factor.

Simple tools, an abundance of computing capacity with good scalability, high transfer rates and compact design with good price/performance ratio provide further scope for intelligent automation. Lot size one has become a realistic option. Competitive systems offering lower production costs coupled with higher quality can be developed within a short space of time.

DC motors directly at the Bus Terminal

Current semiconductor technology enables ever higher integration densities. Two new Bus Terminals, KL2532 and KL2542, demonstrate this very clearly. Two 24 W DC motors can be supplied from a 12 mm wide Bus Terminal. Even higher power density is available if two 175 W DC motors are operated with a KL2542. Minimum turn-on resistances and minimized switching losses of modern transistors enable efficiencies of around 99%.

DC motors with permanent magnets can be very compact and offer high power density with good dynamics, making them suitable for application in small drives.
The new DC motor Bus Terminals further optimize this type of application. A combination of Bus Terminals and DC motors can be used to operate small drives for simple drive tasks, or for handling servo tasks. Connection and adaptation to the required motor is very simple: Only 2 wires are required for connecting a DC motor to the Bus Terminal. As a minimum, the rated current of the motor is stored in the Bus Terminal. With increasing complexity of the drive task, further parameters such as maximum peak current and speed, internal resistance of the motor or acceleration ramps can be set via the fieldbus. The larger Bus Terminal (KL2542) for two motors with ratings of up to 175 W includes an output stage for up to 50 V operating voltage and can supply a continuous current of 2 x 3.5 A. Short-term peak currents are permitted and enable fast accelerations. Moreover, the KL2542 offers an option for direct connection of an incremental encoder for each motor. The Bus Terminal, therefore contains all features of a full interface between Motion Control software and mechanical systems.

Like all other Beckhoff products, the KL2532 and KL2542 DC motor Bus Terminals are integrated into the TwinCAT software PLC. Via the TwinCAT System Manager, the DC motor can be integrated just as easily as any other type of drive.

**Motion Control Bus Terminals with PWM current output**

The magnetic effect is utilized in most mechanical/technical applications of electric current. Lifting magnets directly convert the current into a force. Valves control water, oil or air, for example, via their operating force. For an ideal case scenario, a linear relationship between current and required force is assumed. However, on closer examination this is usually not the case. A PWM-modulated voltage is not sufficient in many cases. The supply voltage can have an interfering influence. Load fluctuations in a power supply unit caused by other power consumers are felt unabated on the load to be controlled. The mean current through a coil is determined by its ohmic resistance. The current causes warming of the coil, which increases its resistance and reduces the current, which means that the current is subjected to constant, undesirable fluctuations. The only way out is to control the current. Rapid supply fluctuations and slow drift have no influence on the load.

The two new Bus Terminals, KL2535 and KL2545, offer controlled current output. The set value is specified via the fieldbus, and the Bus Terminals set this required value. The PWM current outputs cover a wide range of applications for controlled currents and enable connection of hydraulic valves (single/dual coils), lifting magnets, or lamps (dimming).

The KL2535 is the smaller one of the two Bus Terminals. It can independently supply two consumers with a continuous current of up to 1 A. The “large” version, KL2545, can supply 2 x 3.5 A continuous current. Both Bus Terminals can supply a short-term overcurrent of 40%. The supply voltage for the KL2535 is taken from the 24 V control voltage via the power contacts. The KL2545 can be connected with an additional supply between 8 V and 50 V. The high PWM clock frequency of 35 kHz ensures fast response and good control quality, while a small inductance can be used for the connected coil. This ensures fast response and enables compact design.

Unfortunately, the relationship between the current and its effect on the process to be controlled is usually non-linear. Lifting magnets and hydraulic valves are often characterized by a pronounced stick/slip effect. This means that a certain breakaway force is required. The force required for moving the piston from its neutral position is significantly greater than the frictional force of the moving valve piston. This leads to poor control characteristics for the whole application. Under unfavorable boundary conditions, the control loop may even start oscillating. At small velocities, this effect manifests itself in jerky motion. The PWM current outputs can counteract this effect by superimposing a dither signal with

---

**Characteristic curve, coil current in a compensated valve**

**Overlap:** The overlap prevents linear behavior around the neutral point. A small change in set value has no effect. The effect can largely be suppressed by increasing the current in this region. The size of this region is a valve characteristic and depends on the valve type.

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**Pulse width modulation emulates an analog signal**

**Pulse width modulation:** Represents an analog signal through the relative duration of a rectangular pulse within a specified cycle (period). More dynamic processes require shorter cycle times. Pulse width modulation is used in electrical engineering – for digital control of proportional valves or lifting magnets, for example. The technique utilizes the fact that each pulse results in a mean coil current, depending on the pulse width. This current is proportional to the pulse/pause width. The technique has the advantage of significantly lower losses in the electronic system than with an analog output stage.
Overview of Motion Control Bus Terminals

The Bus Terminal system offers various options for integrating drive functionalities within the Beckhoff I/O system:

Stepper motors:
- KL2531: 2-phase stepper motors, 24 V DC, 1.5 A
- KL2541: 2-phase stepper motors, 24/48 V DC, 5 A, encoder feedback
- KL2521: Pulse train interface for power output stages

DC motors:
- KL2532: 2-channel DC motor output stage, 24 V DC, 1 A
- KL2542: 2-channel DC motor output stage, 50 V DC, 3.5 A

Hydraulic valves/lifting magnets:
- KL2535: 2-channel pulse width current terminal, 24 V DC, 1 A
- KL2545: 2-channel pulse width current terminal, 50 V DC, 3.5 A

Extended features of PWM Bus Terminals

- supply voltage
- mean output voltage
- logging of the output stage temperature
- overtemperature warning
- incremental encoder input
- parameterizable switch-on value
- parameterizable bias voltage
- adjustable signal superposition
- compact design
- low power dissipation
- high current controller clock frequency
  - good control
  - small inductances can be used

Extended features of DC motor Bus Terminals

Standard features
- direct connection of two DC motors
- clockwise/counter-clockwise rotation
- current control
- speed control
- status LEDs

Extended functions
- temperature monitoring
- IxR compensation
- 4-quadrant operation
- short circuit protection
- parameterization via software
- fieldbus-independent application
- high clock frequency \( \rightarrow \) small motor inductance

freely selectable frequency and amplitude over the correcting variable and making the valve piston oscillate slightly. If the frequency is higher than the resonance frequency of the system to be controlled, it is this superposition that makes the control loop controllable. Valve hysteresis is largely compensated.

From a control point of view, the neutral point is the critical point for a valve. Valves often feature an overlap in order to ensure that they close reliably. This means that the first control signal has no effect, and the valve will only start to open and release volume flow once a further signal is received. KL2535 and KL2545 support compensation of this valve behavior. The set value specification from the superimposed regulation can thus act largely linearly on the volume flow.

Several settings that can be loaded via the controller, such as maximum peak current and rated current, enable adaptation of the Bus Terminals to the respective application. These parameters can be saved together with the control program and enable fail-safe reproduction of the application. In the event of a fault, only the actual hardware has to be replaced. All parameters are loaded automatically, without DIP switch settings or potentiometer optimization. Central data backup is, therefore much easier compared with other systems where the settings of many different devices have to be saved and documented.

For optimizing an application, the new Bus Terminals can be set and modified via Beckhoff KS2000 configuration software. The Windows operating system runs on each PC and can communicate with the respective Bus Coupler via the serial interface or, in conjunction with the TwinCAT software PLC, via the fieldbus. The Bus Coupler represents the link between the Bus Terminals and the fieldbus. When working with KS2000, the Bus Coupler provides a data connection between the selected Bus Terminal data and the PC. The set parameters are stored in a non-volatile manner in the respective Bus Terminals. The factory settings can be reproduced via the KS2000.
Today, electric drives can no longer be treated in isolation from the respective application. They have to be considered as part of the overall automation system. The TwinCAT System Manager reduces the familiarization effort to a minimum since TwinCAT enables equal treatment of all motors on the software side. The interfaces are almost identical and parameterization is quite straightforward. Variable-speed electrical drives are used in practically all industrial sectors. They are preferred for the following reasons: good system efficiency; good or very good static and dynamic control characteristics and communication with higher-level controllers; and market prices that are in line with user expectations. Electrical drives are also influenced by the control electronics. New Servo Drives enable compact and energy-saving integrated solutions with dynamic control characteristics, good torque stability and controllability down to standstill.

Servomotors are suitable drives for positioning mode. They combine motor, speed and angular position measuring systems. For cost-sensitive applications with low dynamics, stepper motors may be used as an alternative. In the lower capacity range, DC motors offer good controllability with low costs. The suitability assessment of a drive is based on its torque and dynamics. The torque must be sufficient for accelerating or decelerating the motor/gearing load combination and the load must move with constant velocity. The maximum torque $M_{\text{max}}$ and the holding torque (or the rated torque value) describe the capability of the motor to meet these requirements. A characteristic value for the dynamics of the servomotor can be derived from the theoretical proportionality of the moment of inertia $J_M$ and the acceleration torque. Maximum dynamics $D_{\text{max}}$ are achieved with:

$$D_{\text{max}} = M_{\text{max}} / J_M$$

**DC, servo and stepper motors (principle of operation)**

The principle of operation of DC motors and stepper motors is fundamentally different. DC motors generate torque and a rotary motion when a voltage is applied. Stepper motors only generate torque. A prerequisite for the rotary motor motion is commutation of the current, i.e. inversion of the direction of current flow in the electromagnetic coil during a motor rotation. DC motors with brushes are self-commutating. Stepper motors cannot commutate independently. There are three types of stepper motors: motors with permanent magnet, motors with variable reluctance, and hybrid motors. Servomotors are synchronous motors with a permanent magnet rotor. A servomotor could thus be referred to as a three-phase stepper motor with a very small step number.

**Stepper motor**

Stepper motors operate according to the principle of magnetic attraction and repulsion, i.e. electrical pulses are transformed into mechanical axis rotation. The angle of rotation is proportional to the number of input pulses, and the speed depends on the pulse frequency. Stepper motors typically have a permanent magnet and/or an iron rotor and a stator. The torque required for rotating the stepper motor is generated through switchover of currents and two coil packages.

+ natural holding torque
+ no feedback system required
- slightly jerky rotation
## Comparison of motor characteristics

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<th>DC motor</th>
<th>Servomotor</th>
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<td><strong>Control electronics and software</strong></td>
<td>Simple – direct</td>
<td>Complex – feedback from</td>
<td>Complex – encoder required; non-linear characteristic</td>
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<tr>
<td></td>
<td>microprocessor control</td>
<td>encoder/tachometer</td>
<td>control curve</td>
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<tr>
<td></td>
<td>with open control loop</td>
<td>required for accurate control</td>
<td></td>
</tr>
<tr>
<td><strong>Driver electronics</strong></td>
<td>Complex – electronic</td>
<td>Simple – coils commutate independently</td>
<td>Complex – electronic commutation required</td>
</tr>
<tr>
<td></td>
<td>commutation required</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Servicing</strong></td>
<td>No brush maintenance</td>
<td>Brush wear means that regular maintenance is eventually required</td>
<td>No brushes, minimum bearing stress</td>
</tr>
<tr>
<td><strong>Heating of the motor</strong></td>
<td>Higher due to continuous current flow in the coils</td>
<td>Low, since no current flow is at the target position</td>
<td>Low, current-dependent</td>
</tr>
<tr>
<td><strong>Torque and speed</strong></td>
<td>Full torque at low speeds; torque quickly decreases with increasing speed</td>
<td>Shallow torque curve results in higher torque at higher speeds</td>
<td>Almost linear force/velocity curve</td>
</tr>
<tr>
<td><strong>Dynamics</strong></td>
<td>smaller</td>
<td>larger</td>
<td>Good acceleration, high velocities</td>
</tr>
<tr>
<td><strong>(velocity and acceleration)</strong></td>
<td>Vibrations at certain frequencies can cause problems during acceleration. Microstep operation reduces this problem.</td>
<td>Smooth, quiet motion across the whole dynamic range</td>
<td>a wide dynamic range</td>
</tr>
<tr>
<td><strong>Resonance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Servo tuning</strong></td>
<td>not required</td>
<td>PID tuning may be difficult</td>
<td>Full PID controller required with complex system dynamics</td>
</tr>
<tr>
<td><strong>Target position</strong></td>
<td>Reach the target position without overshooting; stable positioning due to natural holding forces; in the event of overload or excessive speeds, the target position cannot be reached with an open control loop</td>
<td>The target position is reached (with error correction) using a closed control loop; correction of positioning errors in the event of incorrect PID tuning; overshoots or permanent control deviation possible</td>
<td>Higher velocity, smaller step size, no backlash</td>
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### DC motors with brushes

DC motors with brushes essentially consist of a cylindrical rotor and coils aligned perpendicular to the cylinder shaft. When a voltage is applied, interactions between the coils and the magnetic field of the stator occur that turn the rotor. For generating a smooth, continuous motion with constant torque, the strength and alignment of the rotor and stator fields have to be kept constant. Therefore, several coils are positioned around the rotor and electrically commutated via two brushes.

The main feature of DC motors is their smooth operation at high speeds. A DC motor will rotate as long as current flows through its coils. Position feedback via encoder is required for precise and reliable positioning.

+ high power density
+ good dynamics
+ good controllability
- limited service life

### Servomotor

Servomotors are electric motors (three-phase current synchronous generator) with feedback that enables the angular position of the rotor to be determined at any point in time. The motor must be able to rotate in both directions. Feedback occurs via a shaft encoder, e.g. a resolver, an incremental encoder, or an absolute encoder (implemented via a potentiometer). An electronic controller compares the shaft encoder signal with a set value. In the event of a deviation, the motor is rotated in the direction that reduces the deviation. Alternatively, the motor position can be monitored digitally and compared with a set value via a suitable computer circuit.

Servomotors are used in applications requiring controlled motion, such as linear positioning axes. For some applications, stepper motors can be used instead of servomotors. However, servomotors are the better solution if higher torques or speeds are required.

Servomotors are controlled via three pulse-width modulated voltages, the pulse width of which generates a three-phase current. These currents are controlled cyclically for most servomotors with a cycle time of 62.5 µs. The set current values depend on the angle of rotation and the load.
The new, ultra compact IE2808 IP-Link Extension Box offers 16 digital 24 V DC outputs at a low price per channel. It is ideally suited for direct connection to valve terminals, for example. Each channel is short-circuit-proof and offers diagnostic capabilities. A 25-pin D-sub connector enables cost-effective connection to the outputs.

The compact IE2808 IP-Link Extension Box from Beckhoff offers 16 digital 24 V DC outputs.

The newest member of the Beckhoff IP 67 Fieldbus Box module family: The IE2808 offers 16 digital outputs for connecting digital actuators on a very small mounting surface of 30 x 126 mm. The Extension Box offers 0.5 A at 24 V DC for each channel, with a total current of 4 A for all connected outputs.

The IE2808 can be connected at the control level via Coupler Box modules with a variety of fieldbus interfaces, including PROFIBUS, DeviceNet, CANopen or Ethernet. In addition to the new IE2808, a wide range of Extension Box modules for all common signal types are available.

The modules were designed for direct connection of multipole valve terminals, which in many cases feature a D-sub connector. The outputs can be connected to the IP-Link system and to the fieldbus and controller via a simple, cost-effective D-sub cable. If the installation requires protection class IP 67 throughout, a suitable cable or field-configurable connector must be used.

The switch status of the signals is displayed in groups via 2 LEDs (outputs 1–7, outputs 8–16). A visual warning appears in the event of a channel being affected by a short circuit. The exact position of the fault can be queried and the cause rectified via the fieldbus.

High signal density in compact housing
Fieldbus Box: New connector for extension modules enables simple, high density installation

Decentralized IP 67 modules installed centrally? The new IP-Link connector enables Extension Box modules from the Fieldbus Box series to be installed side by side and with high density.

In many compact systems, for example in material handling applications, many different signals have to be processed in a very confined space. The new IP-Link jumper (order number ZK1020-0101-1000) facilitates installation and offers even more compact configuration. The flexible center section enables the boxes to be installed at a distance of 0 to 5 mm. The optional ZS5300-0001 mounting rail with ready-made M3 size holes reduces installation time even further. Internally, the IP-Link jumper uses the same POF optical fiber as the standard IP-Link cable. The tried and tested connector technology is also the same, making connecting and disconnecting very easy. Nevertheless, the connectors have been subjected to standard vibration/shock tests according to EN60068-2 / EN60068-2-27/29 and have passed these tests with flying colors.
The robust design of Beckhoff Control Panels makes them ideally suited for harsh industrial environments. The modular Control Panel series features a wide range of variants, including standard displays with touch screens and complete CNC control panels for machine tools. The combination of Control Panels, Industrial PCs and TwinCAT automation software is ideal for PC-based CNC control systems.

Control Panel for CNC control

The CP6xxx and CP7xxx series Control Panels are designed for use as a man-machine interface. As control and display elements they form an independent unit, separate from the control level. Within a slimline aluminum housing the Control Panels combine an elegant design with display sizes between 6.5 and 19". The modular Control Panel series from Beckhoff offer a wide range of variants in terms of housing shapes, display sizes, keys/keyboards and connection types. New Control Panels have been developed for universal application as control units, particularly suited for the machine tool industry. The U-shaped arrangement of the control keys (i.e. control keys arranged on the sides and function keys below the display) matches that of the Transline concept commonly used in the automotive industry. A wide range of control functions can be integrated in the keyboard extension below the display unit, for example, emergency stop buttons, electromechanical keys, 45 membrane keys for axis control and two graycode switches for spindle and override.

The Control Panels are available as built-in or compact versions. The CP6842-xxxx built-in Control Panels feature protection class IP 65 (front)/IP 20 (rear) and are designed for control cabinet installation. The CP7842-xxxx Control Panels are designed for protection class IP 65. They can be optionally installed at the machine tool from the top or via an adapter plate (without auxiliary housing). Two different machine control panels (offering mainly CNC or PLC functionality respectively) are available for simple and convenient machine operation. The design, equipment and functionality of the Control Panels can be adapted to match individual customer requirements.

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<td>CP6842-1001 with PLC push-button extension</td>
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<td>CP7842-xxxx Control Panel for mounting arm installation:</td>
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<td>CP7842-0001 without push-button extension</td>
</tr>
<tr>
<td>CP7842-1000 with CNC push-button extension</td>
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<tr>
<td>CP7842-1001 with PLC push-button extension</td>
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Between 14 and 21 September, the world of metalworking met at EMO 2005 – the biggest international fair for production engineering in Hanover. Beckhoff presented the breadth of its IPC, I/O and automation product range at the show. The universal control solution from Beckhoff is used in a wide range of applications in the machine tool sector. To date, the focus has been on special purpose machine construction covering a wide range of hardware and software requirements, sheet metal working and processing centers. Classic machine tool applications such as turning, milling and grinding will continue to be a focus in the future. The range of Beckhoff products is complemented with industry-specific solutions (based on software CNC and extended operating concepts), providing the market with high-performance control components and complete system solutions.

For decades, CNC control has been dominated by traditional, hardware-oriented control systems, with PCs used only for operation, visualization and data processing, if at all. For years, the NC I software module from the TwinCAT family has already demonstrated that path control is also possible in a pure software solution. The TwinCAT CNC extension enables complete CNC functionality to be realized as a pure, PC-based software solution. TwinCAT covers the whole range of classic CNC path control applications, including high-end solutions.

At EMO 2005 visitors were also able to see product innovations such as the new Control Panel designed for use as a control unit in the machine tool industry.
The Beckhoff rapid new technology development continues unabated. In an interview with Ronald Heinze, chief editor of openautomation, managing director Hans Beckhoff talks about current trends, developments and highlights surrounding the SPS/IPC/DRIVES fair in Germany.

“Factor 10 every 10 years.” – Will Beckhoff meet its growth targets?

“Absolutely, although our target of ‘Factor 10 every 10 years’ is, of course, rather ambitious and brave,” said managing director Hans Beckhoff. “This year our global growth rate will be approximately 16%. Combined with 29% and 31% in 2003 and 2004 respectively, this means that our sales have doubled within three years.” On average, this has been the company’s growth rate over the last 20 years. “From a historical perspective, we can look confidently into the future,” said Hans Beckhoff. “We would obviously be delighted for this rate of development to continue, although we are being realistic to acknowledge that as the company becomes larger, growth figures may appear somewhat lower and ‘more normal’ increases would still represent very positive development.”

In order to achieve these growth targets, Beckhoff continues to expand export activities. In the long run, Beckhoff’s managing director expects a shift in sales ratios over the next few years: “Today, approximately 60% of sales are generated in Germany and about 40% abroad. By 2010 we expect this ratio to be reversed.” In order to hit this target, the company is continuously expanding its international distribution network and continues to establish new Beckhoff subsidiaries in strategically selected countries.

Set for further growth with EtherCAT

EtherCAT also continues its strong growth. The EtherCAT Technology Group (ETG) already has more than 230 members. “The EtherCAT specification has been published by IEC. EtherCAT has been approved as an ISO standard and is being standardized by the IEC as a communication system for both CANopen and IEC-61491 drive profiles,” said Hans Beckhoff, providing a summary of the successes. In addition, more than 100 manufacturers are already working on implementations. “Our company alone has sold more than 100 master and slave implementation kits, one third of which were masters,” said Hans Beckhoff. In addition, new technological developments will be presented at SPS/IPC/DRIVES, including a redundant solution for EtherCAT and Safety over EtherCAT. Safety-related communication, thus becomes part of the EtherCAT communication strategy. This also means that TwinSAFE, a Beckhoff invention, will soon be made available to the EtherCAT community.
Nevertheless, the automotive industry decided to use PROFINET. They state that, for their purposes, the real-time capability of PROFINET RT (PROFINET IO), the flexible structure of PROFINET (line, star, ...), and unrestricted communication using Ethernet TCP/IP via PROFINET are sufficient. The decision to use PROFINET comes as no surprise to Beckhoff’s managing director: “European, American and Japanese car manufacturers have a tradition of standardizing on their existing brands. However – just like in politics – the statements of motor vehicle manufacturers have to be considered fully and within their context. With the AIDA initiative declaration, four major motor vehicle manufacturers decided to use PROFINET IO for networking in body shop systems, provided this system offers technical and economic benefits. As far as we are aware, this rather softly worded recommendation does not apply to other sectors of the automotive industry.”

Providing examples, Hans Beckhoff mentions technology control systems for machine tools, presses or robotics. “These applications require higher performance than can be achieved with PROFINET IO. This is where technology scores over tradition. These are indeed areas where EtherCAT is readily accepted and used,” said the automation expert.

EtherCAT delivers technologically: Numerous topology options offer benefits for system networking. “The EtherCAT ring structure is only mapped technologically in data communication. When it comes to the actual cabling – star, tree, strand and ring structure are all supported,” said Hans Beckhoff. “Furthermore, hot connect and disconnect enable very flexible handling of dynamic system structures. One of the pre-eminent features of EtherCAT is that, in parallel with real-time operation, transparency for general IT protocols such as TCP/IP is retained.”

**Compact EtherCAT ASICs, compact I/O modules**

EtherCAT Slave Controllers have been available as FPGA since November 2004 and are used in a wide range of EtherCAT field devices. Hans Beckhoff stresses that FPGA-based solutions are already very competitive from a technical and commercial point of view. After all, the hardware is less expensive than many competitor ASICs. “The first ASIC variant optimized for modular devices left the Beckhoff development division at the end of August and is currently being implemented by an ASIC supplier.” According to the managing director, the developers were very keen to include several technical highlights, such as distributed clocks. “This chip will be available by the end of February 2006,” said the managing director. “The next version is expected about four weeks later.” Both chips are smaller than the FPGA and have lower current input. In addition, netX chip processors from Hilscher with EtherCAT functionality are becoming available.

**Focus on safety**

A one-stop provider for automation also has to meet the safety requirements of machine and plant manufacturers. The Beckhoff strategy accepts this challenge: “Safety technology is an integral component of the TwinCAT system,” said Hans Beckhoff. “Small and medium applications can be configured via the TwinCAT System Manager and loaded into the KL6904 Logic Terminal. For large safety applications we are developing the safety PLC, which will be freely programmable according to IEC 61131-3.”

The benefits of the Beckhoff safety strategy are obvious: The machine uses a single, uniform automation system, without the need for a separate safety control system. “Simplified projecting, realization and maintenance – with all aspects fully integrated,” said the managing director. Moreover, all safety-relevant signals can be accessed from the standard control system. According to Hans Beckhoff, all this results in “significant improvements in diagnostic depth and higher system availability.”

It goes without saying that EtherCAT also enables safety communication. “The TwinSAFE protocol enables safe communication between safety devices without the aid of the EtherCAT data security layer,” said Hans Beckhoff. The system meets the requirements of safety integration level 3 (EN 61508 SIL 3). “The protocol is designed to enable fieldbus-neutral tunnelling across other bus systems such as PROFIBUS or CANopen. Different data lengths and transfer rates are possible. The communication link between two safety devices is referred to as ‘EtherCAT safety connection,’ consisting of an initiator and a responder. Whether the initiator or the responder is located in an EtherCAT master or slave is irrelevant.” This means that any EtherCAT device – master or slave – can establish one or more EtherCAT safety connections with other EtherCAT devices.
Drives: Simplicity as a basic principle

Motion Control is a central component of the Beckhoff control technology. The company has been offering PC-based software NCs since 1986. “The consistent openness of our control technology enables a wide range of peripheral and drive equipment to be connected,” said Hans Beckhoff. For example, the company can create motion controllers based on almost any communication system. In addition to Beckhoff drive components, products from a large number of competitors can be controlled. “This will continue to be the case in future, although the new AX5000 product line will significantly strengthen our own Drive Technology,” Hans Beckhoff said.

“The new Beckhoff AX5000 drive with intelligent connection system was developed completely in-house,” said the managing director. “This drive will set new price/performance standards.” It can be combined with different motor types such as Synchronous Servo, Asynchronous Servo and Linear Servomotors. “Of course, the drives also support EtherCAT communication and enable configuration of decentralized or centralized control architectures,” Hans Beckhoff continued. Initially, the drives will cover a capacity range between 250 W and 10 kW. Further upward expansion is envisioned for the future. “Our new drives are optimized for PC-based automation,” said the managing director. “We stand by our basic principle: keep it simple. These drives can be commissioned by our customers within a few minutes.” Hans Beckhoff expects this development to have significant impact on further growth for the company.

Hans Beckhoff comments on the combination of EtherCAT and TwinSAFE:
“TwinSAFE protocol enables safe communication between safety devices without the need for the EtherCAT data security layer. The protocol is designed to enable fieldbus-neutral tunnelling across other bus systems such as PROFIBUS or CANopen.”

The new AX5000 Servo Drives with EtherCAT and optional TwinSAFE technology enable connection of synchronous servo, asynchronous servo and linear motors. The drives in the performance range between 250 W and 10 kW are designed as one- or two-axis modules.

Expansion of the Beckhoff Control Panel series: The new Panel PC series is very compact and offers plenty of CPU performance. Two performance classes are available: Pentium M for Windows XP and embedded operating systems and an ARM-based version for Windows CE applications.
Beckhoff also offers Compact Drive Technology: In the output range up to 250 W with extra-low voltage (< 48 V DC), this has been realized in the form of servo and stepper motor I/O terminals as part of the Bus Terminal system. According to Beckhoff, these ultra compact and simple-to-use drives will accelerate the trend towards electric Servo Drive Technology in machine construction. Since safety technology is an integral component of Beckhoff automation technology, it is also integrated in AX5000 Drive Technology. With an optional safety module, the drives offer safety functions such as safe stop, safe restart lock, safely reduced velocity or safe absolute position. “Functions such as safely reduced torque or safe brake control will also become available,” Hans Beckhoff continued. “Significant added value can only be achieved with safe and integrated automation including controls, I/O and drives, combined with a ‘fieldbus-neutral’ safety protocol such as EtherCAT safety.”

**New generation of computers**

At the SPS/IPC/DRIVES fair, Beckhoff will also present new PCs: "The new CP series, short for Control Panel PCs, is extremely compact and is set to establish itself as an ideal machine control platform,” said Hans Beckhoff. “These computers with high-density motherboards behind the panels will reflect a new level of price/service value. These EtherCAT-optimized PCs help demonstrate how EtherCAT will drive the future of automation,” Beckhoff said. Two performance classes will be available: Pentium M for Windows XP, and embedded operating systems and an ARM-based version for pure Windows CE applications. Pure monitor versions are also available in the same housing type. The tried and tested aluminum version enables straightforward, application-specific adaptation of the operating panel based on a range of basic housing designs: Displays are available in sizes between 6.5” and 20”, for example.

Beckhoff’s rapid growth requires continuous development of the company infrastructure. “Our company keeps repositioning itself with new departments and divisions,” said managing director Hans Beckhoff. “At present, we are in the process of detaching the business areas of electrical installation and specialized trade as independent companies.”

Elektro Beckhoff GmbH will be renamed Beckhoff Automation GmbH. The new company will continue all activities of the existing industrial electronics division. The electrical installation division will take on the traditional name of Elektro Beckhoff GmbH. Trade activities will be consolidated in a new company called Beckhoff Technik und Design GmbH. The successful family network will continue.

All Beckhoff Group companies are owned by the Beckhoff family: the three brothers Hans Beckhoff, Arno Beckhoff, Michael Beckhoff and their sister Marlies Hillen. All four also act as managing directors for the individual companies.

Published in openautomation 06/2005, VDE-Verlag.
www.openautomation.de
In order to offer a fully-coordinated and complete range of kitchen cabinets and furniture, a high degree of quality and precision is required during the processing of individual furniture components. A prerequisite for achieving this is deep and interlinked technological know-how for successful machine construction and system automation, as exemplified in the long-standing relationship between Hüttenhölscher Maschinenbau GmbH and Beckhoff.

Nobilia is one of the leading manufacturers of fitted kitchen cabinets and furniture in Europe, with around 1,500 staff and sales of 481.5 million euros during the 2004 financial year. The 107,000 sqm plant at Verl is one of the most advanced and high-performance facilities for kitchen furniture in Europe. Each year more than 275,000 kitchens are produced, with every fifth kitchen being exported to other European countries, as Turkey, Israel, China and Kuwait.
Regular cooperation between the two companies over many years has led to the development of high-performance production machines for Nobilia, one of the leading kitchen furniture manufacturers in Europe. The recent upgrade to EtherCAT as a communication medium opens up immense potential for production line optimization.

The engineers at Hüttenhölscher Maschinenbau GmbH are experts in special purpose machine construction for a wide range of industries. The majority of these machines are built for the furniture industry. Using the example of kitchen specialists, Nobilia, Norbert Jürgenhake, chief designer at Hüttenhölscher, explained: “We supply the machinery for final assembly at Nobilia – this includes all assembly lines for the different cupboard assembly groups. For prefabrication we also supply complete side and front component drilling lines. Special lines, such as those for inserting beading in glass fronts using robots, are also part of our portfolio.”

“Advanced automation and communication technology plays an important role in several respects,” said Dieter Großkatthöfer, manager for engineering systems at Beckhoff. “These systems are very demanding, requiring continuous access to information such as system status, messages and provision of system data via CAD systems. The systems are not operated in stand-alone mode, but are invariably integrated in an IT environment and linked via the ERP system.” Since Beckhoff has been cooperating with Nobilia for years in the development of control concepts and data structures, acceptance of EtherCAT as an Ethernet-based communication technology was high right from the start.

Long and intensive cooperation

Hüttenhölscher and Beckhoff have been cooperating for about 25 years – the early beginning days for both companies. Accordingly, the machine manufacturer strategically uses PC-based control technology from Beckhoff across the board. “This concentration on a single supplier significantly reduces design effort
and costs since the need to adapt to new developments is minimized,” said Norbert Jürgenhake. "Moreover, the Beckhoff engineering department acts as a quasi-control section for Hüttenhölscher and is involved in discussions with the end customer relating to system concepts right from the outset.” Nobilia decided to use EtherCAT for a drilling system for small and narrow components and for a front drilling line as part of a drawer production line. Both lines have very high output: The drilling system for small and narrow components produces more than 22,000 individual components per day in two shifts. The drawer production line is fully automated. It features a total of 14 robots and can be operated with only three staff. Up to 12,000 drawers can be produced each day in two shifts.

Future-proof data communication
"The change-over from Lightbus communication system to EtherCAT was not superficially driven by the faster data transfer offered by the Ethernet system," said Dieter Großekatthöfer: “Even with the original Lightbus equipment, the machines were never limited by the fieldbus. However, EtherCAT was the first step towards an integrated data structure.” "For us as users, this step was quite straightforward," said Norbert Jürgenhake. "We didn’t notice much difference in terms of system handling.”

However, Hüttenhölscher often has to deal with complex process sequences, which is where EtherCAT’s reserve capacity is especially useful. Due to the high output of the drilling system for small and narrow components (up to 40 furniture components per minute), very short cycle times had to be realized at the I/O level in order to ensure precise parts positioning and in order to apply a dual cycle for drilling the components vertically (from above and below) and for fitting dowels horizontally. The system is controlled via 36 NC axes, about 600 I/O points, and around 25 EtherCAT stations. According to Norbert Jürgenhake, there are no problems whatsoever in terms of data transfer.

"We are currently in the process of designing a drilling system involving more than 40 axes with parallel drilling optimization that has to be completed within 2 seconds in each case. Using conventional technology, we would have quickly reached the limits with this new system. Our assembly line is able to produce lot size 1. Very few systems can do this, and it is only possible with truly high-performance control technology,” Dieter Großekatthöfer said: “EtherCAT’s reserve capacity offers further benefits. In the past, systems with a large number of axes had to be subdivided into modules, each with their own control computer. With EtherCAT a single PC is often sufficient. Notwithstanding the complexity of the system, the end customer also requires universal parts or data tracking, resulting in high data throughputs. Here too, we benefit from EtherCAT’s performance potential.”

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Hüttenhölscher Maschinenbau www.huettenhoelscher.de
Nobilia kitchens www.nobilia.com
With the inaugural event held in October 2005, “Beckhoff Automation UpDate” is a series of brief presentations and discussions that will provide regular updates about developments and trends in automation engineering and solutions using Beckhoff technology. The first Automation UpDate was on the subject of safety technology and was organized by the Beckhoff branch in Nuremberg, Germany.

Around 40 customers and interested parties attended the presentations and subsequent discussion forum. After a brief introduction by branch manager Martin Rostan, who gave an overview of the activities of the Nuremberg office, safety product manager Jens Sachs gave a presentation on the hardware and software of the TwinSAFE system and its functionalities.

Wolfgang Negele, sales representative and initiator of the brief informational events, drew positive conclusions: “As a complement to trade shows, Automation UpDate enables us to efficiently provide more in-depth information and introductions to new technologies for our customers. The first event was well received so we intend to hold an additional session on the subject of Embedded PC controllers in early 2006.”

Beckhoff Denmark: Royal visitor at trade show

The HI Industri 2005 fair took place between 6 and 9 September in Herning, Denmark. With more than 1,000 exhibitors, it is one of the largest and most important industrial fairs in Scandinavia.

The trade show was opened by His Royal Highness, Crown Prince Frederik of Denmark. During his official tour, the Crown Prince visited a number of exhibition stands, among them Beckhoff Automation ApS. Claus Clausen, managing director of the recently established Danish subsidiary, introduced the Beckhoff product range to Prince Frederik.

HI Industri 2005 was a great success for Beckhoff. Claus Clausen summed it up: “Many visitors were very interested in the range of products and new solutions from Beckhoff.”

New event series: Beckhoff Automation UpDate

Focus on TwinSAFE, safety I/O system
The company Dr. Ecklebe GmbH, based in Wernigerode, Germany, has been offering specialty automation solutions since 1990. One of the main areas of activity for the company is the development of test facilities for generating and measuring operating data and maximum ratings for a wide variety of industrial applications. Dr. Ecklebe used EtherCAT, the high-speed, real-time Ethernet system for the first time in conjunction with a project to upgrade a test bench for analyzing dynamic, hydraulic and thermal loads on components.

"The upgrade of an existing test bench for hose clips at Hans Oetiker Metallwaren- und Apparatefabrik GmbH, based in Endingen, Germany, aimed to achieve a comprehensive controls modernization and increased performance," said Dipl.-Ing. Michael Paetzel, managing director of Dr. Ecklebe GmbH. One of the requirements was to replace the existing analog control technology with software-based controllers. Each test piece requires different controller settings, which in the past could only be realized through hardware intervention. With TwinCAT PLC software and EtherCAT as a fast fieldbus system, a solution is now available that enables all control tasks to be created in the IEC 61131-3 programming language. "The physical data transfer of the new control system is based on standard Ethernet, with EtherCAT used as the protocol. The system features cycle times in the 50 µs range. Since the hydraulic pressure values have to be kept constant during the test procedure, fast readjustment is required," automation expert Michael Paetzel explained.

"Via a suitable periphery, EtherCAT offers an automation system with data acquisition speeds that in the past could only be achieved with special measuring cards and digital signal processors (DSPs)," Michael Paetzel continued. "In conjunction with TwinCAT, we now have a modular, high-performance control system based on cost-effective, standard components."

The adaptive control algorithms developed by Dr. Ecklebe GmbH run within a dedicated task (500 µs) in the software PLC. All other tasks are handled via a second task (1 ms).

The following tasks have to be dealt with:
- calculation of the set value curve (sine, trapezium, rectangle, etc.)
- position control of the pressure generator
- regulation and monitoring of the test pressure
- adaptation of the controller parameters
- logging and preprocessing of all measured values

TwinCAT integrates the regulation process into the control program. Via TwinCAT ADS, it also provides all process parameters for the visualization program, which is written in Delphi. Hardware PLCs and DSPs are no longer required. This not only leads to substantial cost savings for components, but also reduces the project design, switchgear engineering and programming effort.
“For fast control tasks we use EtherCAT I/O terminals. For normal system control signals, standard Bus Terminal I/O are used with the BK1120 EtherCAT Bus Coupler. Since performance depends on the PC, control system scalability is practically unlimited as PCs become ever faster and more powerful,” said Dipl.-Ing. Paetzel.

Another significant advantage is simplified programming and commissioning. All control software is written under a single development environment. Complex hardware coupling between PLC and DSP, such as multiplexed 5 V DC signals, is no longer required. Signal coupling is dealt with entirely within the software. This makes signal exchange less prone to faults and I/O tests during commissioning are no longer required. Overall, the decentralized configuration leads to further improvements with regard to EMC issues. The control signals are handled with short cable lengths. Full remote system maintenance capability is another advantage: Remote access to the PC enables full access to all relevant system data. “The first implementation of a test bench facility with EtherCAT convinced us and our customer, with whom we cooperate closely, of its performance capability,” said Michael Paetzel. “Commissioning was straightforward, since the system offers convenient engineering tools such as integrated trace functions.”

This application demonstrates that EtherCAT technology is not only suitable for new systems, but also enables existing systems to be modernized and upgraded. “EtherCAT can not only be used for test bench automation, but for any other control task, such as the positioning of electric or hydraulic axes.” For Dr. Ecklebe, the fast fieldbus system offers significant room for technological advancement well into the future.

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Hans Oetiker
Metallwaren- und Apparatefabrik GmbH www.oetiker.com

Dr. Ecklebe GmbH www.dr-ecklebe.de
Rollwalztechnik (RWT) have been producing NC- and CNC-controlled profile forming machines with particular focus on the automotive sector for about 15 years, based on a consistent assembly system for drive, control and hydraulic components. This machine concept offers benefits in terms of simplified service and flexible adaptation to the respective production tasks, as illustrated by a thread rolling machine that sets new standards with regard to flexibility, performance and ease of operation, thanks to PC-based automation technology from Beckhoff.

Innovative machine construction
The design of the thread rolling machines from RWT enables universal application of rolling techniques using thread rolls, for example penetrating rolling or pass rolling with pivoted roller screws, or a combination of both techniques. The compact design of the machines with non-positive roll frame ensures that the rolling forces can be controlled safely. The self-lubricating, asymmetric 3- or 4-column guide prevents slide lift — an important prerequisite for improving the service life of the rolling tools. As a good example for the innovative machine design, Helmut Sroll, technical director at RWT, describes the 2-roller thread...
Rolling machine RWT 30X CNC/AC: “The machine has two pick-up screws for the forming tools. Both are driven by servomotors and synchronized via the NC controller in terms of relative rotational position and synchronous operation. The workpiece to be profiled is located between two forming tools that move towards each other, driven by a servo-hydraulic system. In this way the workpiece is picked up, rotated, and formed through the feed motion of the hydraulic system.”

“The two rotary axes have to meet very high synchronization requirements, in order to be able to produce high-precision workpieces such as external splines for the automotive sector”, said Helmut Sproll. “The hydraulic feed motion of the third axis is responsible for ensuring dimensional accuracy of the workpieces in the 0.001 mm range. For certain applications it can be synchronized with the rotary axes (start angle). Additional quality control of the forming process is achieved by monitoring the forming forces and the drive power. Beckhoff automation technology meets all these requirements.” Frank Würthner from the Balingen Beckhoff branch said: “The special feature of the thread rolling machines is that the required profile can be cold-formed, which means that the natural fibre direction of the material is not disturbed. This results in a higher strength and impact strength.”

Flexible and integrated automation
Helmut Sproll’s decision to start using Beckhoff automation technology about a year ago was based on several factors. The PC Control system is very flexible and can be optimally adapted to the process engineering requirements. It offered an opportunity for creating an integrated user interface, and the high-performance PC achieves very short position control cycle times. “The integrated software PLC enables implementation of a wide range of automation tasks, and the machine can relatively easily be extended with additional NC axes. And all that with a good price/performance ratio,” said RWT’s technical director.

For this first project Beckhoff very successfully handled the software projecting aspects. Frank Würthner said: “We were able to benefit from our comprehensive hydraulics know-how and from the fact that we could respond very flexibly to customer requirements thanks to the open Beckhoff technology. For example, we were able to select the bus system freely without any restriction. Based on the drive technology we used, we decided to use SERCOS.” According to Helmut Sproll, EtherCAT will no doubt become an issue, since it offers substantially higher transfer speed than SERCOS.

The three machine axes are controlled by the higher-level Beckhoff control system, which also deals with the PLC functions for workpiece feed and discharge.
and clamping functions. The system is based on the Beckhoff control cabinet PC C6140 with Windows XP and SERCOS master card and the "Economy plus" Bus Coupler BK7520 for integrating the I/O level and the Servo Drives. Other system components are the TwinCAT NC PTP positioning software, the TwinCAT PLC libraries for hydraulic positioning, and the NC interface on the Control Panel CP7832.

The user interface is displayed and controlled via a touch screen and covers the actual CNC machine control, the PLC application, integrated rolling force monitoring for quality control purposes, and output measurement for the drives. Like the machine control, it was developed based on special industry know-how and in close cooperation between RWT and Beckhoff. Helmut Sproll said: "Our experience has been very good. Through the cooperation with Beckhoff we were able to utilize important synergy effects, and we were very happy with the advice and technical support from Beckhoff."

**Benefits of software control**

Helmut Sproll has no doubt that the decision to use a pure software control has paid off: "The PC-based automation technology from Beckhoff offers flexibility, a common user interface, consistent projecting, and integrated remote maintenance and diagnostic options." According to Frank Würthner, further benefits arise from the scalability of the TwinCAT NC PTP axis positioning software and the hydraulics library. "We expect that about 90% of the wide range of benefits of the flexible and integrated automation solution manifest themselves in the machine design, and 10% in the application." Thanks to the comprehensive functionality of TwinCAT NC PTP, i.e. axis positioning (set value generation, position control), integrated software PLC with NC interface, operating software for commissioning and I/O interfacing of the axes through a wide range of fieldbuses, the software was able to replace conventional positioning modules and NC controllers.
A production facility for printing plates consists of several machines – the actual laser engraver, grinding machines for the printing cylinder, galvanic baths for electroplating of new and used cylinders, crane systems for transporting the cylinders, mixing facilities for the galvanic baths, etc. MDC Max Daetwyler AG, based in the Swiss town of Bleienbach, was looking for a new control concept covering the complete range of its products, in order to open up the performance and full potential of their already proven machines.

The first machine to be upgraded was the "Laserstar" engraver, which features fully automatic, high-quality exposure of gravure cylinders and offers very high running precision with an engraving capacity of 140,000 cells per second, plus a significant improvement in printing quality. The concept is based on the Direct Laser System (DLS), which offers significant advantages in terms of reproducibility, quality and raw material consumption compared with electromechanical engraving (EMG).
Control concept for the future

In the future, all control systems for MDC machines will be based on the same object-oriented architecture in order to enable identical procedures for the software development of all MDC product groups. MDC Max Daetwyler also aims to standardize the diagnostic tools (such as log files) and machine operation for all product groups. The three fundamental control architecture components are integrated into one system:

➔ **User interface/external input:**
  - graphical user interface (operating terminal) with link to high-level control system (no direct coupling with the software PLC)
  - programming language: Java, Phyton or others depending on the task at hand

➔ **High level (process control):**
  - object-oriented development with UML tool
  - programming language: Java or other machine-dependent process control, depending on the operating system
  - low-level controllers (individual modules) controlled via single interface

➔ **Low level (hardware control):**
  - software PLC programmed in ST code
  - subdivision into modules according to the hardware. The modules should be independent of machine types so that they can be used in different product groups (machine types) with identical or similar hardware

Decision in favor of technology shift

At the end of 2004, Daetwyler decided to implement a new control system. Peter Pfister, development manager and member of the Daetwyler management team, explained the principal motivation behind the project: “We have been using advanced controllers for some time, but in the past our systems had not been integrated. The new concept aims to set company-wide standards, with the main aim of simplifying development, training and maintenance.” The decision to use Beckhoff technology was based on several aspects. “Company-wide and long-term strategies are behind such an important decision,” Peter Pfister continued. “We, therefore scrutinized all main automation providers, both in terms of the technology and of the support offered because in addition to the actual technology, worldwide acceptance and support are of central importance for us. In the end, we had to decide between Beckhoff, another large provider from Germany, and one from the USA. Ultimately, the PC-based control technology from Beckhoff won the day.”

Stefan Keller, member of the sales team of Beckhoff Switzerland, is justifiably proud of this market success: “The technological benefits of our system prevailed against a number of well-known and large competitors, not least because Beckhoff has subsidiaries worldwide, is able to respond capably and efficiently to enquiries, and provided the best support for Daetwyler’s worldwide commitment.” Peter Pfister added: “So far our experience with Beckhoff in terms of technical cooperation and service has been very good.”

➔ **The Beckhoff control solution includes the following components:**
  - Control cabinet Industrial PC (C62xx series)
  - Control Panel as control unit
  - Bus Terminals as I/O system
  - TwinCAT NC PTP, PLC and Motion Control software
connection of individual modules with the high-level control system via a generic interface
fieldbus for digital and analog I/Os (preferably Ethernet, PROFINET DP or Interbus)
components for axis control in more complex machines

High-performance automation is needed
So far, the new control concept has been implemented in two Laserstar engravers with six NC axes, approx. 200 I/Os and two 800 W laser heads, which require maximum precision when it comes to automation technology. The NC axes and I/Os of the Laserstar engraver are controlled via TwinCAT software and an Industrial PC. An additional Industrial PC and a customized Beckhoff Control Panel are used for operation and visualization. Stefan Keller explains: “The consistency and ease of use of our system is demonstrated by the fact that the conversion of the machine control system to TwinCAT was completed very quickly – within six months.” According to Peter Pfister, the system has already proven its performance capability: “In general, we are still in the set-up phase, although the first machines have already been delivered. The following performance data illustrate the demands on the control technology: The Laserstar blows 140,000 “holes” per second into a cylinder with a circumference of 2 m and a weight of 2.5 t at a peripheral speed of approximately 15 m/s. Constancy of the movement and alignment of the optical system in the mm range are a significant challenge. In the past it took approximately 15 minutes before engraving could commence. With the new control concept, it only takes 30 seconds. Naturally, this significantly increases machine performance.”

MDC Max Daetwyler AG www.daetwyler.com
Beckhoff Switzerland www.beckhoff.ch
Vignotto S.r.l., based in Gozzano, Italy, has been producing special machines and transfer devices for fitting manufacturing applications since 1971. The company’s corporate philosophy is based on meticulous design, simple construction and high quality standards. The change-over to PC-based control systems with Beckhoff technology led to greater flexibility as well as time and cost savings.

Beckhoff Industrial PC C6140 controls processing centers

A technically elegant solution
The services offered by Vignotto S.r.l. include design, machine construction, planning and implementation of electrical and oil-hydraulic systems, as well as writing software for processing centers. All components are manufactured in-house on CNC machines. This production technique guarantees a uniform, high level of quality. CAM (Computer Aided Manufacturing) enables fast and direct implementation of computer models for actual production.

**Transfer devices and robotic cells for mechanical machining**

The transfer devices consist of a rotary table with multiple stations and vertical or horizontal axes with a fixed or relocatable/tiltable processing head. Through the combination of these components, a wide range of production cycles for mechanical series production can be configured. In addition, Vignotto installs robots and robotic cells for automatic feeding of workpieces to transfer devices and processing centers. The robots are controlled visually via a video camera that monitors the position and alignment of workpieces on the conveyor belt.

**Inefficiency and complex wiring lead to changes**

The transfer device requires a wide range of inputs and outputs for controlling the NC axes. A machine with 12 processing units for manufacturing fittings (mixers/taps), for example, requires a system with approximately 150 digital I/Os and 16 analog outputs for controlling spindle speed and 17 NC axes. In the past, a PLC with interface cards (each controlling 4 axes) was used for the connection with the NC units, which meant that the NC environment was not very flexible: If an additional axis was required, for example, a complete unit consisting of 4 axes had to be added, making expansion rather costly and inefficient. Furthermore, the wiring between the NC units and the PLC (encoder and drives) was complex and the installation and switch boxes required a lot of space, which often led to problems on site. In addition, different programming environments were used for PLC and NC so that different software programs and hardware interfaces were required for commissioning the systems.

**Flexibility is the solution**

For these reasons, Vignotto decided to use flexible PC Control technology from Beckhoff: The system is now controlled by a C6140 series Industrial PC with CP6831 Control Panel, 15-inch TFT monitor and extended keyboard using Windows XP operating system and an FC7502 SERCOS interface card. According to the company owner, H. Giovanni Vignotto, the key aspect of the Beckhoff solution is uniformity of the assemblies, which optimizes the configuration – digital or analog I/O Bus Terminals with 2, 4 or 8 channels and a wide range of Bus Couplers, including the BK7520 with SERCOS interface can be used. On the software side, TwinCAT NC PTP integrates PLC and NC functions, as well as the programming environment. TwinCAT delivers maximum versatility: Adding 1 axis no longer requires costly hardware involving 3 or 4 unneeded axes, but can be achieved with simple installation of the encoder module or wiring of the additional drive. Maintenance costs are also reduced significantly: In the event of a fault, only the affected module has to be replaced, not the complete NC unit for 4 axes.

The SERCOS fieldbus makes wiring between the different parts of the I/O system and the drives quick and straightforward. The encoder units are installed at the machine. Instead of expensive wiring with plug connections between the machine and the control cabinet, a two-core optical fiber cable is sufficient for connecting the encoder directly with the switch box. The space requirements for the installation are also reduced significantly. “The Beckhoff solution enables not only the realization of an integrated system within a uniform environment, it also offers maximum flexibility as well as time and cost savings for wiring and maintenance,” Giovanni Vignotto concluded.
Industrial Automation and Control Systems N. Sofikitis, based in Athens, Greece, specializes in the integration of industrial motion and process management systems for the chemical industry and other sectors. Applications of this type require a high degree of reliability and flexibility. For detergent manufacturer, Eurochartiki S. A., based in Aspropyrgos, Athens, Sofikitis designed a control system consisting of a Beckhoff Industrial PC and I/O components.

Chemical processes require high accuracy and coordination during the mixing of different ingredients. Under laboratory conditions this is an easy task, since specialized staff are available and only small quantities have to be dealt with. In mass production, however, the conditions are very different and a wide range of production parameters such as weight, pH value, recipe quantities, viscosity, temperature and color have to be taken into account, making the task very complex.

**Three-part production process**

Eurochartiki S. A. required a control system for their production plant that could deal with these tasks reliably and was flexible enough to enable integration into existing quality control equipment. The production process is divided into three parts:

1. **Preparation**
   - Mixing the ingredients according to the recipe.
   - Ensuring the correct proportion of each component.
2. **Concentration**
   - Adjusting the concentration of the mixture to meet the desired standard.
   - Monitoring the pH level and other parameters.
3. **Quality Control**
   - Performing quality control tests to verify the consistency and concentration of the product.
   - Integrating the results into the production process.

A chemist carries out quality control tests in a laboratory.

Optimized quantity and quality
stages: The pre-production stage where the production manager decides how many batches will be produced per day, the production stage where the technicians monitor the automated process and the post-production stage where samples are taken and subjected to several quality control tests in the chemical lab. These processes are controlled by a C6140 Industrial PC with TwinCAT PLC software and Bus Terminals as the I/O system via a real-time Ethernet network. IAS, L. J. Skourgialos, the Beckhoff partner in Greece, provided support for Sofikitis during the implementation of the control system.

Process monitoring via Ethernet
The decentralized SCADA client enables production monitoring and control via Ethernet. Each of the individual silos can be assigned batches via the SQL database, in which the recipes are stored. The production process then commences. The SCADA system provides detailed information about the batch data and the technicians can start the process from any silo Control Panel, which serves as the user interface. These user interfaces are operated via the TwinCAT Modbus TCP/IP server and Ethernet. Depending on their user level, production technicians can modify recipes during production, for example, by adding an ingredient, changing its weight, or removing it altogether. Such modifications are permitted because ambient conditions have significant influence on batch quality in chemical production and processes. Once the production process is completed, a sample is taken and several quality control tests are carried out in the chemical laboratory.

“ The Beckhoff control system we use for detergent production has led to an impressive improvement in terms of quality and quantity for all production parameters,” said Constantinos Tentas, production manager at Eurochartiki.

Beckhoff automation components:
- Control cabinet Industrial PC C6140
- TwinCAT PLC
- TwinCAT Modbus TCP Server
- Bus Coupler: 3 BK9000 Ethernet Bus Couplers
- Bus Terminals: various digital and analog I/Os, including 32 KL3356, 1-channel precise resistance bridge evaluation

Eurochartiki S. A. www.eurochartiki.gr
Beckhoff Sweden relocates headquarters to Malmö

On 1 July 2005, the Swedish Beckhoff subsidiary, Beckhoff Automation AB, moved its head office to a new, larger building in the city of Malmö. In addition to its headquarters, Beckhoff has a second Swedish office in Täby, a suburb of Stockholm.

“Exactly three years after Beckhoff Automation AB was established, it was time for a change in order to accommodate the growth of our company. Restructuring and investments were required in order to continue offering our customers a consistently high level of service in terms of distribution and support and to enable further growth,” said sales engineer Håkan Brandt from Malmö.

The new office building is located in the south of Malmö, the third largest city in Sweden. Since the opening of the Öresund Bridge as a direct connection between Denmark and Sweden, Malmö has developed into the strongest growing region in the country. The head office of Beckhoff Automation AB is located only about ten minutes from the bridge, making it easily accessible.

“Having decided to acquire the larger premises, we also decided to move our head office from Täby to Malmö. The Täby office is now a pure sales office,” said Björn Forssberg, managing director of the Swedish Beckhoff subsidiary. “All logistics and main elements of our technical support are now pooled at Malmö.”

“The relocation and restructuring enables us to bundle our forces and to deploy our workforce more efficiently. We now have more time for customer service and we are more easily accessible,” said Håkan Brandt, underlining the benefits of the new head office.

“Sweden is a growing market for PC-based control technology and demand for our technological know-how is continually increasing. With our new training center in Malmö we can provide much better service than in the past. Establishing state of the art “New Automation Technology” not only means selling a product, but also developing suitable solutions in collaboration with our customers,” said Håkan Brandt.

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As one of the top manufacturing countries in the world, Japan is naturally one of the biggest markets for control systems in the world. However, foreign manufacturers are still finding it difficult to establish a foothold in Japan, with Mitsubishi Electric and Omron dominating approximately 75% of the Japanese PLC market. Beckhoff has been represented in Japan since 2004 through the Tokyo-based company K.MECS Co. Ltd. and has already had some successes. One example is a robot control automation project for Kanto Seiki.

Kanto Seiki Co. Ltd. developed the Ethernet-based robot control system with BK9000 for robots with 4 to 6 axes. Masahiko Hashizume, director of the development division at Kanto Seiki, presented his PC-based robot control system at Jimtof, the largest trade show for the machine tool sector in Japan. He was delighted when he discovered Beckhoff Bus Terminals at a trade show: “While modular I/O systems were already available in Japan, most of them required backplanes and quite a bit of space. In contrast, the modular Bus Terminals from Beckhoff are very compact.”

Kanto Seiki therefore decided to use the Bus Terminal system with Ethernet networking. The BK9000 Ethernet Bus Coupler is connected via the Ethernet port on the robot or with a higher-level controller. This enables additional modular I/Os to be added as required. Conventional LAN components can be used for the wiring. Kanto Seiki uses Modbus TCP as their Ethernet protocol. A robot control software library was developed as an application aid for the BK9000.

The new robot control system was presented at Jimtof, the largest trade show for the machine tool sector in Japan. “The feedback exceeded our expectations,” said Hashizume and continued: “Many visitors, including Denso were impressed by the Ethernet-based robot system utilizing the BK9000. Initially, Denso was sceptical about I/O connections via Ethernet because in the past, they had used Ethernet only for communication systems and were not convinced about the reliability of the system. The application presented at the trade show demonstrated the reliability of Ethernet in practice.”

Toshiyuki Kameda, managing director of K.MECS, the Japanese distribution partner of Beckhoff, considers the success of Beckhoff technology against the background of Japan’s history and its special market mechanisms. Japan has a very traditional attitude. Historically, the country only opened up to the West under pressure, with associated consequences for technological development. “Today, Japan has become a modern culture,” said Toshiyuki Kameda, “and I am optimistic that Beckhoff technology will be able to break into and revive the Japanese market.”
Continental Tire’s Charlotte, NC plant decided to modernize its tire curing presses. The project involved replacing the hardware PLC with a PC-based controller, the CP7130 Panel PC from Beckhoff, leading to a 50 percent reduction in controller costs and installation time.

The modernization was prompted by the global shift towards larger SUVs. The existing presses had been in use since the early 90s and were designed primarily to mold tires for small to mid-sized cars. The Charlotte facility had to be able to mold more large tires — specifically, the ContiTrac™ and AmeriTraq™ lines — to meet the shifting demand. Demand has also been very high for UHP — ultra high performance tires.

Continental decided to change the design of 34 of their curing press machines away from “Two Piece Molds” (best suited to smaller tires) to “Segmented Molds.” As the name suggests, two-piece molds use two cupped pieces of steel to press “green tires” (those that haven’t fully cured) around inflated bladders to achieve the proper shape and seam. Segmented Molds are better suited to maintain the mold uniformity and overall quality of larger tires.

The 34 presses slated for upgrade primarily used early 90s-era PLCs for control. Continental decided to look toward a more cost-effective and centralized PC-based control alternative. This was largely due to costs associated with the price of buying new PLC controls and the extensive wiring for decentralized control architecture on so many machines.

In addition, a fundamental design issue to resolve was that the PLC-controlled presses did not operate in a true manual mode. “It was more of a ‘semi-automatic’ system,” Continental Tire electrical engineer, Jack Pyler said. “Individual system sequences could be queued to operate, but not the individual components. As a result, individual components could not be tested in a stand-alone fashion.” These different requirements ultimately led to the decision of using a PC-based control solution with central intelligence.

**Industrial PCs take the heat**

In order to succeed in implementing Industrial PCs, Continental required a motherboard that could withstand the harsh temperatures in their plant. “We have ambient temperatures that can exceed 100°F/38°C near the presses, which themselves reach a maximum curing temperature of 362°F/183°C,” Pyler said.

Continental FMF, Continental AG’s machine manufacturing and specialist control division, was responsible for the electrical design of the new Segmented Mold machines and chose Beckhoff CP7130 Panel PCs as the control centerpiece.
“Beckhoff is the global standard supplier for the majority of the Continental AG controls, so it was a logical vendor to start with. A key feature of the CP7130 was that we were able to spec 330 MB of compact flash memory running Windows XP Embedded rather than a rotating hard drive,” Plyler said. “This removed any last ditch arguments for keeping the old PLC approach. Plus, the Panel PC has a heat sink instead of a fan.”

Continental also chose to use Beckhoff Lightbus I/O for the curing press upgrade. Utilizing fiber optic technology, Lightbus features a transfer rate of 2.5 Mbaud and with one Lightbus interface board, up to 255 decentralized modules can be operated at a maximum distance of up to 30 m between two modules. “While it’s probably known best for speed, we primarily chose Lightbus as the curing press fieldbus because the equipment is very cost effective, flexible and simple to wire,” Plyler said.

Flexible operating modes

The new presses were designed to have three true modes of operation: a “Manual Mode”, “Mold Change Mode” and “Automatic Mode”. In “Manual Mode”, all machine components can be manually actuated and all processes can be carried out manually. In Mold Change Mode tool change, maintenance and cleaning work are done. In automatic mode, not only tire loading and unloading functions are automated but also the whole process is controlled by pressure and temperature control loops inside of the IEC 61131-3 application. Curing and production data are monitored by the TwinCAT control system software, which is displayed on the Panel PC.
Continental chose fiber optic Lightbus as the curing press fieldbus due to reduced equipment cost and reduced wiring effort.

Curing and production data are monitored by the TwinCAT control system software, which is displayed on the Panel PC.

TwinCAT OPC Server monitors production data
Because of Continental quality guidelines, facilities have to chart tire temperature and pressure throughout the tire curing process. In the past, Continental used 24 hour chart recorders with paper and pens, but by using TwinCAT OPC Server, they’re able to tie the machines to a central server over Ethernet and view chart information online via a web browser and historian. “Diagnostics and troubleshooting with TwinCAT and TwinCAT OPC Server is straightforward and can be done with ease from my office. It usually takes only about 20 seconds to get a full view of what’s going on the plant floor and determine if there’s a developing problem with any of the presses,” Plyler said. “Also, if I want to look at a chart dating back a month, I can find it in seconds instead of sorting through piles of paper charts.”

Ethernet controller controls tire conveying system
Beyond the Segmented Mold machines, Plyler chose to design an additional controls upgrade on a tire drop and conveyor system with a Beckhoff BC9000 controller. Via Ethernet and TwinCAT ADS this Bus Coupler with integrated PLC functionality communicates with 34 Continental curing presses that feed tires to the conveyor. With 12 presses running at high capacity on each side, the controls had to be able to ensure that tires weren’t piled on top of each other on the conveyor. “The BC9000 was a good, low-cost solution for us because it does the job and understands when the conveyor is clear for a new tire to be dropped in place,” Plyler said. “Plus, the wiring is much cleaner than with the previous relay solution. Now, instead of spaghetti wiring to 24 different presses, there’s just one Ethernet cable.”

Working smarter, not harder
“The results of the PC-based design were immediately apparent in terms of cost savings. New controls — electrical and mechanical — on the 34 upgraded curing presses were at least 50 percent less costly. There were even greater savings when field installation — including wiring, pneumatics and hydraulics — were factored in. Electrical installation time was reduced by 50 percent over the previous presses, a savings of over 100 engineer hours.”

“The centralized control strategy really helped here. The new control design was more streamlined than conventional press control systems. In the past, having intelligent controls distributed all over the place often meant a lot more wiring to deal with. Plus, I expect that we’ll have a lot less downtime with the centralized approach,” Plyler said.

Older Continental press designs would have as many as 20 push buttons and switches. The new Continental curing presses were scaled back to three push buttons, an emergency stop and a selector switch. Most manual functions and mode change functions are handled by function keys located next to the screen on the Panel PC. “All those extra push buttons added a lot of wiring, labor and equipment cost when you’re dealing with 34 big machines. Having function keys already integrated into the Panel PC saved us a lot of grief,” Plyler said.

With phase one of the curing press upgrades complete, Continental has been able to supply tires of all sizes in the quantities the market calls for without skipping a beat. To continue to stay in step, Continental’s future plans include the upgrade of 18 additional presses to the same Segmented Mold presses with the CP7130 and PC-based control system.

Continental Tire www.continentaltire.com
Beckhoff USA www.beckhoffautomation.com
Beckhoff
North America: New product training director appointed

The American subsidiary, Beckhoff Automation LLC is pleased to announce that Tim Blaeser has been hired as Product Training Director at the company's Burnsville, Minn. headquarters. Blaeser took over responsibility for product training in early October. His courses will focus on TwinCAT software programming in the areas of maintenance, PLC basics and Motion Control.

"Over the past 12 months, Beckhoff has had an increase in demand on our North American training resources by over 100 percent," said Graham Harris, President of Beckhoff Automation. "Now is the perfect time to bring in Tim as our technical training director to most effectively meet this rapid increase while also helping shape the future direction of Beckhoff training procedures in North America."

Prior to accepting this new position, Blaeser, who has a Bachelor of Science degree from the University of Minnesota, served at Lisec America Inc. in Eagan Minn. as a controls engineer and installation coordinator for all of the company's new glass fabrication installations in the US. He also has extensive technical training and instruction experience as a Senior Training Engineer for UNICO Inc. in Franksville, Wis. Blaeser trained customers around the world in the installation and maintenance of diverse microprocessor-controlled servo systems.

Beckhoff establishes new subsidiary in Canada

The Beckhoff subsidiary, Beckhoff Automation LLC, based in Burnsville, Minnesota, has been operating a local sales office in Canada for 4 years. On 13 October 2005 the Canadian agency became an independent branch. It is now called Beckhoff Automation Canada Ltd., is based in Guelph, Ontario, and has a sales office, a training centre, and an exhibition room for product presentations.

The city of Guelph is located in the center of the manufacturing and machine-building region in south-western Ontario, where 80% of the Canadian manufacturing industry is based, including automotive and automotive supplier industry, machine construction and system engineering, packaging systems, pharmaceuticals and food production, communication and semiconductor industry.

"Through the establishment of Beckhoff Automation Canada we are strengthening our commitment to customers in Canada," said Joe Ottenhof, Regional Manager of Beckhoff Canada. "We are now significantly better positioned and equipped. In future, our Canadian customers can depend on local technical support and training opportunities for implementing Beckhoff technology." The sales and support team of Beckhoff Automation Canada will be expanded with several new staff in due course.

"Canada is an interesting market, characterized by strong growth. The Canadian economy is very strong at present, with minimum inflation, low interest rates, and dynamic growth. Good reasons," said Graham Harris, President of Beckhoff Automation LLC, "for strengthening and expanding our position here."

Beckhoff Automation Canada will continue to work closely with the headquarters in Burnsville and share technology, product management, and warehouse space.

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MarquipWardUnited, a division of Barry Wehmiller and located in Madison, Wis., is a leading manufacturer of off-line and on-line dual rotary knife sheeters for the printing and converting industries. Sheeters precisely cut and stack paper, plastic, tinfoil laminate and tag board from rolls at extremely high speeds. Rolls of material are run through tension systems and cutters, with sheets of the material in various sizes stacked at the end of the process for end-use.

Customers demand PC-based control
According to Tom Miske, senior engineer of controls, MarquipWardUnited’s motivation to redesign their machines’ control systems had its roots in the company’s commitment to listen and act upon their customers’ feedback. Thanks to a major redesign of the control system away from PLCs using PC-based controls, MarquipWardUnited was able to offer their customers the open system they were asking for. The simplified architecture greatly reduced the number of system components, installation costs, and engineering effort. Miske’s team was also faced with the challenge of replacing more traditional machine components that were considered obsolete and were being phased out by their manufacturers.

“The sheeter machine market is cutting edge and very receptive to innovation,” said Miske. “End-users want to save as much money as possible, but at the same time, need solid technology that’s open and easy to understand, along with user-friendly operating features. Many of them, being knowledgeable of modern Industrial PCs, asked us ‘why do you have to use PLCs? They’re expensive.’ In fact, several customers told us after we introduced the new control system that if the solution wasn’t PC and Windows based, they wouldn’t be looking at
MarquipWardUnited. After a search and comparison of several PC-based systems, MarquipWardUnited concluded that TwinCAT from Beckhoff provided the best automation control system using Windows that met all their requirements. “We feel that the engineering that goes into Beckhoff products is superior to anything we have seen. From a hardware standpoint, it’s much simpler to implement. In addition, TwinCAT offers plenty of scope for further developments. The flexibility and power the technology has is impressive for the cost-effective price.”

**Going the speed of Lightbus**

Beckhoff components used by MarquipWardUnited include a C6240 Industrial PC running TwinCAT IEC 61131-3 software, 15 inch Control Panels for operator interface and Lightbus I/O with a Lightbus PCI card inside the PC. “The dual rotary knife on our machine needs to run at extremely high speed,” Miske said. “Lightbus was one of the only fieldbuses available to us at the time that could handle our millisecond signal transmission requirements.” The speed of Lightbus has helped MarquipWardUnited increase sheeter machine production speeds from 1,100 feet per minute to 1,500 feet per minute.

“Beckhoff is truly OEM-friendly. We got high quality support on the technology side and didn’t need much on the programming side. The IEC 61131-3 programming standard was instrumental in allowing us to do a higher level of programming language than LADDER. Programming PLCs with LADDER limited our engineering opportunities,” Miske said.

**Controls that adapt as quickly as you can**

Having a technology migration path was an important ingredient in MarquipWardUnited’s decision-making mix. “We are a vertically integrated company and typically have had to invent most of the components on our machines. We were looking for an off-the-shelf, open system so we could connect to different systems if necessary. We needed something that was simple enough to use, but at the same time, gives us a technological and competitive edge – we found it in Beckhoff,” he said. “IEC 61131-3 is a standard that ensures if things change you can program on other hardware later and can always support older hardware.” Virtually every sheeter is customized in one way or another. “Because of our control flexibility, openness and power, MarquipWardUnited is able to meet a multitude of different requirements at a reduced cost.” The switch to Beckhoff technology has meant lower costs for MarquipWardUnited on several levels. However, this also translates into an approximate 60 percent cost savings for MarquipWardUnited’s customers when critical spare parts are needed for their machines. Besides system component savings for all parties involved, there has been a dramatic reduction in factory wiring and field installation labor. “With fieldbus and distributed I/O, we can factory test the system, then plug the modules for shipping so all of the wires don’t have to be field terminated. We figure this would have taken about three days” Miske said. “It now takes just one day.”

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MarquipWardUnited [www.marquipwardunited.com](http://www.marquipwardunited.com)

Beckhoff USA [www.beckhoffautomation.com](http://www.beckhoffautomation.com)
The conveyor system consists of four belt conveyors running with a throughput of 1,200 tons coal per hour. The basic tasks of the central control system include monitoring and control of the conveyor belts and crushers installed in the coal conveying system. At the same time, status data relating to operation, fill level and conveyor belt scales are displayed.

The system features two Beckhoff C5102 Industrial PCs, two 17-inch Control Panels installed in the control center and three CX1000 Embedded PCs. Two of the CX1000 controllers deal with control functions. They are installed de-centrally at distances of 2450 m and 3100 m from the central control station. Ethernet glass fiber cables (10/100 Mbaud) ensure reliable and fast data exchange.

A C5102 Industrial PC is used as the central PC and deals with the following tasks:

- Display and central control of intermediate conveying system, transport, bunker feed, bunker distribution, primary crusher, and main crusher
- Real-time status display of pull switch, slope switch, slides, obstruction, conveyor belt scales, and fill level meter
- Display and online monitoring of operating voltage, current and effective power, as well as electric power of the motors for the primary and secondary crusher, transportation, bunker feed, and bunker distribution

Industrial PCs and Embedded PCs from Beckhoff are used in the North Mine open cast coal facility in Inner Mongolia, operated by CPHCG (China Power & Huolin River Coal Group). Extracted coal is delivered via a belt conveyor to the Huolin Guote power plant over a distance of 5 km. Production and management are handled by controllers using real-time industrial Ethernet.
One of the local CX controllers logs and verifies data from local devices such as the protection unit for the conveyor belts and the intermediate conveying system, as well as the signals from central, local, operating and emergency stop units. The voltage, current, energy consumption and output of the intermediate conveying system and the primary and secondary crusher are monitored online via a local KL3403 power measurement I/O terminal so that any faults can be detected. A further CX1000 controls the protection functions for the intermediate conveying system and feeding of the coal bunker.

Beckhoff solutions are becoming more and more popular in China. In order to familiarize Chinese engineers with Beckhoff products and the Beckhoff control philosophy, the Beckhoff agency in Shanghai, together with their business partner, Shanghai Longterms Technology Co. Ltd., organized a seminar on the topic of PC-based control. It was held on 24 August, with more than 100 engineers from well-known construction consultancies and companies in attendance.

Liqiang Liang, managing director of Beckhoff China, Song Zhang, project manager at the Shanghai branch and Kai Zhu, Motion Control expert, presented New Automation Technology products and solutions. Zhang Qi, director of the development department of Shanghai Longterms Technology Co. Ltd., gave a presentation from a user perspective.

The seminar was complemented with an exhibition forum, where Beckhoff solutions and overview of the 10-year history of Bus Terminal I/O were presented, as well as application examples.

Liqiang Liang was satisfied with the feedback: “Seminar participants agreed that their time was well-spent gaining a deeper insight into the Beckhoff philosophy and product offering.”

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EtherCAT complies with criteria for open technologies

Openness means free access to technology
Each company – be it manufacturer or user, competitor or not – may join the EtherCAT Technology Group (ETG) and obtain free access to EtherCAT technology. So far 235 companies from 25 countries have taken up this offer. The ETG executive board has never declined an application.

Openness means lower costs
Charging several thousand euros per year for access to a technology is not exactly a sign of openness. ETG membership is free. ETG members receive specifications, training sessions, circuit diagrams, even development support and software free of charge. The source code for the slave protocol stack is included in the evaluation kit (which is available for a nominal fee), while other technologies charge 5-digit figures just for a project licence. The master, including the operating system, will soon be made available free of charge as open source. The slave controller chips are available at a very reasonable price. Even an FPGA code buyout costs less than the equivalent of two annual membership fees for other associations. Incidentally, FPGAs represent such an attractive implementation variant that other technologies use them exclusively or have converted to them for cost reasons.

Openness means interoperability
Interoperability is only possible if technology discontinuities are avoided. Therefore, with EtherCAT there are no incompatible versions, and no manufacturer has the right to adulterate the technology. The EtherCAT Slave Controllers themselves ensure a high degree of interoperability, because chips from different suppliers are tested thoroughly or use the same code basis. ETG also organizes interoperability validation events (so-called “plug fests”), and conformance and interoperability tests are in preparation.

Openness means standardization
EtherCAT is an open standard, and EtherCAT uses open standards. ETG is recognized as an official IEC partner organization, and EtherCAT has been published as IEC/PAS 62407. ETG experts sit on IEC and ISO standardization committees. EtherCAT is currently being incorporated into four different international standards. EtherCAT uses Ethernet frames according to IEEE 802.3 and supports the use of other Ethernet protocols (including non-IP-based protocols) in the same network.

Openness means multi-vendor capability
From a user point of view, perhaps the most important aspect is that multi-vendor systems ensure competition, lower costs, good availability, and quality. At this year’s SPS/IPC/DRIVES fair in Nuremberg 40 manufacturers will present more than 75 products featuring EtherCAT, including controllers, drives, sensors, I/O components, valve terminals, hydraulic components, tools, and services. For device suppliers themselves, the multi-vendor principle is also important, for example with regard to semiconductors. EtherCAT Slave Controllers are available from different suppliers, and common FPGAs can be used. On the master side, EtherCAT is the only Ethernet technology with true real-time capability that does not require a special interface. An existing Ethernet port is sufficient. EtherCAT masters can be implemented on any Ethernet controller.

Openness means open implementation
There are plenty of implementations of so-called open network technologies, where the configuration tools do not support devices from third-party manufacturers (or only provide very rudimentary support). In the TwinCAT System Manager – the configuration tool from Beckhoff for EtherCAT and many other open technologies – devices from other manufacturers are treated in the same way as Beckhoff devices. It is sufficient to copy the device description into the associated directory in the form of an XML file. Any future devices will be supported without requiring modification of the tool. The same approach applies to configuration tools from other manufacturers.

Openness means future-proofness
EtherCAT is a future-proof technology due to its openness and associated features, and because its outstanding performance ensures that future requirements can be met without a change in technology.
The mini PCs with maximum features

The C63xx series of Industrial PCs has been designed for control cabinet installation. These control cabinet PCs are particularly well-suited for applications where Industrial PC technology in ultra-compact design is required:

**C6320:** Intel Celeron 733 MHz (optionally Intel P III 850 MHz), 3-slot passive backplane (1 free PCI slot), 20 GB IDE hard disk, 128-512 MB SDRAM DIMM module, 1 x Ethernet, 2 x RS232, 2 x USB, optional fieldbus interface

**C6325:** fanless version of C6320

**C6330:** additional IDE CD-ROM drive (CD-RW, CD/DVD-ROM optional)

**C6335:** fanless version of C6330

**C6340:** as C6320 with two additional PCI slots

**C6350:** as C6330 with two additional PCI slots

**CP63xx:** Panel PC in combination with Beckhoff built-in Control Panel CP68xx

→ Standard PC technology with ultra-compact design
→ PC Control with the look and feel of a PLC
→ Removable internal chassis
→ Drives and plug-in cards are easily accessible
Trade shows 2005/2006

**Europe**

**Germany**

*SPS/IPC/DRIVES*
November 22 – 24, 2005
Nuremberg
Hall 7, Booth 406
www.mesago.de/sps

*Automotive*
Munich
www.automatica-muenchen.de

*tire technology EXPO*
March 07 – 09, 2006
Stuttgart
Hall 4.0, Booth 4116
www.tiretechnology-expo.com

**CeBIT**
March 09 – 15, 2006
Hanover
www.cebit.de

**light + building**
April 23 – 27, 2006
Frankfurt
Hall 9.0, Booth D50
www.light-building.de

**Hanover Fair**
April 24 – 28, 2006
Hanover
Hall 9, Booth F06
www.hannover-messe.de

**ACHEMA**
May 15 – 19, 2006
Frankfurt
Hall 10.2, Booth K36
www.chema.de

**France**

*SCS AUTOMATION & CONTROL*
December 05 – 08, 2006
Paris
Hall 6
www.scs-automation.com

**Switzerland**

**Austria**

*VIENNA-TEC*
October 10 – 13, 2006
Vienna
www.vienna-tec.at

**Belarus**

*Automation, Electronics*
March 21 – 24, 2006
Minsk
www.minskexpo.com

**Denmark**

*Automatik*
September 05 – 07, 2006
Brondby
www.automatik2006.dk

**Baltic Industry**
October 25 – 28, 2006
Riga
www.prima.lv

**Finland**

*Tekniikka*
October 04 – 06, 2006
Jyväskylä
Booth C-411
www.jklpaviljonki.fi/tekniikka2006

**Italy**

*PLAST*
February 14 – 18, 2006
Milan
www.plast06.org

**Belgium**

*BIAS September 20 – 23, 2006*
Milan
www.fieremostre.it

**Latvia**

*Baltic Industry*
October 25 – 28, 2006
Riga
www.prima.lv

**Austria**

*automenschion*
June 20 – 22, 2006
Zurich
www.automenschion.ch
North America

Canada

Canadian High Technology Show
March 29 – 30, 2006
Mississauga, Ontario
Booth 212
www.reedexpo.ca/assembly

USA

ATX West/West Pack
January 31 – February 02, 2006
Anaheim, California
Booth 4549
www.atxwest.com

AM-Expo
May 16 – 17, 2006
Greenville, South Carolina
Booth 207
www.am-expo.com

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