The Scientific Automation components are being expanded with Condition Monitoring and robotics functions.

Three new sizes complement the EtherCAT AX5000 drive series with rated currents of up to 170 A.

Vernet Behringer equips its CNC machining centers with integrated PC-based and EtherCAT-based control.

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The much publicized openness in control technology is customary at Beckhoff: from the hardware and software support of all common fieldbus systems to open PC-based control technology and the development of customer-specific solutions, Beckhoff’s open control philosophy is reflected in all business areas.

It is therefore only consistent that we should also offer our customers openness in drive technology. Depending on the area of application, many mechanical engineering companies use very special motors: this could be a milling spindle in a woodworking machine, a specially geared motor in a high-bay warehouse, a washdown motor in the food industry or a motor for the area subject to explosion hazards in a chemical plant. All of these motors are tailored precisely to a special task, for example, to produce a perfect milling result or to polish without streaks; or they fit in the opening provided on the machine due to very specific dimensions. These are all reasons for the mechanical engineer to use precisely this motor. In addition to that, there is the case where a user wishes to use Beckhoff drive technology without changing the mechanics, because they use special sizes of flange and shaft.

Beckhoff has developed the AX5000 Servo Drive series with a multi-motor and multi-feedback system for these customers. Whether it is a three-phase induction motor or a high-end linear motor; whether it is a standard servomotor or a high-frequency spindle; whether it is a torque motor or a linear actuator – regardless of the type of feedback system the motor is equipped with, the AX5000 can drive these motors.

The AX5000 Servo Drive series has been designed for worldwide use in single- or multi-axis applications. The wide voltage range of 100 – 480 V AC provides the flexibility for virtually every mains supply network in the world. The development of the AX-Bridge provides further openness in machine design: single- or double-axis drives are mounted in the direct vicinity of the motor in order to save cost-intensive motor and feedback cables; by means of snapping on the AX Bridge, a multi-axis system is created with DC-Link coupling and integrated brake energy management.

We presented the latest expansion of our AX5000 series for the first time at Hanover Fair 2009: the EtherCAT drives have been supplemented with six versions featuring higher rated currents of up to 170 A (see page 18). The 120 kW power packs can be used as replacements for hydraulic drives or as the main drives in machine tools or printing machines.

Challenge us with your special drive requirements!

Christian Mische
Product Manager, Drive Technology
Beckhoff increases turnover to 278 million euros in 2008

Beckhoff Automation, with headquarters in Verl, Germany, closed the 2008 business year successfully with turnover growth of 20%. The company’s 1,227 employees worldwide – a 12% increase in personnel – generated turnover of 278 million euros in total.

Beckhoff Automation also expanded its global sales network last year by founding new subsidiaries in Slovenia and Turkey. Beckhoff is now represented worldwide in over 60 countries by 23 subsidiary companies and distributors. The export share of total turnover for Beckhoff was 44% in 2008.

Hans Beckhoff, Managing Director of Beckhoff Automation, expresses his satisfaction: “We achieved very good results in 2008. Our PC-based control technology with decentralized I/O, software and drive technology all continue to be well received and have gained in market share.”

On account of the worldwide economic crisis that is affecting the entire automation industry, Beckhoff is not expecting growth in turnover this year, but certainly expects to gain new projects and customers. “In order to achieve these goals, we are continuing to expand our capacities in technology development, sales and marketing,” explains Hans Beckhoff. “As a technology and user-driven company, we can support our customers with better and less expensive solutions, particularly in times of crisis.”

The international Beckhoff sales network will be expanded again this year by strengthening existing business structures, founding new subsidiaries and acquiring new distributors.

PC-based safety solution

In the course of Hanover Fair 2009, Beckhoff announced a PC-based Safety PLC. Since 2003, the safety solution TwinSAFE has been supporting the integration of safety related functions into the automation system via flexible Bus Terminals. Beckhoff, known as a leading supplier of PC-based technology, takes the next logical step and integrates the Safety PLC function into the PC. The launch of this new technology is scheduled for the end of 2009.

In the eighties, Beckhoff has started as a pioneer with control systems that rely on PC-based technology. The rapid development and tremendous growth of performance in PC technology were directly adapted to the performance of a machine control and used to increase the efficiency of the machine.

With a Safety PLC running on a standard Industrial PC, the performance available for the standard logic is now offered for the safety logic as well. The solution consists of software that is integrated into the TwinCAT system. This software allows safe processing of safety functions. No hardware extension is needed within the PC. That means that every PC can be used as a Safety PLC.

For safe communication between the Industrial PC with the Safety PLC and the decentralized TwinSAFE components, the Safety over EtherCAT protocol is used. As it is already used for previous TwinSAFE components, the safety system can be compatibly extended with a high performance PC-based Safety PLC.
Beckhoff was represented by two booths – in the ‘Industrial Automation’ area and at the new ‘Wind’ leading trade fair. Numerous product innovations of Hanover Fair 2009 are being presented in the current PC Control issue: for example, the new blocks for Scientific Automation described in the cover story (page 8), the compact 32-bit Embedded PC on page 16 or the expansion of the AX5000 up to the 170 A Servo Drive series (page 18). Further impressions from Hanover Fair from page 48 onwards or online at: www.beckhoff.com/hmi

Hanover Fair 2009

Hanover Fair 2009 from 20 to 24 April was well attended by a total of about 207,000 visitors.

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CP-Link 3 premiere at the Herkules Kart Trophy 2009

The Kart Trophy held on 9 May 2009 by the mechanical engineering company Maschinenfabrik Herkules GmbH in Siegen, Germany, marked the 10th anniversary of this company event, in which the Beckhoff team from the Rhine-Ruhr branch office also took part. Numerous customers and core suppliers are invited every year to this motor sport event at the Herkules works site. This year, 35 teams from Europe as well as North and South America took up the invitation. The race takes place using identical carts with about 5.2 kW engines.

In order to constantly display the current standings of the individual teams to the spectators, Beckhoff Ethernet Control Panels were installed in four different places. The data was transmitted using the new CP-Link 3 technology. This TCP/IP- or UDP-based technology enabled the race results to be sent via the company network from the race PC, which evaluated the transponders of the individual karts, to the individual Beckhoff Ethernet Panels.

The CP-Link 3 host software runs on the PC and the corresponding client software on the CE panels, which required no operator intervention at all during commissioning and connected themselves immediately to the host PC within the Herkules network. A CX1020 Embedded PC was installed as a CP-Link 3 client, to whose DVI output a TFT display was connected.

The CP-Link 3 technology in use at the Herkules Kart Trophy 2009

The race ended in yet another victory for the Herkules works team, their 10th in a row. The Beckhoff TwinCAT Racing Team finished 6th.

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The real-time capability of Windows CE 6.0 is impressively demonstrated using the Schtick pendulum commissioned by Microsoft. The inverse pendulum is balanced on two electrical drive axes in the x/y planes and kept vertical by a Beckhoff Embedded PC CX1020. The compact fanless controller, equipped with Windows CE 6.0 R2 as operating system, Intel® Celeron® processor and 256 MB DDR RAM calculates both the PLC and Motion Control with a cycle time of 500 µs. Besides the cyclical control of the drive axes, the PLC also calculates a monitoring system: a traditional control scenario to determine missing parameters from a parallel system. The I/Os and servo drives are controlled using EtherCAT.

In order to make the control system as robust as possible for use on the machine, the database information is stored on a hard disk. The Schtick demonstration comprises three devices with different operating systems: the CX1020 controller with Windows CE 6.0 R2 for controlling the inverse pendulum, a CP6203 Ethernet panel with Windows Embedded Standard as operating station and a device with Windows Embedded Server 2008 for data storage in an SQL database. Web Services on Devices (WSD) from Microsoft was implemented for communication between the three devices. WSD is available in all Microsoft operating systems. Devices in the network can recognize each other automatically and be operated using plug and play, without any additional configuration. The CX1020 simply scans through the network for a device with database function. As soon as it has found this, a type of small handshake takes place and the data are stored asynchronously by the PLC in the database. The Control Panel loads the Windows Embedded Server 2008 web page into the browser and calls up the data from the server using WSD.

The Beckhoff CE system uses approx. 20 % of the available CPU capacity for controlling the inverse pendulum, including the monitoring system and communication tasks. This means that the CPU still has enough available capacity in order to process further tasks centrally. Microsoft exhibited the demo pendulum to the public for the first time at its trade booth at this year’s Hanover Fair. The centerpiece of the demonstration was the scalable range of Microsoft operating systems and their main application areas and interactions. Since then, the Microsoft Embedded product team from Redmond has presented the Schtick pendulum at the TechEd US international development conference and demonstrated the technology in lectures in cooperation with Beckhoff. The pendulum made such an impression that Intel has now also ordered a demo system from Beckhoff in order to demonstrate the high performance of the Intel® Atom®-based controller CX5000.

Microsoft presents the 2009 MVP Award to Beckhoff employee Stefan Hoppe

Following the nomination of Beckhoff as Embedded Gold Partner in November 2006 and presentation with the 2008 Excellence Award, a Beckhoff employee has received a personal award for his committed work for the Microsoft Community this year. Stefan Hoppe, TwinCAT Product Manager for Connectivity and Embedded Systems, received the MVP (Most Valuable Professional) Award for Embedded Software.

Every year Microsoft singles out skilled representatives of technical communities with the MVP Award. Together with the award Microsoft grants the selected MVPs direct, early access to technological information and various product and expert teams. MVPs tend to be early adopters of new technologies and act as multipliers, passing on their technological expertise and experience to other technology users, e.g. as instructors during international Microsoft developer conferences or technological web conferences.
Leveraging high-speed Ethernet
PC- and EtherCAT-based control technology from Beckhoff

EtherCAT Drives
- Highly dynamic Servo Drives
- Integrated, fast control technology

EtherCAT I/O
- Real-time Ethernet down to each I/O module
- Large selection for all signal types

PC-based Control
- Bus connection directly to Ethernet port
- Software instead of hardware: PLC and Motion Control on one PC

www.beckhoff.com/EtherCAT-system

Beckhoff EtherCAT components:
Fast, flexible, precise and always cost-efficient

Beckhoff offers ideally-suited components and streamlined automation systems for the EtherCAT real-time Ethernet system:
- Industrial PC: powerful PCs for any automation task
- Embedded PC: modular DIN rail with direct I/O interface
- EtherCAT Terminals: IP 20 I/O for all signal types
- EtherCAT Box: machine-mountable IP 67 I/O directly in the field
- EtherCAT drives: highly dynamic Servo Drives
- TwinCAT: flexible automation software for multi-PLC, NC, CNC
- TwinSAFE: Safety PLC integrated into I/O terminals

www.beckhoff.com
The concept of Scientific Automation is being constantly pursued and advanced with innovative hardware and software products. Additional solutions were presented at Hanover Fair 2009. Various new EtherCAT Terminals expand the Beckhoff system with high-precision measurement technology and Condition Monitoring. With TwinCAT Kinematic Transformation software, robotics also becomes an integral part of the PC-based control solution from Beckhoff.
The power of the PC Control philosophy offers sufficient capacity to integrate numerous advanced functions beyond standard control. Scientific Automation complements the conventional areas of control technology such as PLC, Motion Control and control technology, for instance, with precise and fast measurement technology and the associated engineering algorithms.

The Beckhoff PC-based control technology provides the necessary basic foundation with powerful CPUs, fast I/O, the fast EtherCAT bus system and TwinCAT software.

The concept of Scientific Automation serves as the prerequisite to enable functions such as Condition Monitoring or robotics for a wide range of PLC programmers in a familiar format. The aim is to integrate the functions from the traditional "black box" into a standard PC-based software environment.

Since machine concepts will undoubtedly change in coming years, Scientific Automation is reaching out even further to the future. Developing trends are moving towards increasingly complex PLC programs and ever shorter cycle times. The number of axes to be controlled synchronously will increase further, and the type of coupling between the axes will become more complex. Moreover, the number of electronic cam plates and electronic gearboxes will increase. In the future, many axes will be operated based on interpolation. However, in a few years’ time, an advanced CPU will easily be able to cope with this. Integrated vision and robotics systems are implemented in software. With sufficient CPU power, advanced and familiar control algorithms — such as neural networks — may become suitable for industrial applications. However, more complex machines require more diagnostics and maintenance. More advanced systems with sophisticated diagnostics will make life easier for the end user. New input and output options such as voice input will simplify machine operation.

Another developing area is artificial intelligence. Until now, no intelligence to equal human intelligence has been replicated. It might certainly be possible to come closer to achieving this dream in the future with several cores and extreme computing power. In future computer generations, gestures, voice and image recognition procedures will be able to access terabytes of local data and at least provide support as highly sophisticated systems. In industry, this can be used for improving process operation, more human interaction, faster troubleshooting and ensuring product quality. Each system component or machine module could be allocated to a core, so that parallel processing with high clock frequencies might become possible.

Scientific Automation is available in products in real terms and offers enough further potential for future developments and visions.

www.beckhoff.com/Scientific-Automation
What does Beckhoff mean by “Scientific Automation?”

Josef Papenfort: Scientific Automation is the integration of findings from engineering science into automation software. With PC Control, Beckhoff has a very powerful control platform that offers ample space for this integration, above all with a view to the future, with even more powerful processors.

Even now, PC Control is based on the most advanced processor technology: currently quad-core technology and, in the near future, octa-core architectures. By means of the continual increase in power, the control is no longer utilized by PLC applications alone. This means that the control has sufficient resources which exceed those required by traditional applications such as PLC, NC and CNC. Additional functions for the single CPU solution can be measurement technology, Condition Monitoring, robotics or the integration of vision systems. We have already presented the first of such solutions. With increasing system performance, further functions such as expert systems or neural networks will follow.

What advantages does the integration of measurement technology and robotics into PC Control offer?

Michael Jost: Traditionally, special functions for measurement technology, image processing and robotics are implemented in separate CPUs. The functionality is either distributed in the field or handled in the PC via plug-in cards. Only the concentrated data are transferred to the central control system. Traditionally, pre-processing takes place in the ‘black boxes’ and cannot be changed as a rule. If the special functions are implemented on a platform in software, there is no friction loss and the programmer can develop all the functions on a platform in a familiar environment.

Measurement technology

How is PC-based measurement technology integrated in the overall Beckhoff automation concept?

Josef Papenfort: Measurement technology is a key component of an automation system. Only integration in a CPU enables all functions of a measuring system to be utilized optimally. Measured data can already be transported to the central PLC via a high-performance fieldbus. A number of PLC libraries with different filters and controllers are already available for this purpose and are utilized extensively by customers. EtherCAT facilitates high-precision measurements in order to obtain measured values in the PLC quickly and with precise time stamps.

Beckhoff defines extremely fast control technology based on PC Control, EtherCAT and fast I/O with XFC (eXtreme Fast Control technology). What do these new options mean for Scientific Automation?

Michael Jost: Ultimately, XFC (fast communication and the acquisition of measured data) is the basis for highly accurate, precise measurement technology. This wide range of communication options and controller computing power are only made possible by this technology, which in turn enables the integration of advanced measuring functions.
High-end-measurement technology through XFC
I Standard I/O replaces expensive special local controllers.
I Standard I/O replaces expensive measurement technology interfaces.
I Measurement technology in an integrated control system, no separate system required
I Condition Monitoring with standard control system

What functions do Beckhoff’s I/O systems offer for Scientific Automation?
Michael Jost: The Bus and EtherCAT Terminal systems provide many terminal types and variants for standard measurement technology. Current/voltage, energy, temperature, pressure, frequency, position or even the new digital multimeter in Bus Terminal format. The EtherCAT Terminal system is primarily designed for high-end measurement technology. It combines the highest performance with the highest possible accuracy. An example of high-precision analog technology is the EL3602 input terminal for voltages from -10 to +10 V. The voltage is digitized with a high resolution of 24 bit. The high precision of 0.01 % at 25 °C enables the execution of high-precision measuring tasks, at a machine or for test rig automation, for example. The seamless integration of measurement technology into the automation solution makes specialized modules unnecessary. These functions for high-precision measurement technology are also available in IP 67 format in the new EtherCAT Box modules for harsh environments.

What additional I/O solutions are to follow?
Michael Jost: We will expand our series of 24-bit terminals, for example. With these we will be offering the precision required by the quality departments of production areas. For if you intend to guarantee a certain class of quality, the precision of your measurement technology must be at least a class higher. This applies both to measuring physical quantities via strain gauge, temperature or vibration sensors and the dimensional measuring of material thickness or spaces for example, as well as to measuring electrical quantities, for example of voltage values. Besides increasing measurement accuracy and speed for standard signals, it will be possible to measure other physical quantities with our terminals in the future. The calibration capability of the terminals for special areas of quality assurance will also grow in importance.

How much “Scientific Automation” is there in TwinCAT already with regard to measurement technology?
What libraries and tools are available? What is planned?
Josef Papenfort: All the main standard filters and controllers are already implemented in the TwinCAT Controller Toolbox. These can fulfill many measuring tasks. On the data display side, TwinCAT Scope 2 has already implemented all the necessary functions. Processes can be recorded very accurately in terms of time with the Scope and conveniently stored as well. Additional, higher-class filter algorithms are to follow in the next phase. In the future, we will offer even better integration of tools such as LabView and Matlab/Simulink.

TwinCAT is closely based on the IEC 61131-3 standard, also known as the PLC programming standard. Does TwinCAT offer sufficient ‘degrees of freedom’ to incorporate Scientific Automation with high-end measurement technology?
Josef Papenfort: IEC 61131-3 merely defines a model, an architecture and the languages. It does not define any functions. This means that a fast Fourier transform algorithm can be included both in the IEC standard and in the programming language C. Accordingly, these two worlds, automation and measurement technology, do not contradict one another. The integration of a C++ algorithm for a particular filter will be simpler in the next TwinCAT version.

TwinCAT Scope 2
TwinCAT Scope 2 enables the full utilization of the graphics features of the newest PC generations. TwinCAT Scope 2 combines fast data logging with a fast graphic display tool. The logger can process both long records and very fast cycles, including those from oversampling terminals, and make them available to the viewer part of the Scope. A large number of curves can be illustrated and precisely defined in time terms in the viewer. Different interfaces enable Beckhoff customers to use parts of the Scope directly in their application.
Condition Monitoring

Condition Monitoring will also become an integral part of PC-based control with the new EL3632 EtherCAT Terminal. What advantages does this offer the user?

Michael Jost: Our solution permits the integration of Condition Monitoring functions into the machine at little extra cost. The EL3632 is the first step towards integrating Condition Monitoring functions into the Beckhoff controller. Condition Monitoring is becoming increasingly important in machine design and plant engineering as a means of avoiding downtime and prolonging maintenance intervals. Customer demand together with the new possibilities offered by EtherCAT prompted us to develop the terminal. The EL3632 enables the direct connection of different accelerometers which usually have an IEPE/ICP interface. The data are recorded and transferred to the PC where they are evaluated, that is, the warning and switch-off thresholds are set. The data can then be further processed in the PC either as a complete solution with TwinCAT libraries or through the assessment of the raw data via the user’s own evaluation. The fact that the information is available on the central controller and can be evaluated there accordingly is the most important aspect.

How does this differ from solution concepts offering Condition Monitoring analysis up until now?

Michael Jost: Until now, special, proprietary systems were required for Condition Monitoring which could only be used for this function. By integrating Condition Monitoring into the EtherCAT Terminal system it becomes an integral part of PC-based control technology, providing high-class added value.

Josef Papenfort: With many of the approaches until now data are processed directly on-site. Only ‘defective’ or ‘non defective’ binary information is given or shown via LED display. Further processing of the measured values is impossible or only possible via very complex means. Correlating the recorded data with other signals such as temperatures or pressure is not possible. However, in many cases, this correlation is necessary for sophisticated applications. For this reason, in Beckhoff’s solution, all the raw data are transferred by EtherCAT to the PC where they are processed by the software in the TwinCAT system. The Condition Monitoring solution is supported by corresponding TwinCAT libraries: for example, by a library with top-quality filters or fast Fourier transform. TwinCAT Scope 2 is also being expanded for Condition Monitoring.

Robotics

A TwinCAT robotics module was presented for the first time at Hanover Fair 2009. What were the reasons for developing this software?

Josef Papenfort: The main reason was to integrate independent robotic cells into the production process, that is, to cut down on external robot CPUs in order to improve integration and optimize costs. So in other words, it is intended to pursue the concept of Scientific Automation consistently. Our customers want robots to be integrated into the existing TwinCAT platform in order to cut down engineering costs. This means completely integrating configuration, programming and diagnostics into the TwinCAT system. The application and product are improving in qualitative terms because friction loss, which occurs when different CPUs for PLC, motion and robots interoperate, can be avoided.

What are the application areas for TwinCAT Kinematic Transformation? What are the highlights of this new solution?

Josef Papenfort: Kinematic Transformation for TwinCAT has primarily been developed for pick-and-place applications. We have succeeded in making a PLC, a Motion Control system and a robot run in synch on a PC-based CPU. The advantage is the integration of the robot kinematics into the existing program, in other words, complete control on the ‘normal’ control PC. The synchronization of the robotics with the existing Motion Control blocks in TwinCAT NC PTP and TwinCAT NC I is particularly interesting. Any of the NC PTP features such as cam plates, flying saw and NC I can be combined as desired. The simple programming is a great advantage as well. The target coordinates are programmed conveniently in the Cartesian coordinate system. Conversion to the corresponding motor positions (reverse transformation) is done by the kinematic module. In addition, the dynamic model for torque pre-control can be calculated.

Outlook

What are Beckhoff’s next steps in the field of Scientific Automation?

Michael Jost: We will implement the new options offered by XFC technology in I/O hardware and extend the possible uses of our system in higher precision, speed or with new measuring signals.

Josef Papenfort: Our customers can still expect a great deal from Beckhoff in terms of Scientific Automation. Measurement technology and Condition Monitoring are areas we are continually expanding. A vision solution is also an indispensable component when using robots. This will be one of the next steps.
Condition Monitoring functions can be integrated simply and cost-effectively into the EtherCAT I/O system from Beckhoff using the EL3632 EtherCAT Terminal. For the user, this means: no additional hardware, optimum integration into the control system and considerable cost reductions. The signals are analyzed on the PC using either TwinCAT automation software or user software. The EtherCAT real-time Ethernet system offers the ideal network for high-performance communication of all measured data back to the PC.

**Condition Monitoring: an integral part of PC-based control**

Condition Monitoring systems for tracking the status of a machine or plant undoubtedly help reduce downtime and maintenance costs. To this end, the ever-changing physical variables such as vibration and temperature are measured on the machine. The EL3632 EtherCAT Terminal enables the direct connection of various accelerometers via an IEPE (Integrated Electronics Piezo-Electric) or ICP (Integrated Circuit Piezoelectric) interface. These sensors record vibrations in a machine, bearing or motor so that, by means of analysis, wear and damage can be detected before a breakdown occurs, avoiding unplanned downtime or prolonged maintenance intervals. A central, PC-based controller here is advantageous, particularly if large amounts of data from different devices need to be referred to for analysis or if damage frequencies need to be evaluated in relation to rotary speeds.

Condition Monitoring becomes an integrated part of the controller when using the EL3632. The data is recorded by the standard I/O system and made available to the superordinated PC controller. The measurement signals are evaluated on the PC using a TwinCAT library or user software; the warning and shutdown thresholds are set accordingly. Adjustable filters and supply currents for matching various sensors enable the user-specific adaptation of the Condition Monitoring terminal.

Through interfacing via EtherCAT and support of the distributed clocks function, the measurement results – and any detected defects – can be precisely allocated to an axis position. In this way, the user knows what is happening at each axis position on the machine. By matching positions to acceleration values, conclusions can be drawn about possible sources of error. On the software side, the EL3632 is supported by various TwinCAT libraries, e.g. with high-quality filters such as FFT (Fast Fourier Transformation), digital high-pass or low-pass filters, or envelope monitoring. TwinCAT Scope is also being expanded to include Condition Monitoring functions.

The EL3632 Condition Monitoring terminal is easy to integrate in the control system and is easy to retrofit. Its range of applications is extremely versatile, extending from mechanical engineering and process technology to status monitoring in wind turbines. Traditional Condition Monitoring systems are expensive, constructed as separate hardware devices and need to be coupled elaborately with the automation system. Other solutions merely report the respective operating status without supplying detailed information to the controller. In EtherCAT, a capable communication system is available for the high-performance relaying of the recorded status data to the PC controller. The “Scientific Automation” concept is applied on the central PC: besides sequential control, Motion Control and HMI, TwinCAT also integrates additional functions such as Condition Monitoring on a software and hardware platform. In addition to the perfect integration of all components and the reduction of hardware costs, engineering efforts are also greatly simplified: configuration, programming and diagnostics take place on one system using TwinCAT.

[www.beckhoff.com/EL3632](http://www.beckhoff.com/EL3632)
Robotics integration in TwinCAT enables optimum synchronization between robots and standard Motion Control.

TwinCAT automation software now permits the integration of robots (delta kinematics, SCARA) as well as their interaction and synchronization with existing Motion Control functions. This results in seamless integration into the overall control system and being able to dispense with additional robot CPUs. The PC-based controller from Beckhoff unites PLC, Motion Control and robotics all on one hardware and software platform.

Robotics, Motion Control and PLC on one PC platform

“TwinCAT Kinematic Transformation” software is the first step toward integrating robot control into the TwinCAT automation software suite. The PLC, Motion Control, HMI and robotic functions run on one powerful Industrial PC CPU. This provides the user with a whole series of advantages:

- eliminating the additional CPU required for robot control
- reduction in engineering costs: configuration, parameterization and diagnostics in one system
- TwinCAT, a well-known tool that adheres to global standards for configuration, programming and diagnostics
- no friction losses due to the interaction of various CPUs for PLC, motion and robotics
- Higher performance and accuracy due to direct interfaces; complex communication between CPUs is no longer required.
The dynamic model for torque pre-control can be calculated. The kinematic system can be selected conveniently in TwinCAT System Manager. The kinematic channel is used to parameterize the type (e.g. delta), bar lengths and offsets. Mass and mass inertia values can be specified for dynamic pre-control. The “flying saw” and “cam plate” functions enable robot synchronization with conveyor belts for picking or placing workpieces, for example. These applications are met frequently in the material handling and packaging industries.

TwinCAT Kinematic Transformation integrates itself transparently in the existing Motion Control world: robotic and Motion Control functions can be optimally synchronized using TwinCAT NC PTP (point-to-point axis positioning) or NC I (axis interpolation in three dimensions). All NC characteristics, such as “cam plate” or “flying saw” (synchronization of a slave axis with a moving master axis) can be combined as desired on a common hardware and software platform.

TwinCAT supports various parallel and serial kinematics, such as those used for pick-and-place tasks. Regarding programming, the software is based on TwinCAT NC I and G-Code (DIN 66025). The target coordinates are programmed conveniently in the Cartesian coordinate system. The Kinematic module takes care of conversion to the associated motor position (reverse transformation). In addition, the dynamic model for torque pre-control can be calculated.

The kinematic system can be selected conveniently in TwinCAT System Manager. The kinematic channel is used to parameterize the type (e.g. delta), bar lengths and offsets. Mass and mass inertia values can be specified for dynamic pre-control. The “flying saw” and “cam plate” functions enable robot synchronization with conveyor belts for picking or placing workpieces, for example. These applications are met frequently in the material handling and packaging industries.

www.beckhoff.com/kinematics
Within the Beckhoff controller categories, the CX8000 is positioned between the 16 bit Embedded Controllers and the CX9010 Embedded PC. The CX8000 series Embedded PCs with 400 MHz ARM CPU and microSD card as storage medium are best suited for distributed intelligence. Connection to the higher-level master controller takes place via an integrated fieldbus slave. To this end, the CX8000 series includes six versions with interfaces for PROFIBUS, CANopen, PROFINET, EtherNet/IP, EtherCAT and Ethernet. Programming and commissioning or connection to the Ethernet network takes place via an additional Ethernet interface. Programming can also be performed via the fieldbus interface. The Embedded PC versions for PROFINET, EtherNet/IP, EtherCAT and Ethernet feature additional Ethernet interfaces with switch functions so a linear “daisy chain” topology can be established without additional hardware, which helps cut costs.

Microsoft Windows CE is used as the CX8000 operating system. In the absence of a monitor port, the operating system and its “virtual” display can only be accessed via the network. As with all other Beckhoff devices, TwinCAT software is used for system configuration and programming of the PLC functionality.

The CX8000 device family features an integrated, capacitive 1-second UPS, which in the event of a failure of the supply voltage,
CX8000 Embedded PC: programmable controllers with 32 bit CPU, which serve both to execute PLC programs and to function as slave devices in a higher-level fieldbus system.

provides sufficient energy for saving remanent data. Important data can be preserved in a non-volatile manner without battery backup. The CX8000 Embedded PC is exceptionally compact and, due to its low-power 32 bit ARM processor, consumes little energy. With its flexible fieldbus interfaces, EtherCAT connectivity and comprehensive range of PLC libraries via TwinCAT PLC, the CX8000 controller series represents a powerful and versatile new controller family.

www.beckhoff.com/CX8000
The AX5000 Servo Drive series from Beckhoff integrates high-end control technology while supporting fast and highly dynamic positioning tasks.

- Current control: min. 31.25 µs
- Speed control: min. 125 µs
- Position control: min. 125 µs

The drives utilize EtherCAT for high-performance system communication that is ideal to interface with PC-based control technology. The single-channel Servo Drives from the AX51xx series (rated up to 25 A) and the dual-channel AX52xx series (rated up to 2 x 6 A) are available and already widely used.

**AX5000 series expanded to 120 kW**

The AX5000 Servo Drive series from Beckhoff is being expanded to include drives with higher rated currents. A total of six new Servo Drives enhance the universally designed drive family for highly dynamic positioning tasks. With this development, Beckhoff is responding to the increasing demand for drives with even greater power, in order to replace pneumatic or hydraulic drives with more maintenance-friendly electrical axes, or to cope with the highest dynamism demands, even at high loads.

AX5160/AX5172

AX5190/AX5191

**AX5000: high-performance EtherCAT drives**

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**AX5000 series expanded to 120 kW**

The AX51xx will be supplemented with Servo Drives rated from 60 to 170 A for higher power. The AX5000 drives are designed in three sizes with rated currents of 60 A, 72 A, 90 A, 110 A, 143 A and 170 A. Designed for maximum flexibility, a wide range of motors can be connected to the AX5000. Motors of different sizes and types can be connected without additional measures. Examples include synchronous, linear, torque and asynchronous motors. The multi-feedback interface supports all common standards:

- Resolver
- SinCos encoder 1 Vpp
- TTL encoder with/without Hall
- Single- or multi-turn encoder with Hiperface, EnDat or bidirectional sensor interface BiSS
- Connection option for further feedback

A major highlight of the AX5000 drive series is its high power built into a small device. A great advantage of full EtherCAT integration is that no additional interface cards are required and...
no internal conversion in the controller is necessary. EtherCAT permits the design of simple drives with no local parameter storage, resulting in greatly simplified commissioning and service in the event of maintenance.

The 120 kW power packs are ideally suited for the replacement of hydraulic drives or for use as the main drive in machines with many small drives. Preferred applications for these high-powered drives include plastics processing (injection molding), metal working as well as in milling and boring machines and extruders.

The range of Synchronous Servomotors from the AM3000 series is also being expanded with versions that have higher standstill torques of 80 Nm, 110 Nm and 150 Nm. These servomotors are matched to the rated currents of the AX5000 Servo Drives. This provides users optimally matched drive axes.

The AX5000 drives are designed in three sizes with rated currents of 60 A, 72 A, 90 A, 110 A, 143 A and 170 A.

**Features:**
- high-speed EtherCAT system communication
- rated currents of the new devices:
  - AX5160: 60 A
  - AX5172: 72 A
  - AX5190: 90 A
  - AX5191: 110 A
  - AX5192: 143 A
  - AX5193: 170 A
- supply voltage:
  - from 60 A: 400…480 V AC ±10 %
- multi-feedback interface
- flexible motor type selection
- high-speed capture inputs
- integrated mains filters up to 72 A rated current, Cat. C3 according to EN 61800-3
- optional safety functions: restart lock/TwinSAFE safety functions

The Synchronous Servomotor series AM3000 is being expanded with versions that have higher standstill torques of 80 Nm, 110 Nm and 150 Nm.
To better support commissioning or restricted operating processes, Beckhoff offers four new Bus Terminals that reduce the number of operating components installed in control cabinets and, in this way, the required installation space. Particularly in cases where manual control is only required in exceptional cases, such as for troubleshooting or commissioning, the Bus Terminals with manual operation save space and cost. Manual controls are also advantageous during the assembly phase of a machine or plant, since they can be used to test the function of subassemblies before the control system has been fully installed.

In the field of building automation, the terminals can be used, for example, in sub-distributors for manual light switching or in the HVAC area for switching individual units (pumps or flaps) for the purposes of measurement, troubleshooting or commissioning – independent of the controller.

The four switches and four LEDs in the KM1644 terminal module are available in the control system as digital inputs or outputs and enable the direct input and display of process parameters.

Up to four consumers rated at up to 230 V AC, 16 A, can be connected directly to the KM2614 relay module in order to switch the consumers via the changeover contact both manually and automatically by the controller. Two consumers rated at up to 6 A, 230 V AC, can be switched manually or in automatic mode using the KM2642.

The KM4602 2-channel analog output terminal is the corresponding equivalent for analog signals from 0 to 10 V. The mode of operation (manual/automatic) is selected by a toggle switch on the front panel and the analog value is set via a potentiometer.

www.beckhoff.com/BusTerminal
Crestron allows the networking of independent individual systems such as audio and video, but also of alarm and building control systems. This enables various different components to be concentrated on a uniform user interface and be made available to the user by means of intelligent visualization. The TwinCAT Supplement “TwinCAT Crestron Server” enables communication between a TwinCAT PLC and a Crestron control center. The two systems are linked via Ethernet, based on the TCP/IP protocol. User macros for SIMPL are available for programming the Crestron controller. The required function blocks are included in the TwinCAT PLC library. Read and write access to the other device is available from the Crestron controller and the TwinCAT PLC. The TwinCAT Crestron Server supports all PC-based controllers under Windows CE, Windows XP Embedded and Industrial PCs running Windows XP.

TwinCAT Crestron Server can be applied wherever increased demands are made on the interaction of media and building control systems, e.g. in conference rooms, lecture halls or also in private homes. Although two different systems are being used, the building and media processes can be started at the touch of a button. During a presentation in a conference room, the press of a button suffices to e.g. start the projector, switch on the DVD player, lower the blinds and dim the light. When leaving home, it is just as easy to turn out the light, lower the temperature and switch off the CD player.

www.beckhoff.com/TwinCAT-Crestron-Server
The requirements for locking systems in buildings and other installations are higher than ever today. Implementing sophisticated safety measures efficiently requires innovative machines with software concepts to match. Following a commission from the Swiss company Keso AG (experts in modern locking systems for over 45 years), SEH GmbH developed a high-precision drilling robot for cylinder locks. The software concept comes from Mabag AG, and the control and drive technology was developed by Beckhoff.

In the past, special machines manufacturer SEH GmbH, based in Widnau, Switzerland, worked with various control equipment suppliers with the result that very different drive solutions were often used. The Keso AG order to design a new, automatic drilling machine for their cylinder locks brought about a system change for SEH. “In the middle of 2006, this high-tech order prompted us to make the landmark decision that going forward we only wanted a supplier who could deliver the complete automation solution from a single source. We opted for Beckhoff,” explains Guido Herzog, mechanical engineer and managing director of SEH GmbH.

The highest precision with the greatest possible flexibility

The new special machine drills precise holes for the bolts used in the cylinder locks. The stepped holes have to be accurate to ± a hundredth of a millimeter both in depth and with regard to their X-Y-Z-coordinates. For this reason, it is important to keep the servomotors’ accuracy within a thousandth of a millimeter. “This gives us ten times higher resolution than our specifications require,” says Herzog.

Keso AG were already using CNC machines for the stepped holes in the cylinder locks before then; however, the angles had to be adjusted from 0 to 4.5° mechanically. This necessitated changeover times of 40 to 45 minutes; in addition, there was the potential for waste of as many as four to five cylinders. With the newly developed machine, changeover time – including importing the data and adjusting the drill – is about thirty seconds. There is no longer any waste – even the first cylinder is always useable.

The precision drilling machine features 10 CNC axes in total which are controlled via TwinCAT automation software from Beckhoff. There are also two more axes for adjusting the angles and the height which are equipped with the smallest servomotor in the Beckhoff range. It has a flange size of 56 mm and is about 120 mm tall. The small motor even has a built-in brake. Five servomotors with resolvers and brakes are used altogether, since it must be possible to stop the Z axis in an emergency. Furthermore, the angle setting can be adjusted via the brakes. “The motor that is put under the greatest strain is set to 50 percent of its rated output at most. All the other motors have the same output, even if they are not used to their full capacity. This provides the great advantage that the
Servomotors can be interchanged without any problems in the event of a fault,” explains Guido Herzog.

**Everything under control – thanks to integrated automation solution**

Key data are stored in a database on Keso AG’s server. They can be transferred directly – via bar code – to the controller via a defined interface. In addition to flexibility and adaptability, problem-free data transfer is one of the greatest advantages of the PC-based controller.” Such simple integration may well cause difficulties with another controller," says Robert Schär, managing director of Mabag AG, who compiled and implemented the custom software for this drilling machine. Guido Herzog adds: “Apart from the three high-frequency spindles, all the components, including the controller, the display, the servomotors and the software are from Beckhoff. With the automation system from Beckhoff, we have everything under control: path, power and torque. We can track and control everything at any time. We can even identify wear on the machine.”

**Future prospects**

The current drilling machine is already the second ordered by Keso AG. “The first machine has been in operation for a year and drills around 2,000 cylinders in 12 hours,” explains Robert Schär. Guido Herzog adds: “This machine drills significantly more cylinders in the same time and does so with greater precision than its predecessors.”

Moreover, according to Robert Schär, the machine developed for Keso AG has led to further orders: “It looks as if SEH will be supplying car manufacturers throughout Europe with new machines. All car makers have their own locking system. We at Mabag will see to the programming. Thanks to Beckhoff, it will then be possible for us to access the customer’s server directly in the event of a fault. We will be able to analyze the fault and begin remote maintenance immediately.”

Keso AG, security systems www.keso.com
SEH GmbH www.seh-gmbh.ch
Mabag AG www.mabagag.ch
Beckhoff Switzerland www.beckhoff.ch

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**Beckhoff components**

- 1 CX1020, modular DIN rail Industrial PC with TwinCAT NC PTP and Windows XP Embedded
- 1 CP6901, 12" DVI/USB built-in Control Panel with touch screen
- 2 AX2513-B200 servo master modules, 3 A, Lightbus
- 8 AX2523-B200 servo axis modules, 3 A, Lightbus
- 6 AM3041 servomotors
- 4 AM3021 servomotors
- various I/O terminals
A retrofit was carried out on the transfer area of the dispatch ramps in Druckhaus Spandau, the Axel Springer AG’s printing house. A ramp disposition system developed by EQUAL Software supports the IT coupling with the production control system and enables precise control of the bundles of newspapers. The control centerpiece is a CX series Embedded PC with Beckhoff’s TwinCAT PLC software.

Axel Springer AG is one of the largest media groups in the world. Probably its best known product is the Bild newspaper, produced as partial editions at the printing house Druckhaus Spandau in Berlin, Germany. The range of orders undertaken by the printing works includes a total of nine daily and five Sunday newspapers and job printing for various market segments. Around 1.2 million newspapers are produced and dispatched fresh from the press daily.

Besides the printing, one of the most important tasks undertaken by a newspaper printer is the dispatch of the print products. As readers expect to begin reading their newspaper early in the day, on-time delivery is obviously very important. For this reason, in the course of a comprehensive retrofit, Druckhaus Spandau also modernized the dispatch department and implemented an additional IT coupling of the operative transfer area, known as the ramp. While the plant as a whole was retrofitted by the existing plant supplier, the IT coupling of the ramp and production control system was carried out using a ramp disposition system (RDS) that was developed, implemented and commissioned under contract from the Swiss company EQUAL Software AG.
Coupling of PLC and IT on one hardware platform

EQUAL Software, whose headquarters are in Zofingen, Switzerland, is a service provider in the software development sector. The business model is called Customized Software Services and aims to provide industrial customers with professional software solutions which are on schedule, economical and functional. The technological basis for the development of the service-oriented software architectures is Microsoft’s .NET Framework which, especially using the WCF (Windows Communication Foundation) platform, offers excellent support for solutions with distributed systems. EQUAL Software AG has developed a framework for distributed systems on this basis which can be used for various applications.

For Druckhaus Spandau’s ramp disposition project, EQUAL Software uses a Beckhoff CX1020 Embedded PC for each ramp group with Windows XP Embedded operating system and TwinCAT PLC software, Beckhoff Bus Terminals and a 15-inch Control Panel with touch screen as the HMI. This enables implementation of the operative control system for the plant as a PLC application and the IT coupling in the form of independent modular software components on a single hardware platform.

Targeted task control

Depending on the product, method of dispatch and recipient group, Druckhaus Spandau produces everything from specific bundles all the way to individually addressed subscription copies from the print products. These bundles need to be packaged and have to be placed ready for the designated carrier or pickup person at the correct time on the appropriate ramp. The services are primarily based on the end-to-end data flow, i.e. on the IT concept for task control as well as on the operative control of the dispatch and ramp equipment.

The ramp disposition system is embedded in the retrofit of the dispatch room which follows on from the rotation and inserting areas and in which all further processes up to the collection or dispatch of the print products take place. “Automation of the ramps using the new control system must therefore be viewed in combination with the upstream processes,” explained Dipl.-Ing. Frank Wagner, head of further processing in the printing house, Druckhaus Spandau. The complete task control for the inserting and packaging machines takes place in the dispatch area using the Mailroom Production Control (MPC) system by Müller Martini. A central module, MPC Dispo, transfers order data from the higher-level customer system and distributes this to the
line control for the inserting systems (MPC line control). The MPC LCs under-
take control of the inserting machines, inkjet and cover sheet applicator sys-
tems and stackers. The nine line control systems are connected to the RDS us-
ing nine ramp groups, known as ramp group systems (RGS). Each RGS has a
CX control system which interacts with the control panel. The information dis-
play for the ramp personnel and drivers is controlled by another separate
dock display system. This system receives the relevant information from the
RGS and creates the display according to specific criteria.
The RDS includes various solution and system components. A ramp disposi-
tion manager (RDM) – assigned as the gateway between the dispatch room
and ramps – communicates the order data which it receives from the MPC to
the ramp group system manager (RGS manager). This in turn distributes the
order data to the RGS control PLC. Implementation of the orders, including
time and number, i.e. the completed transfer of the bundles to the carrier, is
notified to the MPC so that the current assignment situation is always record-
ed in the production planning and control system. This makes the MPC a con-
trol system that is able to manage order control for the entire dispatch room:
a control function not available before.

Multivariable platform strategy

At the beginning, implementation of the Beckhoff embedded platform with
TwinCAT PLC software was not part of the retrofit project. “The original pro-
posal was based on an alternative control concept,” Frank Wagner explained.
“The decision in favor of the Beckhoff platform was made in view of the long
lifespan of printing machines and the continuous operation with 20 shifts per
week. This places very specific requirements on the operating resources.”
Michael Wennler, production manager for further processing and the expert
responsible for production planning and processing in the dispatch department of the printing house Druckhaus Spandau. He added: "Our expectations of the machine control systems and their infrastructure are first and foremost for high availability, simple operation and functionality. In the operating phase, the controllers need to be low-maintenance and user-friendly. Finally, they need to fulfill certain aesthetic requirements and the components should be available over the long-term."

"Our products fulfill these requirements," stressed Gerhard Meier, managing director of Beckhoff Automation AG, Switzerland, who provided support for the project. "Our computers, i.e. the motherboards, can still be repaired after ten years if necessary. A further advantage of our control solution is that since 1995 we have been using Bus Terminals for the I/O coupling which have remained in the same format, despite enormous technological advances. What might change would be the CPUs, to which the same existing Bus Terminals can be connected. This means that only the Software has to be adapted to the new CPU; the remaining parts of an application remain unaltered."

Building on standards enables renewed focus on what is most important

EQUAL Software has been working successfully with Beckhoff for some time. As Daniel Althaus, managing director of the company, confirms, the Beckhoff platform has some basic advantages which have also had a positive effect in the current project: "The Embedded PCs undertake the operative control of the ramp groups on the one hand, and on the other, they provide the dispatchers which define the routes for the packages with an interface to the RDM manager. This provides information on what must be sent or distributed where and when. The operational interfaces in use are the Beckhoff "Economy" Control Panels with 15-inch touch screen. The RGS also transfers the data to the DockDisplay."

The software systems from EQUAL Software AG are based on the .NET Framework from Microsoft. Daniel Althaus explains: "We went for the .NET Framework because the advanced development state of this platform enables easy solution identification. We no longer need to worry about details such as software or network interfaces and can concentrate on solving the actual problem. Naturally we find the proximity of Beckhoff’s control technology to the Microsoft environment very convenient."

New control platform installed during operation – no downtime allowed

One condition set by Druckhaus Spandau was that the project implementation should take place without any production downtime i.e. during operation. This method of working was complied with. At certain times, one line could be kept free and retrofitted. In addition, it was always possible to change over to a switch control system, i.e. to switch back to the old machine control systems which were still in the control cabinets, if this was necessary for operational reasons.

Those in charge of the project in the printing house Druckhaus Spandau are very pleased with what has been accomplished. For Daniel Althaus from EQUAL Software AG, this has proved his company strategy correct once again: on the one hand, the framework developed in-house provides the solution to complex IT tasks, on the other hand, the Beckhoff automation platform has proven itself both in the operative control area as well as for the coupling of automation with the IT environment.
The generation and investigation of dense plasmas is only possible under extreme conditions, above all at high temperatures. With the aid of various diagnostic procedures, such as ion, plasma and laser diagnostics, experimental data is obtained from which physical parameters can be extracted. These procedures allow conclusions to be drawn about the density, temperature and expansion velocity of the plasmas, for example, and allow the process of interaction between the ions and the plasma to be understood.

High intensity laser for generating hot plasmas
In the research experiment Z6, the GSI uses the nhelix (Nanosecond High Energy Laser for heavy-Ion eXperiment) high intensity laser to generate the dense, hot plasmas. In the laser room, there are two laser oscillators with which, after amplification, energies of up to 80 J with a pulse duration of 14 ns can be attained. These can be used to generate and diagnose hot plasmas up to 100 eV (electronvolts) — equivalent to around 1.2 million Kelvin.

In order to generate even hotter plasmas, the GSI uses the Petawatt High Energy Laser for Heavy Ion Experiments (Phelix), which is one of the most powerful lasers in the world. Phelix can deliver laser pulses with energies of...
up to 1000 Joules and a power of up to half a Petawatt. It is so large that it is housed in its own building entirely under a cleanroom atmosphere. The laser beam, which has a diameter of 30 cm, is guided by special mirrors to the experiment zone at the ion accelerator and from there it is focused on a point.

**Safety for man and machine**
The task of the monitoring equipment is to minimize the danger to the user and to ensure machine safety in order to protect expensive parts of the plant from being destroyed. In generating the laser pulses, laser beams are sometimes guided openly over optical tables. The laser diagnostics are also structured openly. There is a danger in several rooms due to the use of lasers with the highest hazard class. The laser beams are amplified in optical amplifiers with flash lamps that are operated at up to 20 kV. There is an acute danger due to high voltage here. If flashovers occur during the charging or discharging of the capacitors to the flash lamps or on the capacitors themselves, the high voltage causes a loud bang that can damage hearing.

With the construction of the safety system for Phelix, a more complex safety circuit was implemented for the first time and initial experience was gained in this field. The safety sensors and actuators were connected via multi-core control cables to the system. However, this solution proved to be too space consuming and inflexible.
Structure of the Z6 safety system
The Z6 experiment zone is decentrally structured and is distributed over five rooms (see diagram below):
- The nhelix laser superstructures are located in the laser room. The system is monitored and controlled from here.
- The laser shot is controlled from the measurement container. The evaluation of the measurement data and the connection to the Phelix security system take place here.
- The optical compressor planned for the compressor room shortens the pulse length of the Phelix beam. Part of the beam diagnostics is also constructed in this room. The mirror tower for the diversion of the Phelix beam is located above the room.
- All laser beams run together in the target booth. The target chamber with the actual experimental rig is located here.
- The high voltage power supplies, capacitors and high-current switching devices are housed in a cellar.

Task of the controller
Different laser beam sources, beam guidance and intensities are required for the various experiments. For this reason, different operating modes are avail-
able that can be selected via a key switch. In this way, the alignment laser, nhelix and Phelix beams can be combined almost at will and different safety criteria must be satisfied for each combination. Furthermore, depending on the mirror setting, there are various beam shutters that have to be enabled and monitored. In addition to that, it must be possible to guide the Phelix alignment beam to the beam diagnostics while at the same time carrying out experiments in the target chamber using the nhelix laser.

The compressor room and the target booth are entered via locks that need to be monitored. Since the laser room has no lock, small shutters are rotated into the laser beam when the door is opened, so that no laser radiation can be emitted from the laser. If this fails, the laser is switched off by an interlock. This redundant and diverse safety concept is integrated at many points.

Additionally, there are some machine safety aspects. Some shutters may only be opened if the air pressure is the same on both sides. A high energy shot may only be triggered if the beam path is free all the way to the target. The monitoring logic is therefore rather complex. The highest security level is reached in the case of a Phelix shot, i.e. the entire experiment zone must be scanned. The system only enables the shot after all rooms have been locked.

Safety solution integrated in the controller
On account of the experience gained with the Phelix, it was desired to make the control and safety technology for the Z6 experiment zone more modern and flexible. The requirements were as follows:

- Integration of safety monitoring and the standard controller in one system
- Programming of the logic for the safety components via software
- Flexibility and adaptability of the security system to different experimental rigs

Due to the decentralized structure of Z6, it was an obvious plan to distribute the control system over several control cabinets and to network them. Alongside the safety-relevant monitoring, the system should also take care of general control tasks. The Beckhoff TwinSAFE safety solution ideally lent itself to this task. It satisfies the safety standards IEC 61508 up to SIL 3 and EN 964 category 4. This is a necessary prerequisite, since shutters must be closed and high voltage power supplies switched off reliably when doors are opened.

The non-safety-relevant control tasks are handled by a Beckhoff CX1000 Embedded PC with a Control Panel in the measurement container. The operating mode is controlled and the connection of the Phelix signals is implemented via TwinSAFE terminals arranged in a row with the CX1000. The CX1000 and four BK9000 Bus Couplers are networked in a star configuration via an Ethernet switch in VLAN. Since high voltage is switched in some rooms, the Ethernet bus is implemented via an optical fiber cable. To this end, each control cabinet contains a media converter ‘twisted pair <-> multi-mode fiber’.

Compact safety controller allows changes and extensions without effort
In total, the safety control system includes one Embedded PC, four Bus Couplers, five KL6904 TwinSAFE Logic Bus Terminals, 33 TwinSAFE I/O terminals and 70 standard Bus Terminals. The signaling devices (operating elements, door contacts, feedbacks) and the actuators (warning lamps, interlock contacts, shutters, door locks, etc.) can be connected directly to the nearest controller via short connections.

In order to display the status of all sensors and actuators, TwinCAT OPC Server is used, which displays the system variables in a GUI (LabVIEW). The mirror settings and the shutter, door and room statuses can be seen at a glance. The integration of the safety solution in the controller allows the construction of a uniform and flexible control and monitoring system. Naturally, it is not a problem to integrate additional devices in the safety system.

Gesellschaft für Schwerionenforschung GSI www.gsi.de
TwinSAFE www.beckhoff.com/TwinSAFE
Much like the historical progression of computer technology, more cost-effective robot technology is steadily advancing into areas that were previously too cost-sensitive to apply it. Food manufacturing, packaging and warehousing are prime areas to experience the next wave of robotics with high-performance, low cost robots entering the marketplace from leading suppliers such as AEMK Systems. In order to boost control performance while reducing cost, AEMK’s DeltaBot line has been recently upgraded with a control system from Beckhoff.

Based in Waterloo, Ontario, Canada, AEMK is an innovative provider of high-speed robotics systems for a wide range of applications. The company was established to commercialize the results of five years of research at the University of Waterloo involving ultra high-speed robots. “We strive to provide customers with the most cost-effective robots possible with simple integration, low maintenance cost and outstanding customer service,” Amir Khajepour, AEMK President and University of Waterloo Professor, said. The AEMK robots use tensioned cables instead of rigid links to reduce moving inertia and mechanical equipment cost compared to conventional pick-and-place robots. It also means that very little maintenance is required to ensure high repeatability. Due to their cost-effectiveness, AEMK robots are used in many labor-intensive applications such as the food and packaging industry or automated warehousing with high capital cost barriers to incorporating automation equipment.

**DeltaBot: the PC-based pick-and-place robot**

The three- and four-axis models of these ultra high-speed robots are dubbed DeltaBot. They are capable of over 120 pick-and-place cycles per minute and have proven to be highly effective for high-speed assembly, automatic inspection and packaging applications. The DeltaBot uses passive cables to control the movement of end effectors. This design permits the robot’s workspace to be easily scaled to adapt to any application. In addition, their straight-line design makes the robots ideally suited for use in the food industry with its strict hygiene regulations.

**PC platform with scalable performance**

In order to boost control performance while reducing cost, the DeltaBot line is equipped with a Beckhoff control platform consisting of a CX1010 Embedded PC, TwinCAT PLC automation software, EtherCAT I/O terminals as well as AX5000 Servo Drives. “The impressive price/performance ratio was the deciding factor in selecting the CX1010 as the DeltaBot’s control centerpiece. We wanted the smallest possible footprint for the controller that would also give us the most programming flexibility,” Khajepour said. “The basic DeltaBot configuration features the CX1010, however we can also easily scale up in performance using the CX1020 or CX1030 for the robots with an integrated vision option.”

**Embedded PC replaces two PC controllers**

The previous DeltaBot controllers were all PC-based, but not as powerful or flexible. The Embedded PC from Beckhoff replaced an architecture that included two PCs; one served as the real-time robot controller, the other PC generated the robot’s path, ran the HMI and connected with vision systems or any other applications that were needed. “The major drawbacks of the previous system were unreliable communication and the difficulty of running at a consistent, low scan time,” Khajepour said.
TwinCAT's real-time control system gives us an all-in-one platform to create high-speed, reliable control architectures,” Khajepour explained. “The Structured Text programming language, one of TwinCAT’s many available IEC 61131-3 languages, makes the DeltaBot’s code easy to program.” The DeltaBot moves extremely fast and completes most of its paths in less than 500 milliseconds. “This barely permits any time for communication jitter, even in the range of single digit milliseconds,” Khajepour noted. “Fast access to the I/O and ease of integrating remote I/O into our systems are among EtherCAT’s key features. Also, the AX5000 drives were instrumental to accommodate a wide range of power requirements, drive communication at ‘EtherCAT speed’ and very low cycle times. Plus, the seamless integration with the rest of the DeltaBot’s system components is exactly what AEMK was looking for.”

**Improved positioning and repeat accuracy**

“We are able to run the DeltaBot position controller at 2 kHz, which came without the hassle of having to integrate various proprietary technologies into the same system. This allows AEMK to increase the DeltaBot’s positioning precision as well as the repeatability at the same robot speed. Due to its deterministic features using its precise timebase, the new DeltaBot system has made great gains in reliability, consequently generating fewer errors than the previous system,” Khajepour stated.

**Cost-effective pick-and-place**

AEMK Systems has successfully implemented DeltaBots in several projects and has introduced the robots as stand-alone products to the market. “Because of its reliable nature, the new DeltaBot has greatly reduced our testing and integration time. Considering TwinCAT’s ease of programming, DeltaBot development time has drastically decreased by almost 50 percent,” Khajepour said. AEMK has been involved with Beckhoff for more than a year now and will continue to implement Embedded PCs with TwinCAT as the standard platform for future projects.

“Our goal is to offer flexible automation. The Beckhoff control architecture will help advance DeltaBot development and help make it the preferred robot solution for many more cost-sensitive applications,” Khajepour concluded.

AEMK Systems  www.aemksystems.com
University of Waterloo  www.uwaterloo.ca
Beckhoff Canada  www.beckhoff.ca
Automatic guided vehicles (AGVs) have traditionally been a niche technology used at relatively few facilities in the United States. As a company that is unwilling to spin its wheels on old technology, manufacturer America in Motion (AIM), based in Charlotte, North Carolina, USA, has reinvented the AGV design based on a PC-based control platform. The new automatic guided carts (AGCs) are easier for end-users to integrate and cost about half as much as traditional AGVs, making the technology attainable for far more applications than previously possible. Specific examples include news printing, automotive assembly, the plastics industries, food and beverage and general warehousing.

“AGVs are an ideal solution here to increase flexibility and cost-efficiency with a highly mobile alternative,” said Tommy Hessler, CEO of America in Motion. Compared with conventional material handling systems based on automatic conveyors, transfer cars or manually operated vehicles, AGVs offer a high degree of flexibility. If loads being transported from A to B suddenly need to change directions, the AGVs from AIM will immediately change their route and handle the new tasks without the operator having to lift a finger.

Flexible controls enable application-specific configuration
AIM has introduced a dynamic new line of AGVs, which are actually automatic guided carts (AGC). They feature a full PC-based automation system from Beckhoff. The AGC consists of a standard burden carrier ‘base’ with an adaptable top to which different load handling devices such as roller decks or lifting forks can be added. “It’s quite easy to add or remove capacity based on the type of load the AGC must handle due to the modular structure of the Beckhoff controls,” Hessler said.

On-board intelligence
“PC-based controls have allowed AIM to integrate on-board intelligence into the vehicle,” noted Theresa Blasius, Vice President of Engineering at AIM. “Our AGCs can be best utilized in applications that already have some automation control such as robot cells or automatic conveyor systems with a PLC. Via OPC, these types of controllers can easily command our AGC to carry the load anywhere in the facility, a feature that previously was unobtainable for stationary automation,” Blasius emphasized. “PC-based control with Windows CE as the operating system enables us to integrate voice-activated commands,” Hessler added.

Panel PC as the all-in-one system controller
AIM uses the Beckhoff CP7202 Panel PC with 15-inch touch screen as an ‘all-in-one’ system controller and user interface. Installed in a central location as a fixed AGC operator station, the Panel PC handles a broad range of functionality including traffic management, vehicle selection optimization, vehicle task management, load tracking, user interface for system monitoring tools, path programming logic, and AGC fault finding & diagnostics.
CX1010 Embedded PC for controlling internal functions

The onboard CX1010 Embedded PC handles all internal functions required for the AGC to operate, partly using TwinCAT automation software from Beckhoff and partly through C# software developed by AIM. The main functions of the Embedded Controller are guidance (magnetic tape or wire), routing (RFID), charging, steer control, drive control & precision stop, manual control via pendant, automatic load handling and safety devices (managed by TwinSAFE).

TwinSAFE onboard – the safe bet

The CX1010 devices are directly connected to Beckhoff Bus Terminals and TwinSAFE Terminals for streamlined implementation of safety devices on the AGCs. TwinSAFE Terminals do not require a dedicated safety PLC, resulting in significant savings for wiring of safety devices. The KL6904 TwinSAFE controller terminal deals with the required logical link between the inputs and outputs. “TwinSAFE technology helps AIM maintain a competitive advantage by easily and cost-effectively integrating emergency stops and bumper stops into the AGCs,” Blasius said.

The mission of AIM is to transform AGV design and make it far more affordable so it can be applied in a much wider range of applications.
Flexible communication via WLAN or OPC
AIM also typically installs distributed Bus Terminal I/O near the Panel PC stations and utilizes WLAN communication between the Panel PC and the CX1010 onboard the AGCs. OPC is used for communication between the AGC system and other PLC controlled equipment, such as conveyor systems and robotic controllers. TwinCAT OPC Server helps AIM easily integrate their AGC systems with other material handling products while facilitating streamlined system communications.

Costs reduced, reliability increased
"The new AGCs containing the complete Beckhoff control system have run flawlessly in production mode," Hessler said. "With our new design running in the field since August of 2008, we have determined that AGC reliability has been superb and system uptime has been maximized for our customers." With our recent cost reductions, Beckhoff controls have helped AIM get into more markets by reducing the cost of our AGCs. "We can now reach numerous applications, such as food and beverage that are often too cost-sensitive for full fledged AGVs," Hessler added.
Commissioning – including installation, testing and acceptance – of a traditional AGC is typically a two or three week project. "AIM successfully completed the commissioning of the new Beckhoff controlled AGC in only four days," Hessler said. "Utilizing the Beckhoff Embedded PC with Windows CE environment, AIM has been able to quickly integrate with our other equipment to create the total solution," Blasius added. "We have also implemented remote access for customer service and support using the CP7202. This saves AIM a great amount of engineering time and expense that would otherwise be spent for on-site support visits."

Driving toward the future with AGCs
"By using PC-based controls with PLC functionality, we can offer outstanding flexibility to all our customers," Blasius said. "Users of AGCs from AIM can be highly involved in the customization of system programming or they can simply run and maintain the systems; the choice is theirs."
AIM intends to continue moving AGC technology forward using PC-based and Industrial Ethernet technologies. "To serve our customers even better, we plan to implement EtherCAT I/O terminals and expanded WLAN capabilities," Blasius said. "We don’t think there are any serious alternatives to Beckhoff considering the available tools from Windows CE to .NET framework, to the open, PC-based architectures."
"I think we are on the brink of seeing PC-based control used in new ways such as AGCs paired with robotics," Hessler said. "This would be a way to tie both technologies together where the robot is the master and the AGC acts as the slave in the application. In this way, systems integrators could offer more than just the robot; they could also offer the material transportation to the warehouse."
Based in Annandale, New Jersey, USA, Wierciszewski Controls specializes in packaging technologies for the food and beverage industry and pharmaceutical and medical applications. Wierciszewski developed two custom-designed machines to handle packaging and visual inspection of blood testing products for a major medical products manufacturer. The “tray erector” and the “accumulation table” are automated using a PC-based control platform from Beckhoff which meets the exacting requirements for precision and flawless timing.

The tray erector developed by Wierciszewski erects the cardboard trays for packaging the blood test cassettes, prints and applies the labels and performs vision inspection on the applied labels – all on an extremely compact 3-foot by 3-foot floor area.

The blood testing cassettes are filled with a mix of glass beads and reagent which is monitored by the vision inspection system in order to guarantee correct filling, i.e. a proper fill mixture. To enable precise measurement of the fill ratio, Wierciszewski Controls developed an accumulation table with a 4-foot by 4-foot floor space for 600 cassettes and a throughput of 80 cassettes per minute. The accumulation table not only meets the customer’s size and speed requirements, but also integrates a vision inspection and reject system. This enables upstream detection of filler and labeler malfunctions so any defective products can be dealt with.

All-in-one Panel PCs for packaging and inspection of blood testing products
The visual inspection requires a PC with HMI to display and analyze the results. The camera has to collect an immense amount of information, such as serial number, bar code grade or fill levels. "In previous systems, the communication speed between vision inspection to HMI and to the PLC was a bottle neck," explained Jerry Wierciszewski, owner of Wierciszewski Controls.

Perfect timing required
The tray erector machine has to tolerate some variability in the trays’ raw materials. If there are materials changes, the timing to bend the flaps, fold the cardboard, etc. must change accordingly. The accumulation table complicates the challenge with an in-feed system that has very demanding precision requirements. The conveyor timing must be very tightly controlled when the cassettes are moved through the system to facilitate gentle product handling. "It can be very tedious work to perfect the system timing, but it is a necessity when dealing with blood testing products," Wierciszewski explained. "This made it necessary to move to a new control system."

Reliable recording and logging of all production data
In the United States, the FDA (Food and Drug Administration) requires rigorous electronic record keeping. Both machines therefore have an SQL database for audit trails and detailed tracking for CFR 21 part 11 compliance according to U.S. regulations. As this is one of the highest demands in the packaging industry, especially in medical applications, there must be a reliable system in place to keep track of all the changes in production and to create detailed reports on these.

Two machines share one Panel PC
As the controls centerpiece, Wierciszewski selected a Beckhoff CP7202 Panel PC with 15-inch touch screen to handle the automation, Motion Control, SQL database and HMI functions for his two machine systems. "The main reason for choosing the Panel PCs with
TwinCAT PLC software was the requirement for a small footprint. Even greater space savings resulted from the fact that the Panel PC did not require a housing, but is attached to a moveable mounting arm," explained Wierciszewski, adding: "The CP7202 is more than up to the task for the CPU-hungry vision system and the control functions for the two machines. Using TwinCAT ADS, huge amounts of data can be transferred between the HMI and PLC in real-time."

Wierciszewski also developed his own HMI software using a Visual Basic .Net and C# platform. "The HMI can communicate very easily with TwinCAT and display visual inspection results, counters and any other system information," he added.

**All control components from one source**

Due to the limited space, Wierciszewski designed a stepper motor system using Beckhoff KL2541 I/O terminals that are wired directly to Beckhoff AS1050 and AS1060 stepper motors. Integration in the Bus Terminal system dispenses with the need for additional amplifiers.

Wierciszewski networks the Bus Terminals via Ethernet TCP/IP using a Beckhoff BK9000 Bus Coupler. Additional Bus Terminal I/Os are used for relay outputs, motor starters on the conveyor and solenoids, each with 1 amp power consumption. "In the past, we were using separate analog outputs, thermocouple inputs or heating control units from various suppliers. Now all these functions are covered by one I/O system," explained Wierciszewski, listing the benefits.

**Time savings and cost reductions add up**

From concept to finished machine, the tray erector took about four months. The accumulation table was even faster, taking just two months to design and build. Both machines were fully programmed in only four days.

In addition, costs for the control system and development time were significantly reduced. "Even with the integrated SQL server and comprehensive vision system, the Beckhoff control platform cost is an average of 40 percent less than the devices I used previously," Wierciszewski explained. "Using one Panel PC to control two machines saves considerable time and money. The I/O wiring, which could take several days previously, is now significantly easier using Bus Terminals and Ethernet TCP/IP. In addition, the PC-based control enables remote access to the machine via Internet so that errors can be corrected quickly online."

In the near future, Wierciszewski Controls would like to incorporate high-speed EtherCAT into their machines and use AX5000 EtherCAT Servo Drives to increase performance even further while offering comprehensive connectivity. "Beckhoff has enabled us to plan more efficiently and ensure that our machines deliver ideal performance every time," Wierciszewski concluded.
Vernet Behringer makes PC Control standard

Vernet Behringer’s product range includes high-performance CNC multi-spindle gantry drilling machines, universal machines for punching, drilling and marking, shear and punching units and CNC flame-cutting equipment for machining steel profiles and steel plates. All machine modules have a PC- and EtherCAT-based automation platform from Beckhoff. EtherCAT enables rapid communication between the PC controller, drives and I/Os, thus optimizing the whole production process.

The machine type MAG B from Vernet Behringer provides a drilling, punching, marking and plasma cutting machine for steel plates measuring eight by two meters with thicknesses of up to 50 mm. Equipped with tool changers on the drilling and punching units and various options for marking, this machine enables a variety of machining processes.

Integrated automation increases productivity

In order to meet the requirements of particular markets, the integrated automation of “stand alone” machines into flexible machining centers is an absolute must. “The resulting increase in productivity is a primary selling point,” explained Loïc Guillou Keredan, automation manager for Vernet Behringer: “We have been installing PC-based control systems and user interfaces since 1990. This enabled us to provide a simple and user-friendly interface for controlling our machines and to integrate direct connection functions which were implemented in advance for the CAD clients.”

“After examining various Motion Control suppliers, it turned out that Beckhoff’s open, PC-based control platform with EtherCAT as well as TwinCAT PLC and NC/CNC for automation and Motion Control is ideal for controlling our CNC machine tools,” Keredan explained, adding: “The EtherCAT performance is remarkable: delays are in the range of a few nanoseconds.”

Standardized control platform creates price advantages

“The Beckhoff automation platform has been universally in use for our entire product range since January 2007 after it had been tried out on the...”
The MAG B from Vernet Behringer is a universal machining center for sheet metal up to a max. 50 mm thickness (for flame-cutting and drilling) and up to 20 mm thickness (for punching). It is used mainly in steel construction for quick and accurate flame-cutting of contours, for drilling, punching and for marking.

Loïc Guillou Keredan, automation manager, and Hervé Nawrocki, IT manager, from Vernet Behringer. The machine tool manufacturer uses the PC and EtherCAT-based control technology from Beckhoff in its entire machine range.

MAG B for three years,” the automation manager reported. A strategy which aims at interoperability and flexibility and is in line with Vernet Behringer’s company philosophy. Further benefits include standardization of the control cabinets and the reduction of the training period for operating and maintenance personnel.

“PLC and Motion Control are now combined in the reliable, economical and compact C69xx Industrial PC. It is easy to install, connect, program and maintain. In addition, the PC platform can be extended with additional functions,” Hervé Nawrocki, IT manager at Vernet Behringer stressed. By using EtherCAT, no additional fieldbus cards are necessary in the IPC. Furthermore, the quality of the machine is improved because importing processing files such as e.g. the cycles for drilling, tapping, guiding, lubrication control, automatic measuring functions for extension elements, collision protection systems for slides and flame-cutting units, gripper control etc. takes place considerably faster. Due to the compact construction of the C69xx, the Industrial PC only requires a small amount of space in the ventilated and temperature-regulated control cabinet. The control cabinet can now be made smaller and is also lighter, more accessible and easier to connect.

PC platform enables future integration of additional functions

“The TwinCAT software replaces the customary PLC hardware. We have developed exchangeable software function blocks on various machines. In the future, this control architecture will allow us to concentrate more on NC and to manage or re-group more axes, to work at interpolations or to think about vision systems,” explained Hervé Nawrocki.

A further advantage is to be able to carry out control and maintenance tasks decentralized via Internet. “Secure remote maintenance gives us an overview of the machine and its operating state at any time. This guarantees rapid assistance and at the same time allows a reduction in the time and energy expended, as over 80 percent of the problems that occur can be solved without a technician needing to be on site. Maintenance and repair will be simplified because all data will be stored centrally by the PC,” Hervé Nawrocki concluded.

Vernet Behringer www.vernet-behringer.com
Beckhoff France www.beckhoff.fr
Leaf House, which at first glance looks like many other residential buildings from the outside, is the first carbon-neutral house in which state-of-the-art considerations of energetic sustainability were put into practice.

Living in harmony with nature

Leaf House is the first energetically independent building in Italy; a place to exchange thoughts on the subject of ecological sustainability and the home of the “Leaf (Life Energy And Future) Community”. The project was implemented by the Loccioni Group together with a network of companies. The Leaf House is a building with six residential units that is operated using only clean energies and does entirely without CO₂ emissions. What makes this model experiment special is the proof that ecology and modern living comfort do not have to contradict one another. Intelligent building automation by Beckhoff provides the basis for this.

The Leaf Community has set itself the goal of developing and practicing integrated and completely environmentally-compatible forms of living using the latest technology. Leaf House is therefore not just a comfortable residential building that is completely independent in terms of energy and does not pollute the environment in any way whatsoever, it is also a kind of laboratory for the acquisition and processing of data for the optimization of technological developments in the service of a sustainable lifestyle.

Efficient energy management with the latest technical standards

With a photovoltaic system for generating electricity and solar panels for heating the tap water as well as supplementing heating, the solar energy of the south-facing building is utilized in the best possible way. In addition, there is an air treatment system that serves well-being in the interior – with constant control of temperature, humidity and carbon dioxide in the rooms. A system for the reclamation and treatment of rain water, which is collected in a tank under the garden, is used for sanitary areas and for watering. The energy efficiency of the building goes into great detail: from the use of electrical devices and household appliances with low consumptions of electricity and water to lighting systems in which sources of light are used that radiate very little heat. Loccioni chose Beckhoff as its technology partner in particular for the realization of the energy-saving system. Loccioni had clear ideas with respect to the technical requirements for a PC-based building control that could integrate various systems.

Efficient energy management with the latest technical standards

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Loccioni found the desired components in the extensive range of products from Beckhoff without any custom manufacturing being necessary. With its special function blocks, the TwinCAT Building Library additionally offers comprehensive solutions that are tailored to the specific requirements of building automation. In this way, it was possible to implement all of the building functions in Leaf House on a software basis.

Embedded PC for control, Control Panel as operating unit

The entire Ethernet-based building control consists of seven CX1020 Embedded PCs and two BK9000 Ethernet Couplers. Built-in Control Panels with 15-inch TFT displays and DVI/USB interface are used as user interfaces. The panels can be installed up to 50 meters away from the PC and serve the monitoring of room functions. The data points are connected via Beckhoff Bus Terminals. The KL3403 power measurement terminal acquires all relevant electrical data from the mains supply; the comprehensive network analysis provides the basis for efficient energy management. The KL6401 LON Bus Terminal integrates the air conditioning unit with LON interface into the control system. The KM2774 modules control the sun shades. The KM2604 relay modules serve the automatic separation of loads and allow appliances with a high current consumption to be connected directly to the mains supply. Analog I/O terminals and thermo-couple terminals offer the basis for the control of heating and air conditioning.
The wide range of I/O components for the control of various lighting scenarios as well as for room control also makes it possible to acquire data that has an influence on energy consumption and the well-being of the inhabitants, such as the control of external window shutters, protection against ‘prying eyes’ from outside, the movement of doors and windows, and also the correlation of climate conditions from indoors and outdoors. There are many different ways to optimize energy consumption, whether by integration of window contacts in the heating controller or by lowering of set room temperatures at night or when the inhabitants are absent.

The PC-based technology enables remote diagnosis, maintenance and monitoring. It is therefore the ideal platform with which to ensure the monitoring of energy and consumption data as demanded by Loccioni.

Shaping the future with the technology of today

Leaf House is already carbon-neutral today, i.e. the energy is obtained completely from renewable energies, so that there are no CO₂ emissions. It is a residential building, but at the same time it is also a laboratory for new technologies for the efficient use of clean energy and a place for “environmental education” that wants to make a contribution to forms of living aimed at the future of our Earth.

Leaf Community  www.leafcommunity.com
Loccioni       www.loccioni.com
Beckhoff Italy www.beckhoff.it

Published in Automazione Oggi nr. 317 Oct.2008 – by Maddalena Pria
Renowned Italian confectionary products manufacturer Bauli S.p.a. has subjected its pallet and warehouse management to a “sweet” revamp. The introduction of a PC-based controller has optimized the automatic label printing and pallet production count at the end of the production line. A Beckhoff CP62xx Panel PC ensures greater reliability in tracking the ongoing production and supplies precise inventory information.

Bauli commands about 50% of the market share in Italy for seasonal confectionary products (Christmas and Easter) and 11.9% in the case of Easter egg products. In recent years the company has undertaken various restructuring and improvement measures to optimize its internal production processes. Bauli has been supported in upgrading of its warehousing division by Itworks S.r.l. from Ancona, Italy, a company with years of experience in monitoring and tracking systems, and by Beckhoff, its controller supplier. “In the past, the seasonal demand for our products and the related high staff turnover made troubleshooting and pallet production counting difficult. However, this information must be absolutely reliable to help the company’s management make the best commercial and strategic decisions,” explains Giuliano Bonizzato, systems coordinator at Bauli.

**Reliable facts and figures promote efficiency**

The aims of the measure were to improve the tracking of pallet assembly and individual batches, to reduce stock level uncertainties and to optimize the use of the workforce at the end of the production line in order to improve working processes. The whole system was to rely on an open and distributed control architecture.

The PC-based control, to which the three palletizing and wrapping lines were converted, guarantees absolute reliability in the production quantity count and of the warehouse input. It also simplifies the automatic pallet label printing process by eliminating all the print codes while new operating panels facilitate system display and monitoring.

**CP62xx Panel PC makes operation simple**

In the previous system, delays and issues relating to the management of machine downtimes were exacerbated by the fact that no direct tools for assessing the situation and no display for immediate handling of the problems in the production line were available. This has now been rectified. A Beckhoff CP62xx Panel PC displays summary information about the ongoing production and the number of pallets...
detected — and compares with the number of pallets specified for production. The touch screen Panel PC makes it easier to carry out troubleshooting even when faults occur during the production process. For export purposes the production order can be complemented with formatted data according to the country of destination.

The touch functionality of the Panel PC makes it easier to rectify errors that may occur during the production process. If the system is unable to recognize the product code during product identification, the pallet is stopped at the winding station. In order to complete the mandatory registration for the process to continue, the operator has to enter the product code manually.

If the scanner does not recognize the product code during a pallet production count, the affected pallet is stopped in its tracks immediately. This prevents it from entering the warehouse. The pallet readers are situated together with I/O terminals at the final station with the roller conveyor to prevent unauthorized removal.

**EtherCAT, the efficient network**

Beckhoff EtherCAT Terminals have been used throughout all processes. The system-wide, open control platform from Beckhoff with unlimited programming flexibility enables the simple integration of all components from the Bauli host PC via Ethernet and the monitoring PCs to the field level. For example, the printer for the pallet labels are connected directly to the distributed serial terminals in the EtherCAT I/O system.

A lot has changed compared with the previous system, including identification of the palletized product, transfer of the information to the Bauli host, preparation of the pallet label, identification of products intended for foreign markets, input prompts for mandatory pallet label data, production counting, and fault alarm management. Gilberto Biasi, production personal manager at Bauli, is delighted with the new control system: “The system hardware with its touch screen and PC makes the operator’s work much easier while reducing costs.”

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Bauli S.p.a.  [www.bauli.it](http://www.bauli.it)
Itworks S.r.l.  [www.it-works.it](http://www.it-works.it)
Beckhoff Italy  [www.beckhoff.it](http://www.beckhoff.it)
Historic milestone for EtherCAT Technology Group: the 1000th member

With 1000 member companies joining in just over 5 years, the EtherCAT Technology Group (ETG) is undoubtedly a dynamic organization powered by rapid growth. The 1000th member of the ETG is Multivac, a world leader in packaging machine technology with its headquarters in Bavaria, Germany.

The ETG was introduced to the world at a press conference in November 2003 and the group’s Kick-off Meeting took place March 9 - 10, 2004. Since these early events, EtherCAT has not only become an international standard, but a globally accepted fieldbus technology with considerable market penetration. Today, the ETG has members in 45 countries, runs offices in Germany, the United States, China, Japan and Korea, and keeps its growing team of 15 quite busy. For two consecutive years, the ETG has grown by an average of one new member every business day. Near the beginning of the group’s existence, 70% of members came from Germany; today, over 65% of the membership hails from other countries. The second largest member group by country is the United States, closely followed by Japan, then China/Taiwan, Italy and Switzerland. In Asia alone, there are an impressive 220 member companies.

“Of course, we are extremely happy to have achieved this membership milestone so quickly,” says Martin Rostan, Executive Director of the ETG. “I believe it is the highly compelling nature of the EtherCAT technology itself that caused this enormous interest. The story of this success is not told only by the number of members, but also the worldwide distribution and acceptance of the technology. EtherCAT has been firmly established both with vendors and users and has been deployed successfully in a massive variety of applications.”

Alois Allgaier, business unit manager for control engineering at Multivac, explains the decision to join the ETG: “EtherCAT provides a big step forward technologically. Our cycle times have been optimized and our machines are even more efficient and reliable today. Thanks to Safety over EtherCAT, we can also meet our functional safety requirements with the same base technology. So to Multivac, membership in the ETG is obvious. The effective structure of the ETG allows users to become involved and put forth our points of view in order to advance EtherCAT technology.”

EtherCAT Technology Group expands test tool to include CANopen Drive Profile

The ETG is expanding the organization’s Conformance Test Tool to include the CANopen drive profile, CiA402. This step supports the consistent implementation of this profile and further facilitates the hassle-free commissioning of EtherCAT drives. The first version of the expanded test tool will be released in a few weeks.

The CANopen Profile, CiA402 is probably one of the most widely used drive profiles in the world. It is not only supported by European vendors, but also increasingly in Asia and North America. The profile, as well as its mapping on EtherCAT, is standardized in IEC 61800-7. It contains three modes for cyclic-synchronous motion control. These new modes were introduced into the standard in 2005 by ETG members with EtherCAT in mind. They are the basis for the corresponding ETG implementation guideline, which was published in 2007. The test tool enhancement checks the object dictionary entries and the state machines for conformance with the standard and helps to reduce the effort customers have to spend for commissioning drives. The working group conformance within the EtherCAT Technology Group is in charge of the EtherCAT test cases as well as the test enhancement to cover this device profile.

“The commissioning of EtherCAT communication itself is very simple. The application interface, which is specified by the device profile, sometimes needs more work – in particular with drives and especially if drives from different vendors are used. With the test tools extended to drive profiles we expect a further unification of implementations and even shorter commissioning times for our customers,” says ETG board member Dr. Peter Heidrich, R&D manager drives at Baumüller.
EtherCAT booth at Hanover Fair well attended

Despite all predictions to the contrary, Hanover Fair and particularly the joint EtherCAT booth were well attended. The booth team registered more visitors than for any other Hanover Fair in the past. Several Korean exhibitors were represented at the ETG booth, reflecting the fact that Korea was the partner country for this year’s Fair. RedOne Technologies presented an EtherCAT-based mobile robot. A further highlight on the booth was the multi-vendor drive demonstration: 25 different drives from 16 manufacturers were synchronized with each other in a single network – probably a new record in the history of fieldbus technology. In total, the 40 co-exhibitors on the joint booth presented around 200 different EtherCAT products. Hanover Fair was also a meeting place for the international ETG crew: Korea was represented by Prof. Yong Seon Moon, ETG representative for Korea, and Key Yoo, manager of the ETG office in Seoul. Other foreign officials included Takeshi Kameda, ETG representative from Japan, and Joey Stubbs from the ETG office in Austin, Texas. Beryl Fan from the ETG office in China used the opportunity to take part in the ETG marketing committee meeting in Nuremberg after the Fair.

EtherCAT goes India

Asia is a focus of the EtherCAT Technology Group’s activities in 2009: numerous introductory seminars and training classes are held; and ETG is present at many trade shows. The recent Industrial Ethernet Seminar series in India marked the beginning of ETG’s presence in this fast growing economy. Although aimed at ETG member companies only, the seminar series was very well received: more than 150 registered attendants mark India’s interest in the EtherCAT Technology. The seminars in New Delhi, Bangalore and Pune covered a detailed technology introduction as well as an EtherCAT application overview. In India, EtherCAT is already used in a large variety of applications such as packaging machines, automotive test beds, wind turbines and semiconductor manufacturing equipment. But Indian companies not only use EtherCAT for regional applications: since many multinational companies operate R&D centers in India and others also make use of Indian engineering services, there are many EtherCAT implementations under way.

EtherCAT seminar series in North America

In North America the successful EtherCAT seminars will continue in 2009. In 2008, technology events took place in 13 cities in the USA and Canada – from Seattle in the north-west to Charlotte in the southeast. This year the seminars will be held in a further six locations. In addition to the introduction seminars, regular EtherCAT implementation workshops are also held in the USA – most recently in May in San Jose and Chicago. The EtherCAT seminars and implementation workshops meet the requirements of the national US engineering association and therefore count as CPD events for engineers in the USA.
Review Hanover Fair 2009

At Hanover Fair 2009 from 20 to 24 April, Beckhoff was represented with two booths – in the “Industrial Automation” area and at the new “Wind” leading trade fair. At its main 800 m² booth in Hall 9, Booth F06, Beckhoff presented its complete product range and numerous IPC, I/O, Motion and Automation product innovations.

Expansion of Drive Technology:
new Servomotors up to 150 Nm

New display sizes: 24-inch panels were presented as built-in and compact panels.

New: robot integration in TwinCAT enables optimum synchronization between robots and standard Motion Control.
The complete range of Beckhoff products at Hanover Fair: IPC, I/O, Motion and Automation

Impressions www.beckhoff.com/hmi

Around 600 students from eastern Westphalia visited Beckhoff at Hanover Fair.

The initiative for the promotion of national and international vocational competitions crowned the German champion at Hanover Fair: Daniel Bräckling from Beckhoff headquarters in Veit also competed.

Skills Germany: the initiative for the promotion of national and international vocational competitions crowned the German champion at Hanover Fair: Daniel Bräckling from Beckhoff headquarters in Veit also competed.

Partner country Korea – the South Korean Beckhoff distributor Tri-TEK visited the Hanover Fair (left to right): Genie Son, Tri-TEK; Kai Ristau, International Sales Manager at Beckhoff; Key Yoo, managing director Tri-TEK; Hans Beckhoff, managing director Beckhoff; Mike Kim, Tri-TEK; Sam Jang, Tri-TEK

RoboCup German Open 2009: the team from Eindhoven University of Technology, which is sponsored by Beckhoff, took 3rd place in the Middle-Size League category of the RoboCup.

Hanover Fair 2009: the Beckhoff booth in Hall 27 as part of the new Wind leading trade fair

Wind

PC Control 02 | 2009
Trade shows 2009

Europe

Germany
Motek
September 21–24, 2009
Stuttgart
Hall 9, Booth 9108
www.motek-messe.de

FachPack
September 29 – October 1, 2009
Nuremberg
Hall 9, Booth 240
www.fachpack.de

FMB
November 04 – 06, 2009
Bad Salzuflen
www.fmb-messe.de

Austria
Smart Automation
October 07–09, 2009
Linz
Booth 235
www.smart-automation.at

Switzerland
Go.automation technology
September 01–04, 2009
Basel
Hall 2.0, Booth K78
www.go-automation.ch

ineltec.infrastructure technology
September 01–04, 2009
Basel
Hall 1.1, Booth A82
www.ineltec.ch

Belgium
ECH
Brussels
September 23–24, 2009
Brussels
Hall 4, Booth 1061
www.ech-expo.com

Mocan Hydromech
October 14 – 15, 2009
Brussels
Hall 7, Booth 7025
www.ech-expo.com

Denmark
Hi-Industri
September 01–04, 2009
Herning
Hall 9, Booth 5310
www.bi-industri.dk

Finland
Automaatio
September 23–25, 2009
Helsinki
Booth 4019
www.finexpo.fi/automaatia

France
MECATRONIC EXPO
October 12–23, 2009
Toulouse
www.mecatronicexpo.com

SIANE
October 13–15, 2009
Toulouse
www.zalenexsiane.com

IN MACHINE’2009
November 26
Paris
www.in-machines.com

Italy
Save
October 20 – 22, 2009
Verona
www.exposave.com

Norway
EuroExpo
September 09–10, 2009
Porsgrunn
www.euroexpo.no

Poland
Protech
November 18 – 19, 2009
Wrocław
www.targi-protech.pl

Russia
PTA
September 22 – 24, 2009
Moscow
www.pta-expo.ru/moscow

Automation
December 02–04, 2009
Saint Petersburg
www.en.farexpo.ru/ais2009
PTA Ural
December 08–10, 2009
Ekaterinburg
www.pta-expo.ru/ural

Hi-Tech Building & House
December 08–10, 2009
Moscow
www.hitechhouse.ru

Sweden

EuroExpo
August 26–27, 2009
Sundsvall
www.euroexpo.se

Scanautomatic
October 13–16, 2009
Stockholm
www.scanautomatic.se

EuroExpo
November 25–26, 2009
Luleå
www.euroexpo.se

North America

Canada

Industrial Automation &
Instruments Exhibition
August 20–23, 2009
Qingdao
Hall 2, Booth 2P16
www.zd-yiqi.com

China Wind Power
October 21–23, 2009
Beijing
Hall E1, Booth 1C19
www.globalwind.org.cn

Industrial Automation Show
November 03–07, 2009
Shanghai
www.industrial-automation-show.com

Korea

Kormarine
October 21–24, 2009
Busan
www.kormarine.net

USA

Pack Expo
October 05–07, 2009
Las Vegas
Hall S, Booth 5641
www.packexpo.com

Isa Expo
October 06–08, 2009
Houston
Booth 1701
www.isa.org/expotemplate.cfm

Fabtech
November 15–18, 2009
Chicago
Booth 1300
www.fmafabtech.com

For additional information on our worldwide subsidiaries’ and
partner companies’ trade show schedules please check:
www.beckhoff.com

Achema 2009

Beckhoff was represented at
Achema in Frankfurt, Germany,
from 11 to 15 May 2009. Solutions
for process automation, e.g. for
controlling pumps and valves,
were on show alongside system
solutions for packaging technology
or for measurement and control
technology.

Impressions www.beckhoff.com/achema

Ligna 2009

Beckhoff presented its PC- and
EtherCAT-based control technology
for woodworking machines at
Ligna 2009 in Germany. The focus
was on the new performance
classes for the AX5000 Servo Drive
series and industry-specific solu-
tions such as drill optimization.

Impressions www.beckhoff.com/ligna