EtherCAT measurement terminal enhances condition monitoring of large-diameter rolling bearings in wind turbines

Seamlessly integrated precision measurement and control technology provide mobile early fault detection

CMS Universal mobile condition monitoring solution

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Hamburg-based cms@wind GmbH specializes in monitoring slow-turning drive components in complex environments and develops mobile systems for condition monitoring (CM) based on structure-borne sound. The system detects abnormalities in slowly and irregularly rotating rolling bearings in drive trains measuring up to 4 meters in diameter. With regard to data acquisition, the high-precision ELM3602 EtherCAT Terminal made it possible to replace the previous measurement hardware with precision measurement technology integrated directly with standard control technology.

Until 2018, the solutions from cms@wind had relied exclusively on dedicated hardware for measurement technology. In 2017, however, the company recognized the advantages of the high-resolution ELM3602 EtherCAT measurement terminal for evaluating IEPE (Integrated Electronics Piezo-Electric) sensors, as owner Dr. Brit Hacke explains: "The ELM3602 met all key requirements of our application. The new measurement module is able to acquire vibration time signals at the IEPE input extremely reliably and without interference in true 24-bit mode."

In the case of slowly rotating large components, long-term data acquisition is required to facilitate a reliable diagnosis of incipient damage in the early stages by means of a reasonable number of recorded revolutions. According to Dr. Brit Hacke, measurement intervals of up to 5 minutes can be implemented without any problems, with data being reliably stored by the CX5130 Embedded PC used as computer hardware, and conveniently retrieved via remote access.

User-friendly condition monitoring for wind turbines

The systems from cms@wind were designed for large-scale components in wind turbines and are often used for measurement project implementation in locations that are difficult to access. Typical applications in the mobile area include temporary application from a few minutes to several months and often before the end of warranty in wind turbines from 3 MW upwards. In addition to monitoring conventional drive trains with three or more gear stages and high-speed generators, applications involving gearless systems have become more common.

According to Dr. Brit Hacke, customers increasingly wanted to have technicians install the CM solutions on site or else relocate them to other systems. The mobile systems make this possible; however, until now, they did not offer the user-friendly and responsive user interfaces typical of conventional measurement technology. This made familiarization more difficult for end users. Fortunately, the new CMS Panel developed by cms@wind and based on TwinCAT 3 now

Simple sensor adjustment via the CMS user interface

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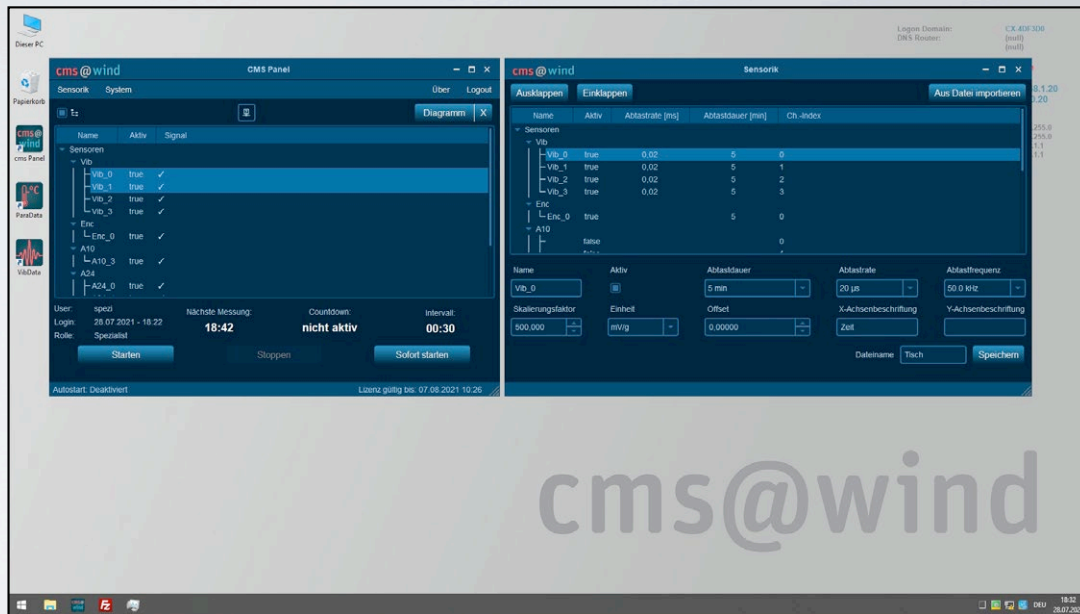
Representation of a shock pulse sequence

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allows on-site technicians to program the mobile systems professionally without advanced automation expertise and even verify the full functionality of all sensors after transferring them to another system. The operating menu corresponds to the working environment that is familiar to measurement technicians, and the signal curve can be viewed at any time while recording.

The new user interface has also made it possible to integrate additional sensors. In addition to the classic IEPE sensors in drive train and rolling bearing analysis, cms@wind also uses sensor technology for time-synchronous speed monitoring, detects low-frequency imbalances using MEMS technology, and on request even integrates decoupled signals from the controller into the projects to be able to assign specific events. Dr. Brit Hacke goes on to add: "Leveraging the comprehensive range of EtherCAT Terminals from Beckhoff, we can easily integrate additional signals. In the new CMS Universal condition monitoring solution, which has been available since 2021, for example, analog measurement signals based on ±10 V or 4 to 20 mA are provided in addition to Pt100

signals. The decision regarding which EtherCAT Terminal is used – for example, a classic EL3104 analog input terminal in 16-bit mode or a high-precision ELM measurement terminal with 24-bit resolution – is determined by the respective measurement task. Up to now, any technical limitations have only been apparent from the installation space in the case."

With CMS Universal, remote access and data transfer via mobile communication are possible in addition to conventional network integration. Direct on-site access is provided via a LAN or WLAN connection. The mobile devices have so far been used in offshore and onshore locations where systems permanently installed by the wind turbine manufacturers left end customers with a real information deficit.

More information:
www.cms-wind.de
www.beckhoff.com/condition-monitoring
www.beckhoff.com/elm3602

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RWCM-2500-A rail-straightening machine from Aigre Tech uses the Beckhoff CP22xx multi-touch built-in Panel PC for convenient operation.

Optimized manufacturing and handling of railroad tracks

Improved rail and track quality with PC-based control technology

When it comes to producing high-quality railroad tracks, two Chinese specialists rely on the performance of PC-based control technology from Beckhoff: Chengdu Aigre Technology Co., Ltd. (Aigre Tech) applies it with a rail-straightening machine to create seamless tracks, as does China Railway Chengdu Group Co., Ltd. with a tandem crane lifting system made up of four overhead cranes.

Founded in 2003, Aigre Tech is a high-tech company that forms part of the SWJTU industrial group located at the Chengdu Modern Industrial Park. The company has developed over 100 machines to date, and these have been used to a large extent for producing seamless tracks in the rail transport sector, e.g., for high-speed trains, heavy-duty trains, inner-city subways and light-rail systems. The key to creating these seamless tracks is in the quality of the welds between rails and the straightness of the rails, all of which has a direct impact on safety, comfort and the service life of the rails.

Due to the difficulties caused by lateral bending of the rails during the welding process, among other things, it is not possible to guarantee straightness. This is where the RWCM-2500-A rail-straightening machine comes in, newly developed by Aigre Tech and equipped with PC-based control technology from Beckhoff. It is primarily aimed at the high-end export market and can detect both horizontal and vertical bending defects in welded joints and straighten these automatically. For this purpose, the rail is initially scanned horizontally and vertically with a line laser. After the rail has been fixed in place with a clamping and positioning unit, it is corrected several times by four straightening hydraulic cylinders until

it meets the quality requirements. An expert system based on fuzzy logic technology (many-valued logic) is used here.

Straightening machine with integrated control platform
After extensive evaluations, Aigre Tech opted for the integrated control platform from Beckhoff as a complete solution. This was due to its high level of reliability, clear system architecture, simple remote maintenance and use of established programming standards in accordance with IEC 61131-3. The straightening machine uses the powerful CP22xx multi-touch built-in Panel PC (dual-core Intel® Celeron® processor with 2.2 GHz) to implement all of the control functions. Servo drives from the AX5000 series are used for axis control. An EtherCAT I/O system in a ring network architecture provides fast and reliable data communication. The high computing power of the CP22xx supported development of the user interface directly in the controller using C#. The data is synchronized with the control program and updated via ADS in millisecond intervals.

The system requires high-quality data to control the straightening process correctly. Both the database and set of rules are based on Aigre Tech's prac-

tical experience with welded rail connections. The conventional control system used previously had relatively poor data processing and storage capacities. With TwinCAT Scope View software, Aigre Tech believes that the Beckhoff control platform, on the other hand, provides a powerful and efficient solution that simplifies the recording of rail positions, curvature, force applied, etc., and makes it possible to develop the core database required in a convenient manner.

The powerful Beckhoff hardware and software platform, according to Aigre Tech, increases not just machine availability but also system performance. The first machine equipped with PC-based control in November 2019 successfully passed the comprehensive test for straightening 60 kg/m, UIC 60 and UIC 52 rails, as well as the final approval of the end customer – India's Ministry of Railways.

Efficient and precise control of tandem crane lifting system

According to the China Railway Chengdu Group Co., Ltd., the key challenges in controlling tandem crane lifting applications are improving the efficiency when handling long railroad tracks, preventing rails from warping during the lifting process and precise synchronization when lifting or lowering rails. With PC-based control from Beckhoff, the company successfully achieved these requirements in a lifting system used in southwest China to handle single-piece rails, which are generally 100 m long. China Railway chose their control platform based on the following requirements:

– a powerful CPU as the main controller to coordinate the functions of each sub-crane
– an excellent position-control algorithm to control the driving speed and position of the overhead crane precisely and in real time
– a high-speed communication system to guarantee the timely implementation of various crane instructions, as well as the locking and coordination of the primary and secondary hooks
– an efficient and reliable wireless remote connection

More specifically, CX5120 Embedded PCs (Intel Atom® processor with 1.46 GHz) are used as the main controller for each overhead crane as well as TwinCAT software for the logic functions and NC PTP for precise positioning and synchronization of the overhead cranes. The CX5120 records the external position signal and the data from the laser distance sensor used to move the crane and hook and to raise/lower the hook via the EL5001 SSI encoder interface terminal. Functions such as position control and collision avoidance were implemented via standard TwinCAT NC function blocks. The 1 ms control cycle time implemented here resulted in a significantly increased system response speed, according to China Railway.

The sensor signals distributed across the entire overhead crane structure (e.g., position switch, limit switch, load signal) are controlled via decentralized substations – with the EK1100 EtherCAT Coupler and EL1809, EL2809 and EL3154

© China Railway

Tandem crane lifting systems from China Railway handle 100 m railroad tracks, among other things.

EtherCAT Terminals, among others. These substations and the individual modules are connected via EtherCAT, which is what a spokesman for China Railway believes ensures the quick and reliable transmission of all signals: "The real-time properties of EtherCAT exceed those of traditional bus systems by far. According to the crane operators, the control sensitivity of the overhead cranes has also improved considerably."

As the distance between several overhead cranes can be up to 25 m, the visual observations of the operators are of particular importance. Therefore, in addition to the strict safety precautions that ensure normal operation of the system, numerous pieces of data are to be recorded and monitored, including the driving speed, distance between overhead cranes, their positions and the rail lifting height. It is therefore important to have a user-friendly HMI which – according to a spokesman for China Railway – can be supplied with data efficiently and flexibly via ADS and, as a result, is very easy to implement with a wide range of development software packages. What's more, TwinCAT Scope View allows users to record, monitor, manage and analyze operating states, the degree of efficiency or any faults and their causes easily and reliably. China Railway summarizes it as follows: "We have been able to significantly improve the efficiency of the lifting system with PC-based control from Beckhoff. The control system has exceeded our expectations and is very much appreciated by our engineers."
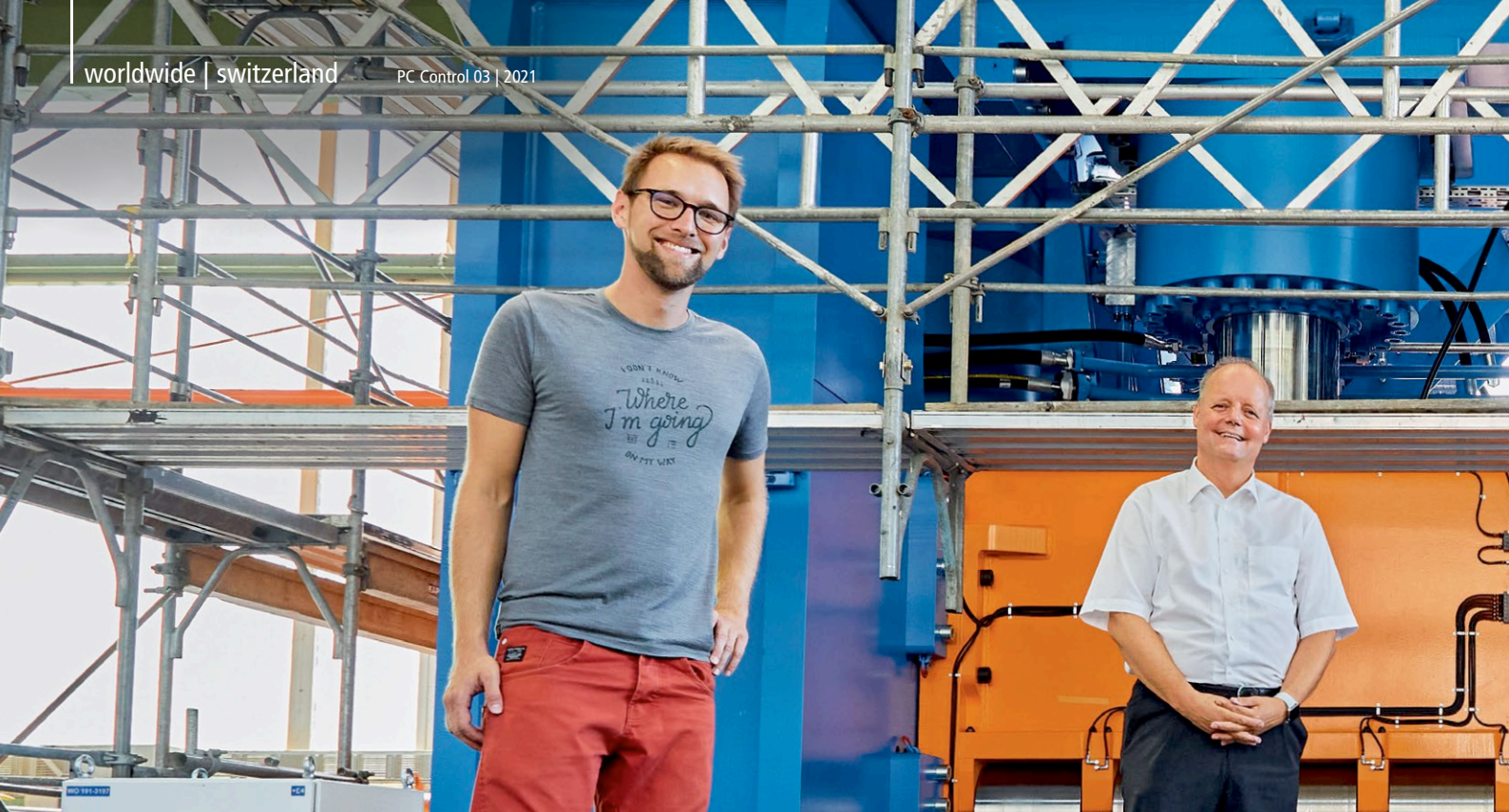
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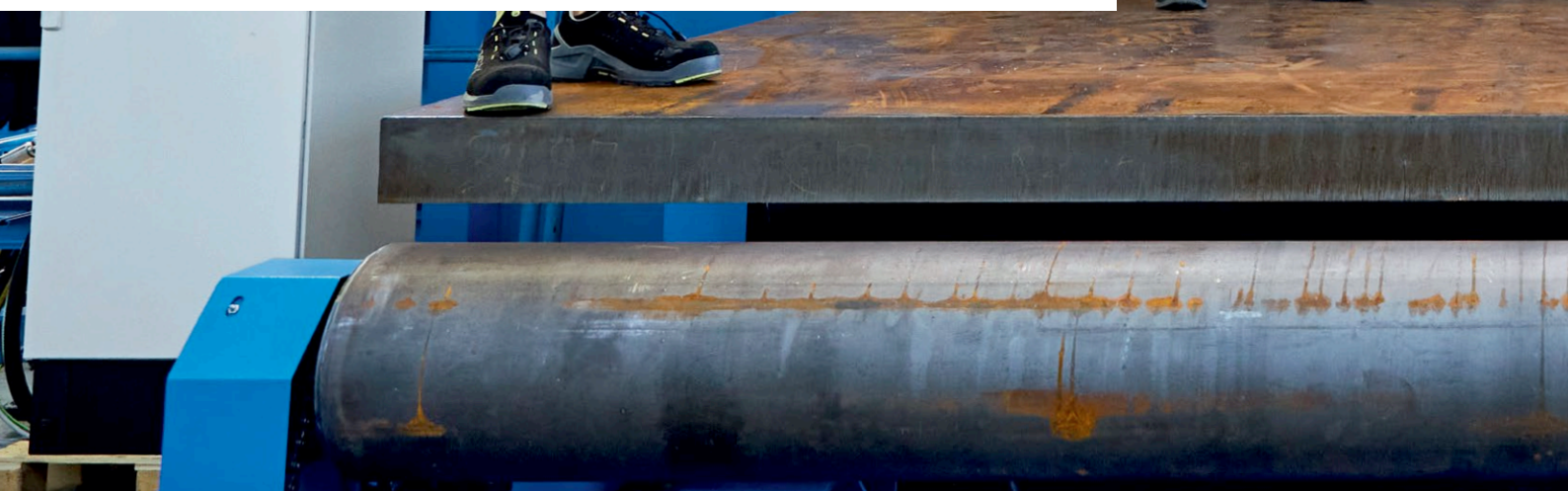www.beckhoff.com/ipc
www.beckhoff.com/twincat

PC-based control used for forming steel plates in one of China's largest shipyards

PC control guides precise shaping of the heaviest steel plates

Haeusler AG, based in Duggingen, Switzerland, is a leading specialist in large-scale facilities for forming metal plates. At the end of 2020, a giant 1,245-ton straightening machine was delivered to one of the largest shipyards in China. The company explains that this plant, the largest of its kind in the world, is used in the production of oil tanker hulls. In this context, PC-based control technology from Beckhoff ensures that the enormous forces for precisely forming steel parts are guided in the right direction.

For the steel plates, which are up to 120 mm thick, the project experts are far from a heavy load (from left): Patrick Stadler, deputy head of the electrical department at Haeusler, Peter Reinstadler of Beckhoff Switzerland, Haeusler CEO Jürgen Freund and Benjamin Schaeuble, head of the mechanical department at Haeusler.

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Haeusler is a special purpose machine manufacturer that was founded in 1936 and employs around 120 staff today. Since then, the company has developed a wide variety of machines and production lines, including customer-specific designs, for processing sheet metal for use in applications such as wind turbine towers, pipelines, the Ariane rocket, shipbuilding or enclosures within power plants and reactors. After an 18-month design and construction period, the latest RI 4000 X 87 straightening machine was delivered to the Chinese customer. The company's numerous shipyards produce a wide range of different vessels – from oil tankers, cargo ships and passenger ships right up to speedboats.

80 years' experience with straightening machines

Haeusler draws on more than 80 years' experience in developing customer-specific straightening systems. The result of this expertise is the RI machine series, which is fitted with five, seven, nine or 11 straightening rollers, depending on the technical specification. This includes the latest, gigantic forming system, which, standing at 12 m high, coming in at a dead weight of 1,245 tons and equipped with five large straightening rollers, can apply up to 19,000 tons of force during the forming processes. It is capable of machining 120-mm-thick, 4-m-wide and 12-m-long high-strength steel plates (1,000 N/mm2 yield strength) weighing up

The 12 m forming machine just before delivery

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to 45 tons. Haeusler explains that the capacity to process these huge metal plate dimensions provides significant advantages compared to traditional straightening solutions.

Machining this kind of steel plate is simply not comparable with that of typical metal sheets that are just a few millimeters thick. Here, it is more a matter of evenly aligning the plates as a rule – which are sometimes slightly wavy after manufacturing – for the subsequent work steps. Another task is to homogenize the stresses occurring in the sheet through several passes of cold rolling. For these purposes, the RI series offers a number of advantages, such as special individual roller adjustment for optimal straightening of both thin and very thick sheets. The direct roller drive provides automatic speed compensation and integrated overload protection.

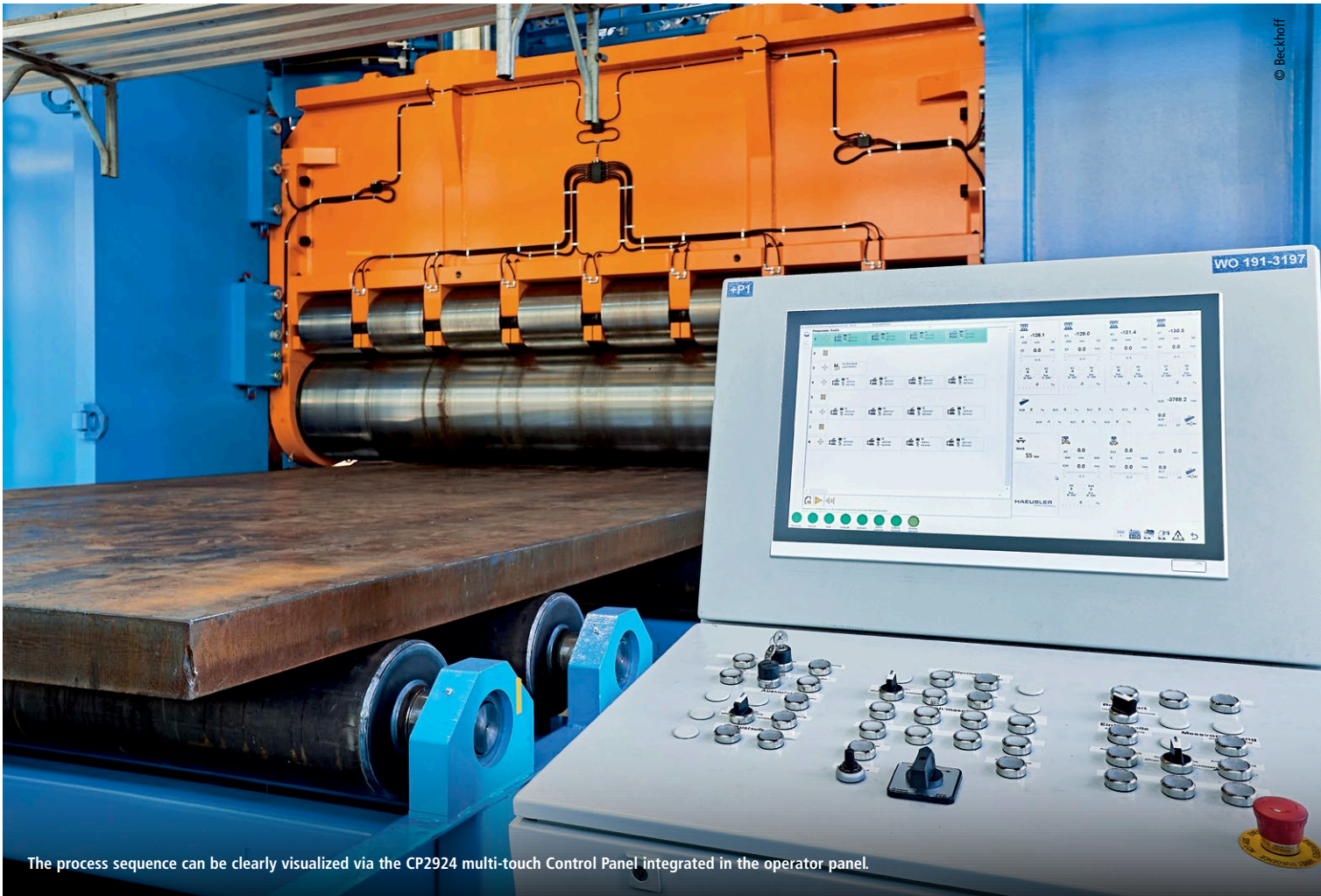**Intelligent machine control optimizes machining results**

Another feature of the RI series is its intelligent machine control system, according to Haeusler. PC-based control technology from Beckhoff allows users to achieve optimum machining results within a short amount of time. The modular components are distributed and networked with the high-performance EtherCAT communication system, which can be ideally adapted to the special requirements of the straightening machine. Patrick Stadler, deputy head of the electrical department at Haeusler, explains that "The strength of Beckhoff lies in the breadth of the portfolio and in particular in how open PC-based control and EtherCAT technology is. This means that if third-party components such as

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The C6920 control cabinet Industrial PC is used in two machine control cabinets.

position measuring systems are required, they can be integrated without a huge amount of effort. What's more, a second control computer was installed in the plant for a downstream measuring application, which enables quality inspections to be performed after straightening. Using the EL6695 EtherCAT bridge terminal, both controllers could be connected to allow real-time data communication with minimal effort. We also use ADS to transfer process parameters between the controllers via TCP/IP and to the HMI that we developed ourselves, and we appreciate how open the interface is in this respect, too." As another example, Patrick Stadler mentions a highly precise laser used for measuring the flatness of the straightened steel plates: "The laser has an RS422 interface and could be easily integrated with the EL6021 serial interface and the corresponding TwinCAT library without painstaking project planning."

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The process sequence can be clearly visualized via the CP2924 multi-touch Control Panel integrated in the operator panel.

The overall control of the latest machine is implemented via two C6920 control cabinet Industrial PCs. These are connected via the efficient CP-Link 4 one-cable solution to a CP2919 (19-inch display) or CP2924 (24-inch display) Control Panel as a convenient multi-touch HMI built into an operator panel. TwinCAT with the TwinCAT PLC Hydraulic Positioning (TS5810) library is used as the control software. It forms the basis for the entire axis controls and coordinates immense forces, according to Patrick Stadler: "A complex hydraulic system is fed from an 8,000-liter oil tank, which transfers up to 3,500 liters of oil per minute. Hydraulic torque control of seven axes simultaneously has been implemented, with torques of up to 10 million Nm. The system is supplied with up to 2,500 A power (at full

load), the majority of which is used for the hydraulics." Patrick Stadler also sees another advantage in the TwinCAT OPC UA Server (TS6100): "With this OPC UA interface, we provide the end customer with the option to efficiently integrate the machine into their shop floor management."

The I/O level distributed across several control cabinets within the plant includes nine EK1100 EtherCAT Couplers, nine EK1122 EtherCAT junctions and more than 150 EtherCAT Terminals. These include 36 EL1008 digital input terminals and 28 EL2008, EL2024 or EL2088 digital output terminals. Four EL2535 2-channel pulse width current terminals are also used. Haeusler benefits from the wide range of terminals available for analog value acquisition. For example, the EL3413 0001 power measurement terminal, which is suitable for up to 600 V AC, can be used to directly integrate particularly powerful machine components. The analog value acquisition is supplemented by 27 analog EL3152, EL3162 and EL3255 EtherCAT input terminals, and seven EL4032 and EL4034 analog output terminals. Other I/O terminals used are the EL5152 incremental encoder interface, the EL6021 (RS422/RS485) serial interface, the EL6080 EtherCAT memory terminal and the EL6695 EtherCAT bridge terminal.

The modular EtherCAT I/O system from Beckhoff can
be perfectly adapted to specific requirements.
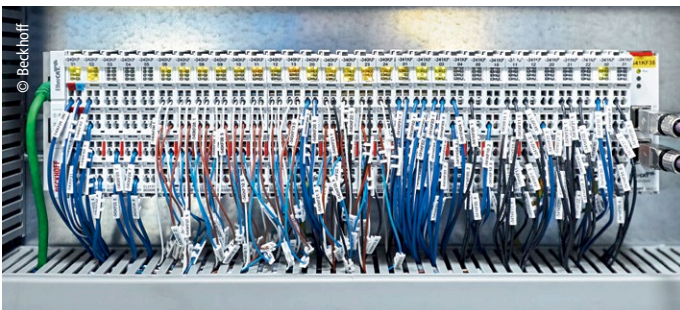
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More information:

EtherCAT- and PC-based control in precision milling for prosthetic tooth manufacturing

Cloud-connected IPC helps enable lot-size-1 dental manufacturing

Following dentistry's CAD revolution in the early 2000s, U.S. dental prosthesis manufacturer Glidewell Dental evolved quickly to reach its current highly automated production. Flexible automation solutions from Beckhoff have helped modernize a prosthetic tooth factory. Here, the C6015 ultra-compact IPC serves as an IoT gateway, delivering patient-specific NC programs from the cloud and transmitting production data from a total of 40 mills every 2 seconds for analysis.

Founded in Jim Glidewell's apartment in 1970, the Irvine, California, company now has more than 4,300 employees globally, producing a broad portfolio of dental restoration and medical device products. Every product requires lot-size-1 manufacturing in restorative dentistry, when supplying dental prostheses such as crowns, bridges or dentures, for example. For Glidewell Dental, producing tens of thousands of patient-specific devices each week requires intensive engineering efforts. "We do business with some 60,000 dentists each year – or nearly 50% of all practicing dentists in the U.S. restorative market," says David Leeson, Vice President of Engineering at Glidewell.

Dentists either mail "impressions" of a patient's oral anatomy to Glidewell or scan and upload 3D digital impression images to the company's proprietary digital platform built on Amazon Web Services (AWS) cloud. A proprietary AI technology then generates a custom prosthetic design to match the impression and turns the CAD file of each patient-specific restoration into a unique NC project. The state-of-the-art Glidewell BruxZir® factory assigns a case with the prescribed characteristics, such as tooth size, shade and thickness, and selects an unrefined block of zirconia material of suitable size, shape and color. A robot transfers this milling blank to a milling tower for detailed anatomical shaping, after which the restoration undergoes glazing for a more natural surface appearance. Barcode scanners and a vision application track the case throughout the process.

"To make this a closed-loop process, optical scanners generate a 3D geometry of the finished product, and an algorithm compares it to the design file. The dental implant must be within 50 μm to pass quality inspection – and most often, it's within 20 μm," says Kunal Patil, Automation Manager at Glidewell. "Performing just the glazing by hand could create variances of up to 150 μm. PC-based automation helps us achieve much higher precision."

Picture above: Every product that comes out of Glidewell's BruxZir® factory is a lot size of 1: Blanks are selected based on patient-specific characteristics and milled according to custom NC projects.

Production expansion requires increased control performance

From the beginning of the BruxZir factory build, the Glidewell engineering team knew that all automation technologies needed to be flexible, scalable and industrial hardened. Also, Glidewell needed to scale up from a single milling tower of four mills to five milling towers in a system and, eventually, to a second complete system of five towers, totaling 40 mills. Finally, the components needed to withstand significant amounts of abrasive zirconia dust.

As Glidewell began to implement the first milling tower in 2018, the engineering team soon realized that its legacy machine control technologies were not up to the task. "We struggled with many issues involving synchronization between robots and multiple controllers, debugging and real-time communication, while using a familiar controller," Kunal Patil says. "After evaluating different automation platforms, we switched to Beckhoff."

Powerful and IoT-capable Industrial PCs

The BruxZir factory leverages multiple Industrial PC (IPC) and TwinCAT 3 automation software solutions from Beckhoff. A C6015 ultra-compact IPC, an AWS-certified device, serves as the IoT gateway, delivering NC programs from the cloud. A powerful C6930 control cabinet IPC is the main system controller, communicating with multiple robots, vision systems, field devices and machine controllers at the milling towers. Each milling tower relies on a CX5140 Embedded PC to run 4-axis motion on four mills – i.e., 16 axes per controller – using TwinCAT NC I. Working in concert, the PC-based controllers provide optimal connectivity, processing power and scalability to automate 20 mills, with

Glidewell has implemented two complete prosthetic tooth manufacturing lines with 20 mills each in its factory for BruxZir® Zirconia restorations, totaling 40 mills. The company is implementing a third full line, reaching a total of 60 mills.

Beckhoff multi-touch Control Panels are used for greater visualization of milling processes.

80 axes of motion, in one standard system. According to Kunal Patil, the controllers also meet requirements for cost-effectiveness and durability.

The BruxZir factory needed to meet California IoT regulations that took effect in 2020, David Leeson explains: "With Beckhoff IPCs, we can run approved antivirus software in the Windows environment. This solution meets all cybersecurity demands without affecting performance, which is impressive." Kunal Patil says his team took advantage of the capability to program the standard machine control logic, advanced CNC programs and APIs in C# and .NET in one software platform.

TwinCAT IoT and the C6015 IPC – which interfaces with AWS IoT Greengrass, the open-source edge runtime and cloud service – send valuable production data for analysis every 2 s. Besides facilitating troubleshooting and predictive maintenance, this enables easier discovery of data insights to boost machine performance and improve product quality.

Precision and efficiency through TwinSAFE and servo technology
With real-time communication rates for the plant floor, EtherCAT makes high-performance production possible. In addition, TwinSAFE makes function-

al safety an integrated part of the control system. "With so many concurrent processes, we do not want every mill to stop if someone presses an E-stop for a particular mill. TwinSAFE allows us to stop specific mills and safety zones, and we can create that logic entirely within one project," Kunal Patil says.

AX5000 Servo Drives and AM8000 servomotors with One Cable Technology (OCT) from Beckhoff power the pick-and-place robots that feed new cases to the milling towers. In the mills, space-saving compact drive technology with OCT is used, that is, the AM8100 series servomotors and EL7211 servomotor terminals. Here, the AM8100 servomotors have proven to be robust, reliable and highly precise in operation, while constant direction changes put substantial stress on the components. "If the motors deviated even slightly, our final product would not match the design file, or the material could chip and show defects even from minor vibrations," Kunal Patil describes the high requirements.

PC-based control reduces number of components and costs
The BruxZir factory achieved both the high-precision manufacturing and data acquisition capabilities after transitioning to PC-based control from Beckhoff. Each mill completes a case in roughly 10 minutes, maintaining round-the-

clock production. The company is now implementing a third full line, reaching a total of 60 mills. PC-based automation cut the number of components required, according to David Leeson: "Our previous controllers could only handle a single mill each, where the Beckhoff controllers operate four mills each. In addition, to achieve the same data acquisition and cloud connectivity, the previous controllers would have required a separate PC." Kunal Patil adds that other control options that Glidewell explored cost nearly twice as much.

Glidewell continues to evaluate new Beckhoff technologies, including Gigabit communication with EtherCAT G and TwinCAT HMI visualization software, to further enhance their solutions. "Glidewell and Beckhoff have similar histories, starting with a single owner, and charting rapid growth through a passion for innovation," Kunal Patil says. "So, we don't see Beckhoff as our vendor. We see them as our partner."

More information:
www.glidewelldental.com
www.beckhoff.com/c6015
www.beckhoff.com/twincat-iot

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(From left) Beckhoff team members Application Development Engineer John Helfrich, Regional Sales Engineer Charles Usher and Applications Engineer Lauren de Rosset work closely with Glidewell's Automation Manager Kunal Patil and Vice President of Engineering David Leeson.

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eXtended Transport System increases flexibility in food packaging

Pizza case packer with XTS replaces three machines and conventional product transport technology

Amid rapid change in the food and beverage industries accelerated by the COVID-19 pandemic, consumer packaged goods (CPG) manufacturers, contract packagers and their suppliers have to dramatically increase their agility to meet an exponential surge in demand. This prompted U.S. OEM Brenton to equip their side load case packer machine with the XTS. Now, the linear transport system enhances flexibility in product infeed and makes changeovers faster. In addition, the machine offers a significantly reduced footprint after the redesign.

Left: XTS is at the core of the M2000 packaging machine from Brenton, pictured above: A series of buckets holds pizzas as XTS takes them around a 180-degree corner to grip and stabilize stacks.

Above: Using XTS, Brenton developed a pitch-less machine that handles completely random infeed timing of all frozen pizza shapes, orientations and SKUs.

Brenton manufactures integrated end-of-line packaging systems for the food, beverage and pharmaceutical industries, specializing in case packing, cartoning, robotic palletizing and material handling. Today part of the expansive ProMach, Inc., group of brands, the company has been in existence for over 30 years.

A major U.S. contract packager enlisted Brenton to take on a challenging case packing application for frozen pizzas. This fast-paced facility required machinery that could handle random timing infeeds as well as 26 different frozen pizza SKUs that were either boxed or simply shrink wrapped in plastic. "This application presented a challenge as we had to eliminate change-out flights for different sized products. Switching from 10-inch to 15-inch pizzas required time-consuming mechanical adjustments," Mike Grinager, Vice President of Technology for Brenton, explained. "We also had to deliver a high throughput of 15 cases per minute without product damage. This is complicated by the fact that pizzas are stacked as many as 15 high in variable orientations while they speed down the packaging line."

Intelligent transport technology handles product variance

Brenton eventually decided that these demands necessitated a mechatronic linear transport system for the company's popular M2000 intermittent motion, side load case packer machine. "This decision led Brenton to the eXtended Transport System (XTS) from Beckhoff, which we found could adapt to these product changes on the fly," Grinager said. "Using XTS, we developed a pitch-less M2000 machine that expertly handles a completely random infeed timing of all pizza shapes, orientations and product variants, including display-ready and bulk packaging."

The upgraded M2000 machine now features 5.5 meters of XTS track with 12 movers to control the product infeed. A true mechatronic solution, XTS offers linear motor characteristics combined with constantly cycling movers on a path available in open or closed versions and the most diverse geometries. As one of many remarkable features, the movers are able to create clamping forces in motion: Two synchronized movers working in tandem grip the pizza stacks

© Brenton

XTS greatly reduces jams and downtime as it moves perfectly stacked pizzas into cartons, according to the packaging specialists at Brenton.

contained in buckets with a predefined force and stabilize them for fast and secure transport to case packaging steps. "That's the beauty of this machine – it takes a stack of 15 shrink-wrapped circular pizzas and can quickly adapt to an infeed of pizzas already in square packaging – all with minimal changeover time," Mike Grinager said. XTS also effortlessly compensates for different infeed timing in the feed because the movers can take up any distance and buffer product in front of the load station to give other production processes extra time if needed. "XTS greatly reduces jams and downtime as it moves perfectly stacked pizzas into cartons," Mike Grinager said. "None of this was possible with other systems we evaluated." Brenton's first XTS application had to handle a heavy payload for this application type considering the weight of the tall stacks of pizzas. Therefore, Brenton integrated a GFX guidance system from HepcoMotion specially adapted to the XTS, which can accommodate higher payloads.

The XTS controller is a Beckhoff C6930 control cabinet Industrial PC. The machine controller connects to a CP2915 15-inch Control Panel display with multi-touch capability. Despite the highly dynamic motion control involved, the XTS only utilizes about 15% of the IPC's computing power, leaving ample reserves for other automation functionality.

Later iterations of the Brenton M2000 also include high-speed EtherCAT I/O systems with a variety of EL series terminals, including 8-channel high-density (HD) variants. "Interoperability between the EtherCAT I/O system from Beckhoff and other fieldbuses is very helpful because it simplifies integration," Mike Grinager said. "Establishing connectivity with EtherNet/IP devices was also easy for the Brenton Engineering team," added Patrick Triemert, Application Engineer at Beckhoff USA. "However, with its extremely high-speed and synchronization, EtherCAT is the perfect bus for mechatronic applications like XTS."
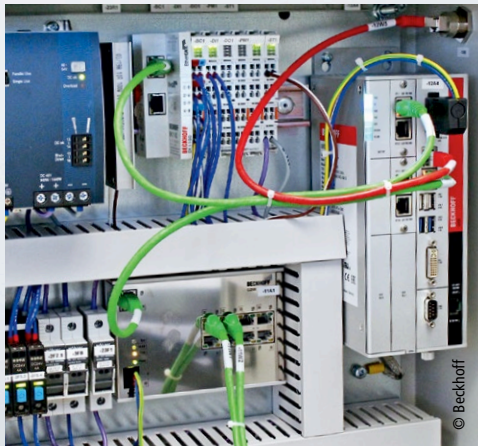
Substantially increased machine throughput

Brenton has experienced impressive throughput from the XTS-equipped M2000 machine. The M2000 is now able to carton as many as 41 different SKUs and
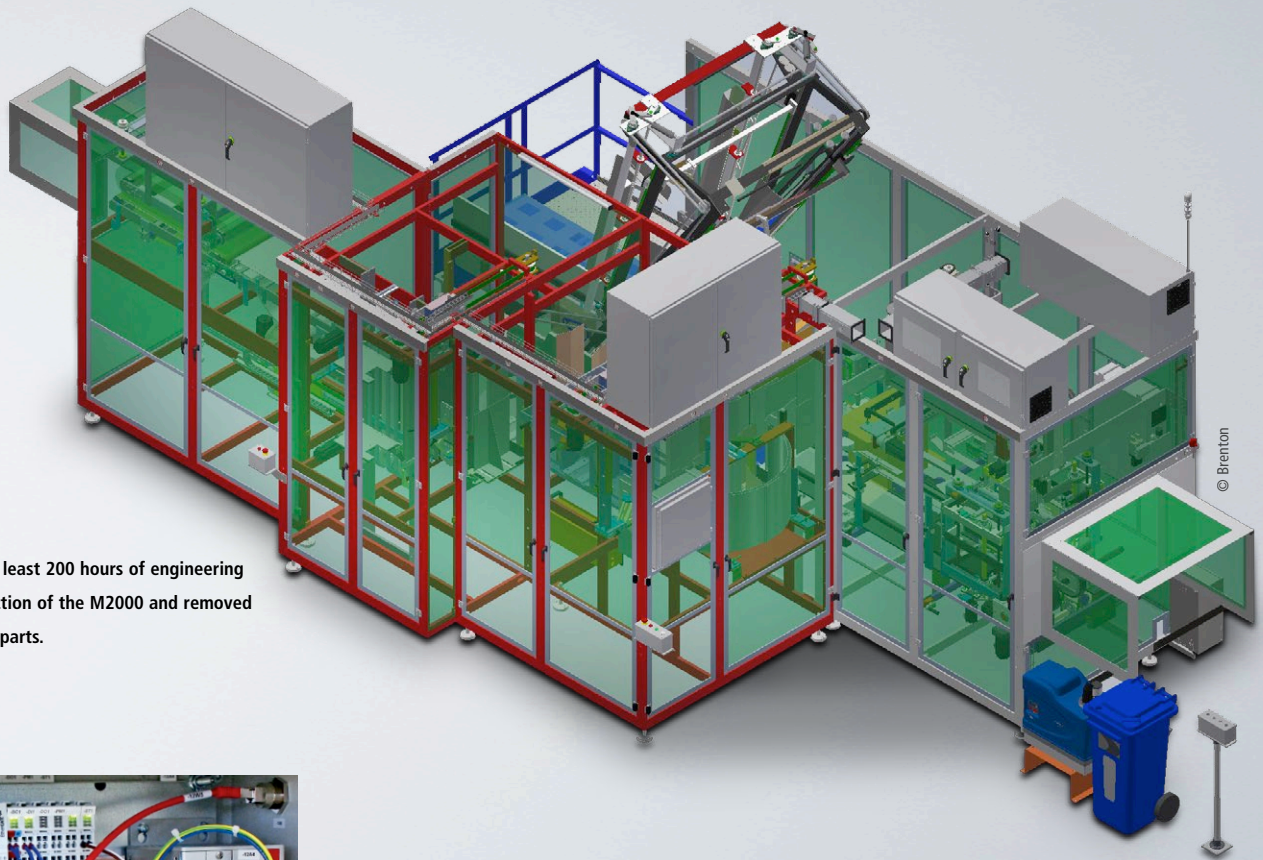
OEM Brenton saved at least 200 hours of engineering time for the infeed section of the M2000 and removed about 100 mechanical parts.

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A powerful C6930 control cabinet Industrial PC is used to control the XTS and other machine functions in conjunction with the ultra-fast EtherCAT communication system and the corresponding EtherCAT I/O Terminals.

up to 27 cases per minute, which equals 140 frozen pizzas per minute. The machine can also implement up to 26 different pack patterns, including more complex, display ready and commercial patterns at a throughput of 12.5 cases a minute. "One XTS-equipped M2000 machine can actually do the work of three conventional case packing machines," Mike Grinager said.

After eliminating many of the change-out steps, Brenton reduced the typical downtime required for remaining infeed changeovers from around 30 minutes down to just five minutes with XTS. Brenton saved at least 200 hours of engineering time for the infeed section of the M2000 and dramatically reduced complexity by being able to remove about 100 parts from the infeed, such as chains, flights, pushers and rotation mechanisms.

Since then, Brenton has already received a third order from the contract packaging company and there are quotes from other customers for additional machines with XTS. In addition to supporting well-established packaging

markets for Brenton, XTS is opening up many new project types for the OEM, particularly in pharmaceutical applications where they see even more potential to expand market share. "XTS supports many new machine designs for projects that we might have passed on previously," Grinager said. "We now have in our reach new concepts that are faster, more flexible and can reduce machine footprint by as much as 50%. Following our initial XTS successes, Brenton is also researching XTS Hygienic for washdown applications in food manufacturing and the XPlanar flying motion system for the most challenging material handling requirements in the industry."

More information:
www.brentonengineering.com
www.promachbuilt.com
www.beckhoff.com/xts

PC-based control and integrated servo drives in modern digital presses

Highly flexible digital printing leverages precise synchronization and distributed servo drive technology

Shorter product life cycles and increasing customization are changing many areas of life, and the packaging market is no exception. Accordingly, manufacturers must adapt the shape as well as the look of their products to their customers' requirements even as quantities decline to levels as low as one unit. Israel-based printing special-ist HP Indigo accommodates these changes with its new V12 digital printing press, in which roughly 100 axes are synchronized and controlled with PC-based control technology, EtherCAT and compact, integrated AMI812x servo drives from Beckhoff.

The fast-growing trend toward individualized products is spurring increased use of digital printing technology in the labels and packaging industry. Since HP Indigo recognized this trend years ago, it has become one of the pioneers and market leaders in the digital printing press field. A prime example is the new V12 printing press. It employs the company's new LEPx technology, which is based on the well-known LEP technology but uses a circulating blanket instead of a conventional impression cylinder. Using the ink developed by HP Indigo, which contains electrically conductive particles, the machine can print almost any color combination (up to 97% of the Pantone palette).

PC- and EtherCAT-based precision
At the core of the PC-based control platform, the V12 press uses a CX2062 Embedded PC. In combination with numerous other Beckhoff components and the powerful EtherCAT communication system, the machine is able to achieve printing speeds of up to 120 m/min with up to six colors. At half the speed, up to 12 colors are possible. The many-core CX2062 coordinates a wide range of tasks. Running TwinCAT automation software, its eight processor cores handle simultaneous closed-loop control of roughly 100 axes while using OPC UA to seamlessly integrate the machine into the plant environment.

As a global communication standard, EtherCAT reliably connects all of the machine's automation components and delivers maximum performance with minimal cycle times. The precise synchronization of all components with the distributed-clocks function of EtherCAT enables HP Indigo to deliver the best printing results possible. All servo axes operate with a time accuracy of 100 ns and a real cycle time of up to 250 µs. Besides the axes – for example, to guide the paper web – many other EtherCAT devices such as the optical inspection systems use the same system time to synchronize their operations.

Distributed drive technology
The new LEPx printing technology is supported by maximum machine modu-larity. Whether the user wants to print with four, six or even 12 colors – every-thing can be accomplished with a single printing press. Here, the compact, integrated AMI812x servo drives from Beckhoff were ideal to implement a decentralized drive concept. As a result, HP Indigo benefits from the technol-ogy's significantly reduced wiring effort and its standardized cabling concept, which delivers immense improvements compared to conventional drive sys-tems. In addition, the integrated cogging torque compensation delivers the best possible printing images.

The AMI812x series, including TwinSAFE STO/SS1 safety functions and an additional I/O interface, allows for highly dynamic positioning in a compact design. Since the integrated servo drives combine power and control electron-ics as well as the motor in a single space-saving housing, they require only one power supply line and an EtherCAT connection to the PLC. The compact drives with an output of up to 400 watts and an integrated EtherCAT interface (in/out) can even be daisy-chained, which eliminates the need for additional infrastructure components.

Versatile EtherCAT I/Os
Using many EtherCAT I/Os, the new V12 machine generation processes more than 50 signal types from roughly 1,000 data points. HP Indigo employs IP20 terminals as well as EtherCAT I/O box modules with IP67 rating that can be mounted directly on the machine base. For example, several EP3356-0022 box modules for load cell analysis measure the web tension of the print medium via strain gauges.
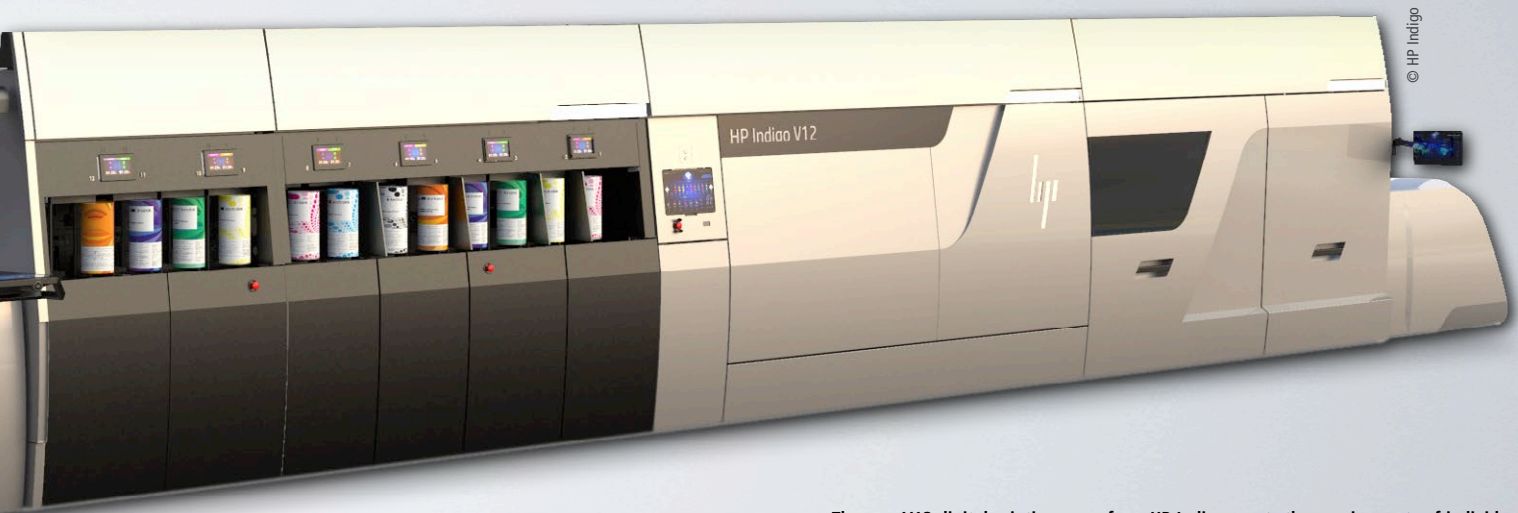
© HP Indigo

The new V12 digital printing press from HP Indigo meets the requirements of individualized product manufacturing with the help of PC-based control technology.

The machine also uses EJ-series EtherCAT plug-in modules, which are mounted directly on the custom-tailored signal distribution board. Their electrical connections are not routed the traditional way via point-to-point wiring to the control cabinet but via the kind of circuitry that is common with printed circuit boards. Compared to conventional control cabinet building, this minimizes potential errors. In addition, the signal distribution board can easily accommodate other components such as circuit breakers, connectors and with appropriate plug-in modules even TwinSAFE functions. This allows HP Indigo to combine application-specific components with standard Beckhoff components, resulting in more standardization.

Efficient automation software
With TwinCAT, HP Indigo relies on a tried-and-tested central runtime and programming environment. With its seamless integration into Visual Studio® and in combination with modern source-code management systems, TwinCAT allows even large teams of developers to collaborate on a single project, which minimizes the overall development time.

The version management integrated in TwinCAT supports the concept of a consistent PLC code basis for different machine series because it makes it easy to generate different configuration versions – also referred to as machine variants. Based on a basic configuration, components can be parameterized or fully activated/deactivated for individual variants. This applies to I/O components such as individual input terminals as well as to complete servo axes and PLC contents. Based on the variant selected, certain portions of the code generation can be included or excluded. If this feature is also used in the declaration section within the engineering environment, it results in a much clearer mapping of the input or output data linkages.

Outstanding system openness
HP Indigo decided to make its supplier strategy as flexible as possible, which is optimally supported by EtherCAT as a global standard that is supported by many vendors. In addition, third-party components can be seamlessly integrated into TwinCAT with EtherCAT. Nevertheless, the company decided to employ mostly Beckhoff components, as confirmed by Alon Gazit, Head of R&D, and Haim Tziosho, Control and Software Section Manager: "We see in TwinCAT and the complete Beckhoff product portfolio a great opportunity for HP Indigo to move the automation technology to a uniform standard and to reduce future development times and costs considerably."

Golan Landsberg, Manager R&D Future Platform, sees the close and open cooperation between HP Indigo and Beckhoff as a cornerstone for success: "The reliable and competent advice on site in Israel plus the global coordination by Beckhoff Germany ensure an optimal exchange of knowledge and information across all international borders. In addition, Beckhoff's global sales and support infrastructure offers customers the security of finding a contact person anywhere in the world."

More information:
www.hp.com
www.beckhoff.com/print

TwinCAT Vision and TwinCAT IoT optimize multilayer label production

Faster and more flexible digital printing with reduced press proof waste

In just a few years, Danish machine builder Refine Finishing has created a secure position among the world's leading suppliers of machines that convert digitally printed labels. Equipped with PC-based control from Beckhoff, in particular TwinCAT Vision and TwinCAT IoT, the machines raise the benchmark for speed, precision and sustainability to a new level. Now even the smallest batches of multilayer labels can be produced on demand.

All mechanical and job-related settings are configured via the CP2916 Control Panel or imported directly from the MES/ERP via order management.

© Beckhoff

Established in 2013 as Werosys, Refine Finishing now has a majority shareholder in the form of Nilpeter, a highly competent player in the field of digital printing. Over 95% of the machines are exported, in particular to customers in the pharmaceutical, chemical and food industries. Refine founder and CTO Bjarke Gerdes-Nielsen states: "We have equipped our new machines with the best options available in terms of automation and software and are proving that Industrie 4.0 can now be achieved in the printing industry – and offers great benefits." In terms of applying this to label finishing, the focus is on reducing previously high printing and finishing costs, as well as the enormous amount of paper required for press proofing (test print run for quality control when setting up a job).

In general, the printing industry is currently undergoing extensive transformation. Small and short-run orders need to be profitable, made to a high quality and produced on schedule despite short order times – as print-on-demand jobs. This requires customized production that can be adapted to process orders placed at short notice. Rapidly adapting to these requirements is only possible using more and more software in the machines and the greatest possible degree

of automation. A positive side effect is that less storage capacity is required and extensive planning that can often take months is no longer necessary.

Machine benefits from high software functionality

Designed for a Dutch customer, Refine's first finishing machine with built-in vision technology is a compact machine made of stainless steel. The distinguished design is simple and elegant with no handles, levers or buttons in sight. The sleek appearance is possible because the settings for the various label rollers are conveniently configured via a CP2916 multi-touch Control Panel from Beckhoff or via web browser and tablet. And justifiably so: The machine is designed to perform all finishing processes for digitally printed multilayer labels – as quickly, precisely and with as little press proof waste as possible.

According to Refine, the fully automatic machine optimizes the workflow for customers with the latest technology, highest speed and precision. Where customers once had to order a series of for example 1 million labels for six months, they can now divide the series into several, smaller portions, and just plan a few weeks ahead. The delivery time for these types of orders can often be reduced

to 24 hours. Fast changeovers, fast start-up and small order sizes shorten the warehousing period and create great flexibility and less waste. Gerdes-Nielsen says: "We can get our machines up and running in just a few hours rather than several days. In addition, the machine typically reduces paper waste by a factor of 100 – from approx. 100 m to around 1 m – during proofing, i.e., when setting up a job. In small production series, it is crucial that the waste percentage remains low. The machine must be competitive on all parameters and help make label production considerably easier, faster and more resource-saving."

Since the usual manual settings via levers and handles are configured automatically by the control system, user errors are eliminated and a more uniform process is created. "Operating the machine no longer depends on the individual skills of the operator. You cannot force anything that the machine has not been programmed to do, and you cannot overload the machine. Because everything is digitized, we can monitor and help with the control via remote access, online and in real-time. It has created great value – especially in the COVID-19 era," highlights Bjarke Gerdes-Nielsen.

**TwinCAT Vision and IoT provide core functionality**
The challenge with multilayer labels is positioning the individual sheets exactly on top of each other. Print marks on the paper rolls indicate how the layers should be positioned. The controller uses a GigE vision camera that has been seamlessly integrated into the control system via TwinCAT Vision to correct and verify that all layers are placed correctly from the start. All job management takes place via PC-based control in a software environment, which facilitates programming, linking data in Microsoft Azure™ via TwinCAT IoT and remotely accessing the machines. Object-oriented programming has also reduced the need for manual programming. "We can tailor our machines completely to the needs of our customers," says Gerdes-Nielsen, "and that flexibility is crucial to our success."

Refine, formerly Werosys, has been collaborating with Beckhoff since it was founded, as Gerdes-Nielsen confirms: "I started Refine Finishing because I wanted to develop machines based on intelligent software and the IoT. The Beckhoff automation philosophy goes hand in hand with our own, and we received the best support we could ask for in every respect. PC-based control with XFC technology is incredibly accurate compared to other control systems. For example, the tolerance threshold for positioning the multilayer labels is very low, i.e., the maximum tolerance deviation is 1/10 mm. The Beckhoff system can achieve this and also meet the high speed requirements. Our machine can process 200 m of paper per minute, while conventional machines can handle 50 m/min with similar applications."

The wide and universally integrable range of components available for PC-based control offers additional advantages. In the finishing machine, the C6017 ultra-compact Industrial PC acts as a powerful control computer that communicates with the I/O level, which is made up of EtherCAT Terminals, and the drive technology – EL7031-0030 stepper motor terminals and AX5000 and AX8000 Servo Drives with AM8000 servomotors – with high real-time capability. Machine safety is also integrated directly into the standard control technology with TwinSAFE. Gerdes-Nielsen summarizes: "With an innovative single-source supplier like Beckhoff, we are equipped for the future. We can quickly integrate various new products and protocols into our modular machines. That flexibility is a huge advantage."

Harnessing the power of Beckhoff automation technology, Refine raises the benchmark for label finishing machines to a new level in terms of efficiency and flexibility.
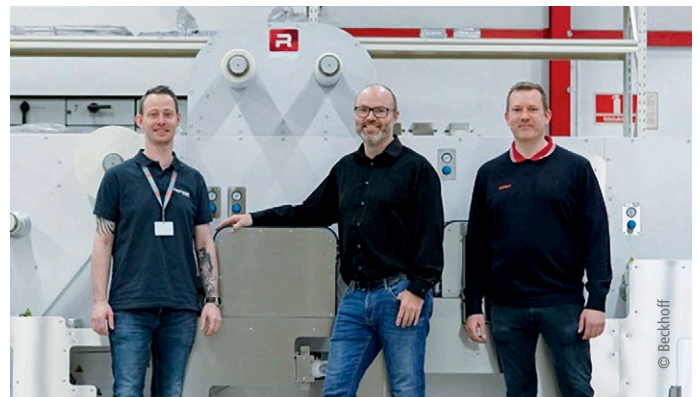
Erik Behrend, Machine Engineer, and Bjarke Gerdes Nielsen, founder and CTO, both from Refine Finishing, and Rasmus Jensen, Support Engineer from Beckhoff Denmark (from left to right), are pleased with the long-term and successful collaboration.
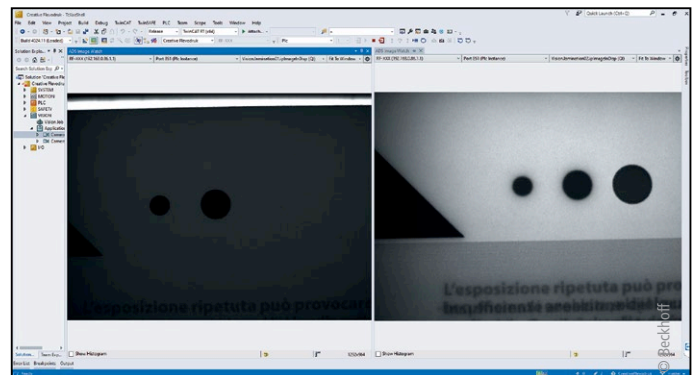
TwinCAT Vision combined with a GigE vision camera ensures there is a significant reduction in press proof waste when setting up and starting new jobs on Refine machines.
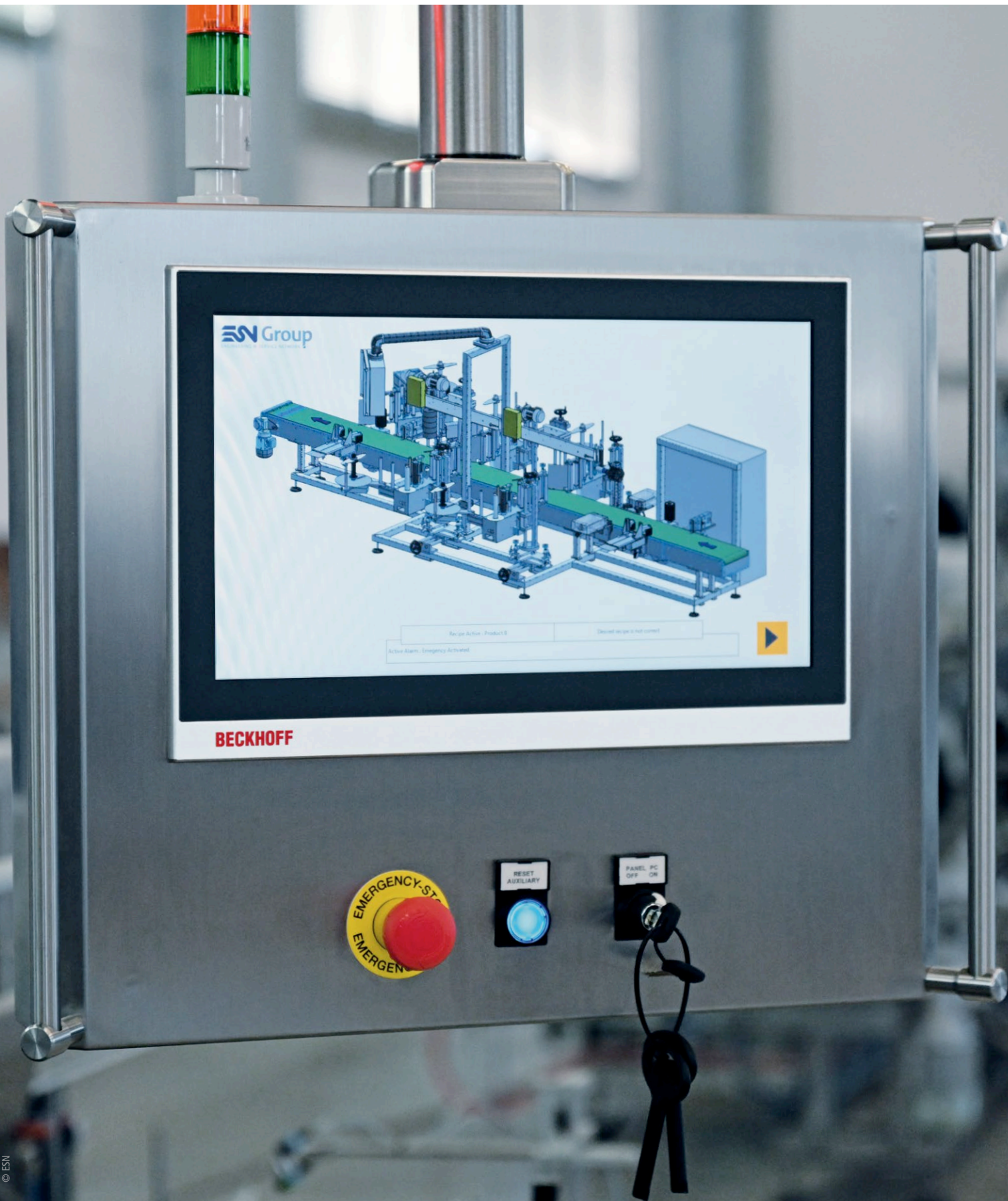
More information:
www.refinefinishing.com
www.beckhoff.com/twincat-vision
www.beckhoff.com/twincat-iot

© ESN

**Each machine module uses a Beckhoff Panel
PC, such as this CP27xx, as a controller.**

PC-based control as a complete solution for packaging line automation

Modular and open control technology increases efficiency and flexibility in machine development

The Italian ESN Group specializes in integrated solutions for the automation of packaging lines, which involves labeling, packaging, palletizing and handling products within a production plant. The company relies on control and drive technology from Beckhoff at every stage, confident that it is the ideal choice for meeting the requirements of modern modular machine building on account of its openness, flexibility and high-quality standards. It also values the close cooperation that has been established with Beckhoff since the very first project.

© ESN/Marco Mussi

Based on a modular machine design, the ESN Group manufactures custom, end-of-line packaging solutions for a wide range of industries.

The history of the ESN Group is that of a classic startup: Founded only four years ago in Treviglio in northern Italy, ESN (Engineering Service Network) comprises a number of specialized partner companies along with all of their combined expertise and experience. The result is turnkey, customized end-of-line solutions for packaging processes that notably include machine modules for labeling, primary and secondary packaging, palletizing and handling in sectors including the food, chemical, pharmaceutical, pet food and mineral oil industries.

© ESN/Marco Mussi

Partner companies bring their respective expertise to the ESN Group and apply it using Beckhoff technologies and components to create customized, end-of-line solutions that fit seamlessly into modern OT/IT environments.
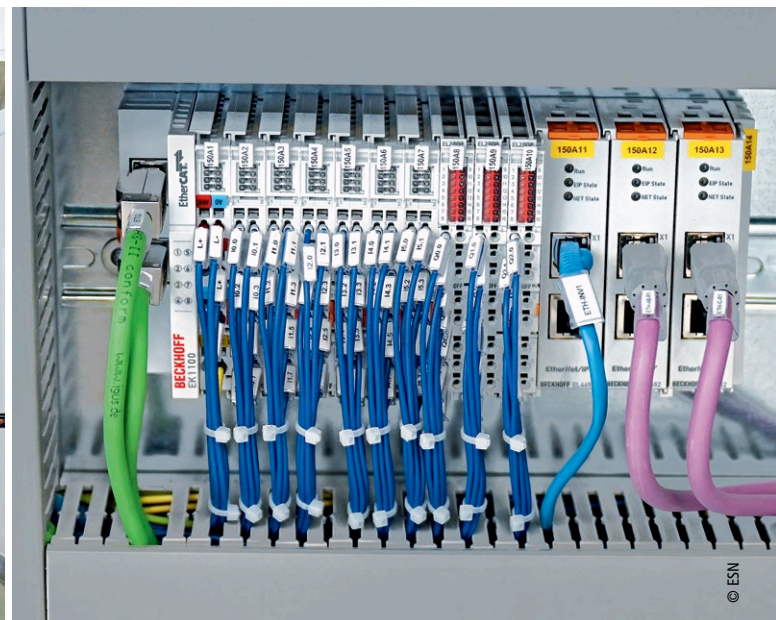

© ESN

The wide range of EtherCAT I/O components, including the EK1100 EtherCAT Coupler, HD EtherCAT Terminals, and EL6652 EtherNet/IP master terminals seen here, permits the seamless integration of all required signals – even in heterogeneous systems.

Focus on medium and low machine cycles

"Our aim is to serve customers primarily in the medium- and low-speed machine segment," explains engineer Glauco Cima, co-founder and CEO of ESN. "This market segment offers real scope for innovation and performance improvements with the help of modern automation technology."

The ESN philosophy is expressed in a particular interpretation of the term 'end-of-line': The packaging process is not seen as several machine modules strung together, but rather as a modular and integrated system that is capable of communicating detailed information about its operation through a combination of classic automation systems and modern combined OT/IT architectures. "Many companies simply combine several individual machines," explains Glauco Cima, outlining the basic problem. "However, this approach results in valuable information that is crucial to the management and performance of a line being lost to shift and production management."

The ESN concept of an end-of-line plant includes all of the aspects that are necessary for the final packaging process:
– labeling and appropriate controls
– product quality controls
– handling
– palletizing
– secondary packaging
– pallet control
– pallet coding and traceability

"The integrated management of each of these process flows in our concept is so important, as it provides end customers with all of the information they need in real time, incorporated into the rest of the production environment," explains Glauco Cima, highlighting the modular approach. "A variable concept like this requires automation technology that is equally modular, open and flexible. And with that in mind, PC-based control from Beckhoff has proven to be the best solution when it comes to putting this all into practice."

Technology supplier and automation partner

"We are familiar with systems from other suppliers, but we were looking for a solution that is reliable, simple and open," notes Glauco Cima. This ruled out traditional PLCs from the outset. But there was also another aspect to consider: "As a startup, we were looking for a very dynamic kind of support, especially in the beginning," the ESN managing director says, "and Beckhoff really was – and is – one of the most dynamic companies out there. This is true not only in terms of innovation and market approach, but also in terms of support for companies dealing with special projects and requirements, like ESN."

According to Glauco Cima, from a technical point of view, Beckhoff automation solutions represent the best on the market for ESN in terms of quality, modularity, compactness and openness. They are also the perfect fit for the machine builder's automation philosophy and the motion requirements that are typical in the packaging industry. "I should also point out that our cooperation with Beckhoff has been incredibly close from the start, and this level of trust is so important to us," enthuses the ESN managing director. "We only ever use Beckhoff automation technology for our projects, from drives to decentralized I/O and from TwinCAT automation software to operator interface panels."

A modular system for modular machines

In ESN's typical end-of-line concept, each module uses a Panel PC as a controller – a CP27xx multi-touch built-in unit or a CP67xx single-touch 'economy' version. Glauco Cima explains: "We decided to combine all of our components into a modular system, which means the end of the packaging line resembles a network of compact Panel PCs that communicate closely with each other for

maximum performance, traceability and quality control. Without this modular approach, it would have been difficult to achieve this goal cost-effectively and without a considerable amount of effort."

The entire ESN automation concept is based on TwinCAT software, which also supports quality control applications such as vision systems. The openness of TwinCAT means it is also possible to integrate external projects developed in C++ or Python, for example. Depending on the specification, the control architecture can process an almost unlimited number of I/O data points connected via EtherCAT Terminals or box modules. Third-party controllers can also be seamlessly integrated via EK1100 EtherCAT Couplers if required. This system openness enables line expansions without the need for automation equipment changes, which is a vital consideration for ESN projects. The compact drive technology from Beckhoff also continues to be used in the form of EL72xx Servomotor Terminals and AM81xx Servomotors, as well as AX5000 Servo Drives with AM8000 Servomotors. This is where One Cable Technology (OCT) comes into play to minimize both cabling and installation effort.

The high performance of EtherCAT and PC-based control offers a number of further advantages – for example, ESN was able to develop an innovative quick-change system for grippers, which reduces production line downtime by allowing I/O signals to be interrupted briefly during operation.

Commissioning machines in record time

The extensive features of Beckhoff technology also shorten the development and implementation time of the projects, as Glauco Cima explains: "This is a very important aspect for being able to deliver custom solutions based on a standardized architecture." This philosophy has been applied to mechanical and electrical plant components alike. As such, the quest for modularity at ESN starts with the design process; it is only at the end that the line is specialized, almost tailored to the process. PC-based control from Beckhoff also makes a crucial contribution to the implementation of this engineering philosophy, as Glauco Cima confirms: "This style of automation fits perfectly with our own concept and offers a suitably modular platform for following precisely this approach in the development of all projects."

Intelligent modularity becomes mandatory

For Glauco Cima, there is simply no alternative to this concept: "The packaging industry is changing rapidly – just like all sectors that rely on advanced technology." He is convinced that the mechanical elements of a machine will become less important in the coming years. Constraints and 'architectural barriers' within companies will increasingly fade away and production will have to be flexibly programmable. The consequence of this is that modularity will become a fundamental feature of a machine. "And in all applications where mechanics hinder an approach like this, electronics and reprogramming will eliminate – or at least circumvent – this shortcoming. The technologies provided by Beckhoff are perfect for this, but they are often still underutilized compared to their full potential," says Glauco Cima.

With all of this in mind, the future development of the ESN Group is closely linked to Beckhoff's dynamic approach to innovation. "From the very beginning, our choice was guided by the continuous innovations driven forward by Beckhoff, but fast forward to today and we still have no doubt that Beckhoff is our ideal partner and will certainly remain so for years to come," asserts Glauco Cima, confirming the Group's commitment to this strategic partnership.

© ESN/Marco Mussi

Glauco Cima, CEO of the ESN Group: "From a technical point of view, Beckhoff automation solutions represent the best on the market for us in terms of quality, modularity, compactness and openness to all common market standards."

More information:
www.esngroup.eu/en
www.beckhoff.com/packaging

PC and EtherCAT-based motion control for intraoperative X-ray imaging

# Compact drive technology makes high-tech CT unit mobile

Austrian medical technology company medPhoton presented its imaging solution for radiation therapy for the first time back in 2014. This Imaging Ring is now also available in a mobile version, which makes it possible to view the inside of the body on surgical wards before, after and even during an operation. PC- and EtherCAT-based control and drive technology from Beckhoff is used to achieve the desired viewing angles and millimeter-precise alignment of the X-ray source to the patient.

The compact drive technology from Beckhoff in the Imaging Ring m/Loop-X mobile imaging robot made it possible to save three control cabinets per device by installing the entire automation technology in the arms, legs and support of the imaging ring.
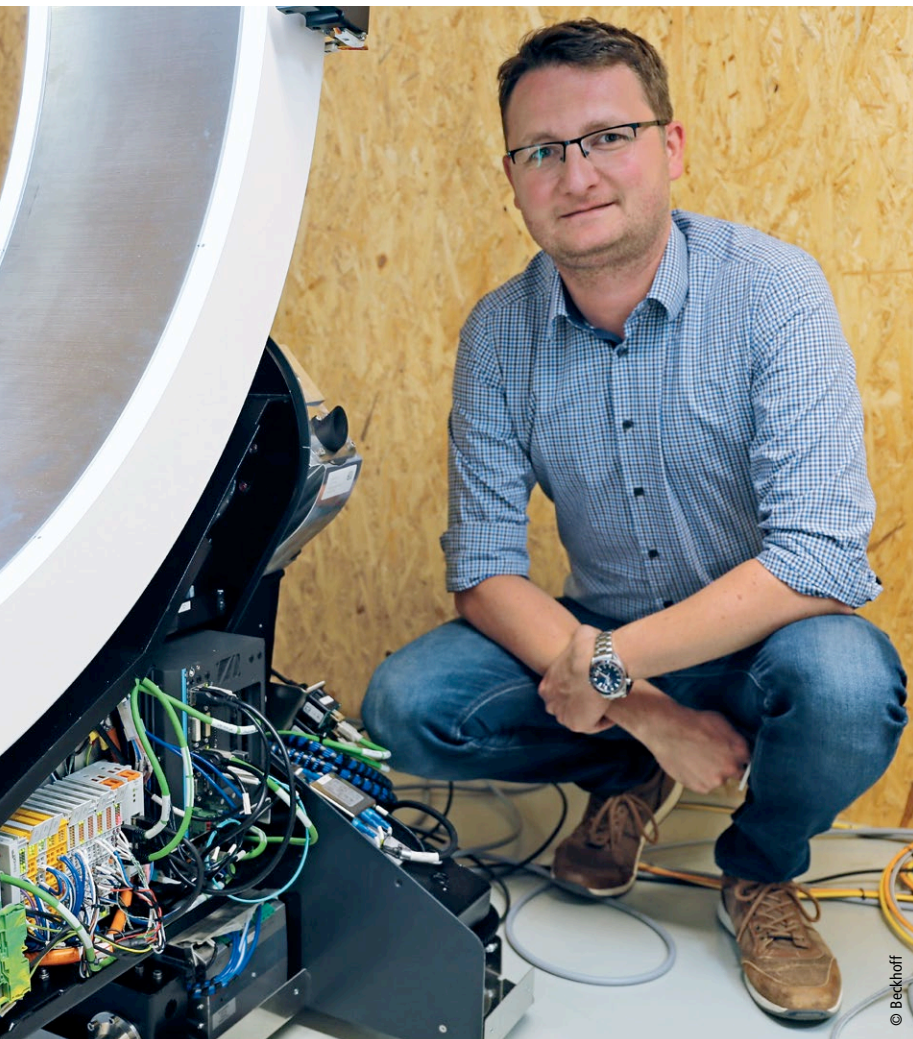
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Left: Andreas Schippani (pictured here next to some of the compactly installed EtherCAT Terminals), executive director finance at medPhoton, very much appreciates the fact that Beckhoff not only provides telephone support, but also competent on-site support when needed.

The company medPhoton GmbH was founded by Heinz Deutschmann in 2012 as a spin-off of Paracelsus Medical Private University and the Salzburg State Clinics (SALK). Together with what was initially a small team of medical technicians and software developers, the distinguished physicist pursued the vision of creating a 'Swiss army knife of diagnostic imaging' and launching it on the market when he became self-employed. Fast-forward to today and around 35 universally applicable devices like these are now being built every year. "Our imaging ring is a high-resolution computer tomograph that not only provides two- or three-dimensional images, but also enables fluoroscopy with pulsed X-rays. This type of functionality is ideal for tasks such as capturing and digitizing intraoperative anatomical changes," explains Michael Hubauer-Brenner, executive director operations at medPhoton, describing a solution that can be integrated into a wide variety of treatment processes.

In oncology, the invention from Salzburg plays to its strengths when it comes to visualizing tumors and offering targeted irradiation, while its surgical applications include facilitating 3D guidance for the operating physicians. "Our company background stems from the field of radiation therapy, where our devices are usually mounted on the ceiling or on the treatment table. These environments offer enough space for two to three control cabinets, but the situation is com-

pletely different in computer-assisted image-guided surgery," notes Andreas Schippani, executive director finance at medPhoton, in reference to the usually very cramped conditions in operating rooms. With this in mind, efforts were made to accommodate the entire automation technology in the arms, legs and supports of the latest CT generation Imaging Rings. This design was facilitated by the compactness of the Beckhoff components used and a decentralized system architecture complete with distributed control and drive intelligence.

Flexibility in movement and imaging

The Imaging Ring m/Loop-X mobile imaging robot was developed in close cooperation with Brainlab – a world-leading specialist in software-based medical technology. It measures just 182 x 87 x 189 cm and offers an exceptional range of movement. "It stands on two legs, each of which have two wheels that can rotate independently in different directions. This is what allows it to move forward, backward and twisted, and perform rotations around its own center of gravity or any other point in the room, and even switch from one operating room to another in battery mode – all completely autonomously. All the operator has to do is enter the corresponding navigation commands on the control tablet," explains Armin Schlattau, head of automation development at medPhoton.
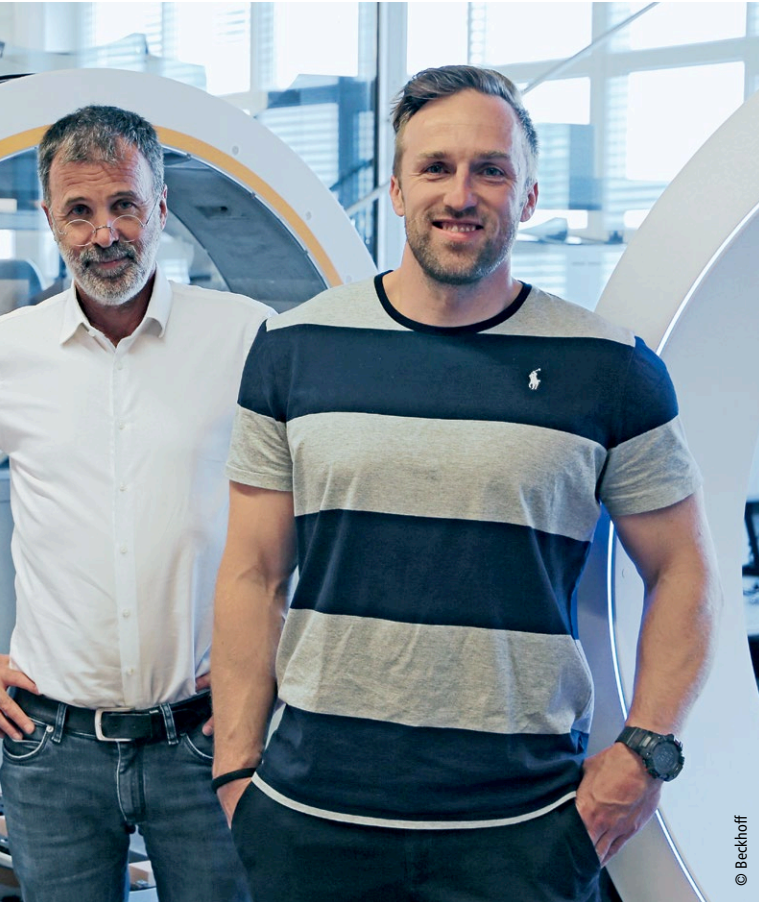
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Above: Balázs Bezeczky, head of the Beckhoff sales office in Vienna; medPhoton founder Heinz Deutschmann; and Michael Hubauer-Brenner, executive director operations at medPhoton (from left to right).

It is also important to note that the robot offers maximum flexibility not only in terms of mobility, but also when it comes to imaging. The radial arrangement of radiation source and detector combined with simultaneous but independent motion offers a host of advantages, which include the ability to achieve a particularly large three-dimensional field of view and the possibility of non-isocentric imaging. "This means that patients do not have to be in the center of the gantry opening during the X-ray, as the system positions the scan region fully automatically in the relevant area," describes Andreas Schippani. His colleague Armin Schlattau adds, "Although we have a small detector area, we can dynamically generate panoramic images with views from different angles by continuously moving the individual axes at different speeds." The interaction between the total of 26 axes is orchestrated by a C6015 ultra-compact Industrial PC with an Intel® Atom™ quad-core CPU. Its dimensions of just 82 x 82 x 40 mm mean it requires minimal installation space, making it a perfect fit for the design concept of the imaging robot, according to medPhoton. On the one hand, the IPC coordinates all motion control tasks and, on the other hand, it functions as a TCP/IP server that establishes the connection to the higher-level data processing computer via the TwinCAT ADS Communication library.

Path-controlled 3D X-ray imaging

Using the TwinCAT NC Camming cam function, medPhoton generates laser projections in the form of lines, crosses or rectangles on the patient as an optical positioning aid for all available imaging processes. This function establishes non-linear relationships between master and slave axes. "To calculate a volumetric 3D image from hundreds of 2D projections, we need to know exactly at which point in time and from which angle the individual images were taken. Any errors would have fatal consequences; after all, we are talking about medical interventions here," stresses Michael Hubauer-Brenner with regard to the importance of the exact, time-stamped signals. "Not only do we depend on precise positional information, but we also measure how long we X-ray from each direction with nanosecond accuracy," says Armin Schlattau, describing a process that uses equipment such as the EL1252 digital input terminal with XFC timestamp function.

Product diversity from a single source

More than 10 different terminal types from Beckhoff are installed in the imaging robot, including TwinSAFE components such as EL1904 or EL6910, as well as EL7037 stepper motor terminals, and EL7221-9014 servomotor terminals with One Cable Technology (OCT). "When we were looking for a control technology supplier for the mobile version of our Imaging Ring at the Smart Automation trade show in Linz back in May 2017, Beckhoff impressed us right away with its extensive variety of products available in a compact format," recalls Armin Schlattau. According to the automation development engineer, the main arguments in favor of the automation specialist from Verl included the stepper motor terminal with incremental encoder, the integration of a full-fledged servo drive within an EtherCAT Terminal that measures just 12 mm wide and the bundling of power supply and a digital feedback system into just a single motor connection cable for the AM8121 servomotors.

"While we certainly increased the complexity and performance of our system, we were also able to reduce the space required for the automation technology to a tenth," says Michael Hubauer-Brenner, delighted with the results of a productive collaboration that has exceeded all expectations to date. But it would seem that the finish line is still quite some way off: "There will certainly be some further developments to our Imaging Rings and we continue to hope for creative input from Beckhoff," Andreas Schippani concludes. Balázs Bezeczky, head of the Beckhoff sales office in Vienna, responds by putting forward an initial optimization idea of his own: "With our new ELM72xx servomotor terminals in metal housings, it would be possible to get even more compact in terms of drive technology. What's more, the ELM72xx-9018 model makes it possible to map a comprehensive Safe Motion function package including Safe Limited Speed and Safe Limited Position options." His invitation to a test run with the two-channel ELM72x2 model has already been accepted.

More information:
www.medphoton.at
www.beckhoff.com/compact-drives

Aboard the Tellus, PC-based control ensures that the ship's diesel/electric drive system provides the required power in a reliable and energy-efficient manner on one of Sweden's busiest ferry routes.

© Danfoss Editron

Automation and drive system monitoring for Sweden's largest hybrid ferry

Compact and modular control technology simplifies project planning for ship technology

Tellus, Sweden's largest hybrid ferry, can safely transport up to 297 passengers and 80 cars per trip on the roughly 2 km long Gullmarsleden link between the towns of Uddevalla and Lysekil. The link is considered one of Sweden's busiest sea routes, accommodating over 100,000 vehicles per month. Two specialist companies have now joined forces to ensure that the ship continues to offer quick and reliable transportation: Danfoss Editron, the Finnish supplier to shipbuilders that specializes in electric drive solutions, and Beckhoff, which supplies PC-based controls for the automation and monitoring of the hybrid diesel/electric drive system.

Among its many services, Danfoss Editron supplies state-of-the-art, decentralized DC power systems up to 6 MW for small and medium-sized seagoing and inland vessels. While the ship systems supplier relies on its own technologies and expertise for the power electronics and electrical machines, it has counted on Beckhoff to supply the control components for the Editron marine system for many years.

Embedded PCs as the core of drive control

The drive and ship control system is divided into a stern and a bow system, which communicate with each other, with the control unit in the wheelhouse, and with the diesel generators and battery system in the hull. While the Danfoss power converters in the power plant and propulsion systems are connected to the Beckhoff CX9020 Embedded PCs as drive controllers via CANopen, the

According to Jussi Paakkunainen, a system technology manager at Danfoss Editron, "Both the fieldbus support and minimal space requirements of the Beckhoff hardware in the control cabinets offer considerable advantages during the project planning and programming phases."

controllers communicate with each other via the TwinCAT ADS communication protocol. This network is designed as a reliable ring structure.

A typical configuration of the Editron control system comprises two CX9020 Embedded PCs with directly connected bus terminals and additional decentralized I/O box modules with IP67 protection. "The spectrum here ranges from digital inputs and outputs to temperature measurements and the acquisition of additional analog signals," explains Jussi Paakkunainen, a system technology manager at Danfoss Editron, illustrating the required range of I/O components from Beckhoff.

Depending on the complexity of the system, it can be beneficial to record the inputs and outputs on a decentralized basis. This is the case for the Tellus project, which involves temperature monitoring of the distribution cabinet for the power supply via a decentralized I/O unit, which is integrated into the control network by a BK9050 Ethernet TCP/IP Bus Coupler. "It makes sense to use decentralized units like this for retrofit projects in particular, as there is often limited installation space available on ships for additional control cabinets," emphasizes Jussi Paakkunainen. Simplifying the signal cabling between decentralized system sections and the control units was a key aspect for him when designing the control architecture.
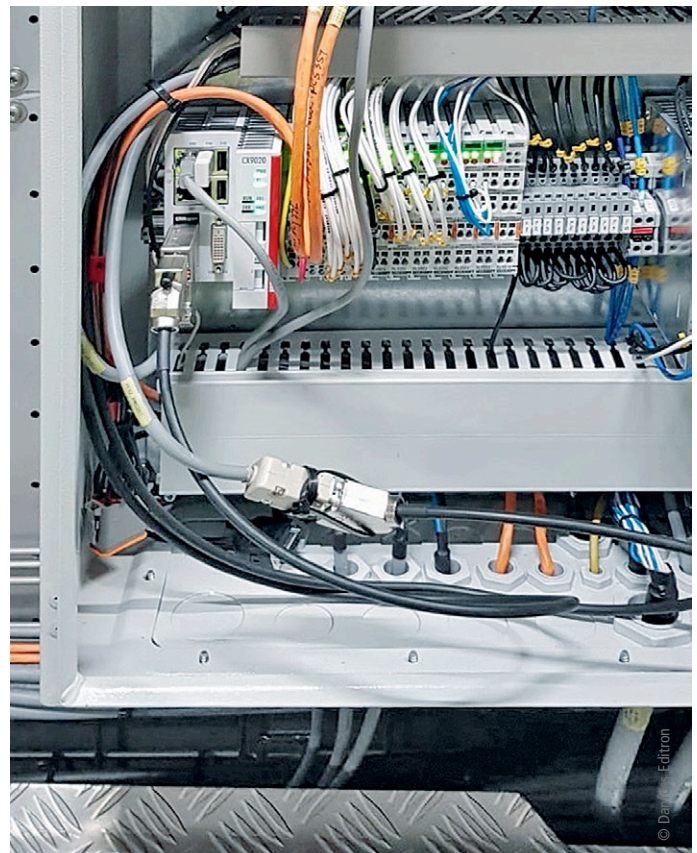
Compact and modular control technology offers advantages

Both the fieldbus support and the minimal space requirements of the Beckhoff hardware in the control cabinets offer considerable advantages during the project planning and programming phases. The CX9020 Embedded PCs also have a role to play here, as Jussi Paakkunainen explains: "Both the CANopen interface for the integrated power electronics and the TCP/IP-based communication interfaces make for a competitive advantage in terms of keeping things compact, which is usually a decisive factor anyway, but particularly on board a ship. It is not always easy to find a suitable place to install control systems within an engine room, but the compact hardware from Beckhoff meant we could overcome this obstacle in no time. On the Tellus, we simply installed the embedded PCs along with the associated hardware in a wall cabinet."

With regard to ship control, the CX9020s pick up signals from the wheelhouse and process them together with information from the diesel/electric generators, as well as the batteries, inverters, converters and motor controls. This ensures both the required propeller speed and the appropriate level of energy generation for system performance. "The algorithms for optimal control of the hybrid power plant work in conjunction with the CX9020 Embedded PCs to make for smooth, efficient and reliable ship operation," summarizes Jussi Paakkunainen.

Space is always at a premium in the on-board engine room: The compact CX9020 Embedded PC and slimline Bus Terminals also fit inside a small control cabinet.

More information:
www.danfoss.com/editron
www.beckhoff.com/shipbuilding

PC-based control technology enhances seed treatment machine

IoT concept simplifies operation and increases machine flexibility

Founded in 1986 and headquartered in Não-Me-Toque in the Brazilian state of Rio Grande do Sul, Grazmec consistently relies on new technologies for its seed treatment machines. The latest developments from the machine builder have relied on PC-based control technology from Beckhoff as an important innovation factor. In particular, it has helped to open up the Internet of Things (IoT) for use in the food industry.

Seed treatment is a preventive way to protect against damage at the most critical harvesting stage. The application of chemical pesticides (fungicides, insecticides), micronutrients (such as polymers and pigments) and the inoculant against infectious materials in the seed can be carried out in two ways:
– on-farm seed treatment, i.e. carried out in the field just before sowing
– industrial seed treatment (IST), i.e. carried out by the seed industry

According to Grazmec, the latter option is more reliable, less strenuous, and reduces environmental impact. As such, it is already the preferred choice of numerous seed companies, cooperatives and large farming operations.

Modern control technology revitalizes machine design
Grazmec has been working with Beckhoff since 2019 to launch a completely redesigned seed treatment machine. Grazmec Marketing Manager Émerson de Mattos explains, "The redesigned GV500i Connect offers improvements to both functionality and the available options, with Beckhoff technology facilitating an

entirely new machine concept in the process. Having won silver in the product design category at the Brazil Design Awards (BDA), this machine is really raising the bar when it comes to programming. Unlike conventional controllers, PC-based control from Beckhoff offers its end customers straightforward machine operation and flexible after-sales options. What's more, any operational issues can be analyzed remotely directly from the plant, which minimizes both time and manpower requirements." De Mattos sees further advantages in the simplification of software upgrades, which can be easily integrated into existing control programs for continuous equipment optimization.

Back in 2013, Grazmec started developing a tractor for sowing that was designed to treat up to 30,000 kg of soybean sprouts per hour according to the end customer's requirements. Electrical control units were already in use here, although the required dosages were still very much determined by the mechanical system design. For this reason, the throughput times and quantities for seeds and chemicals had to be recorded as part of an elaborate calibration process before the machine was

The current Grazmec system for seed treatment benefits from state-of-the-art IT and IoT technologies with PC-based control from Beckhoff.

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The operator interface created with TwinCAT HMI software (shown here on the CP2916 multi-touch Control Panel) ensures optimum operability, including via smartphone if required through the responsive design.

The machine parameters can be conveniently accessed via a CP2916 multi-touch built-in Control Panel with 15.6-inch display, optimally supported by the HTML-5-based operator interface created with TwinCAT HMI (TF2000). As a result, significantly more formulations can now be stored with a greater number of liquid and powder components, extending flexibility in terms of machine functionality and usable seed. What's more, manuals and demonstration videos are stored directly on the machine to simplify system operation, cutting down on process and maintenance times.

As part of Grazmec's IoT strategy, the cost and consumption reports generated by the production control system open up new ways of managing and analyzing data. With TwinCAT IoT Communication (TF6701), the machine data is sent to the Grazmec server via MQTT for this purpose. This can then be analyzed together with information such as daily updates on the quantities of treated seed and consumed treatment compounds, allowing more informed decisions to be made in the process. Other IoT benefits, according to Grazmec, include enhanced remote control and maintenance capabilities that also make the system more straightforward and efficient. Émerson de Mattos sums it up by saying, "The state-of-the-art control technology from Beckhoff will allow the devices to be used in entirely new applications. The TwinCAT software in particular opens up a wide range of possibilities when it comes to upgrades, continuous improvements, ease of use and excellent quality."

put into operation. Despite the smooth operation, high seed flow rate and simple operation, the system was slow and complex, which resulted in several rounds of optimizations starting in 2015. These included better sensor technology, the option of using up to four liquid chemical products for seed treatment, touchscreen operation, storage of up to 10 formulations and product reservoirs.

Greater functionality and IoT communication

The second generation of machines was successful but was increasingly reaching its limits as customer requirements became more demanding and technology levels increased. This called for a further redesign of the machine concept in 2019, not only to make the system more flexible and straightforward, but also to facilitate software upgrades. The CX5140 Embedded PC from Beckhoff (with Intel Atom® quad-core processor and 1.91 GHz) equipped with TwinCAT 3 automation software provides the necessary computing power, while the associated I/O system is formed by EL1819 and EL2809 high density (HD) digital input and output EtherCAT Terminals.

More information:

www.grazmec.com.br
www.beckhoff.com/ipc
www.beckhoff.com/twincat

PC-based control technology at the Müpa Budapest festival hall

# Festival theater modernized with advanced stage and acoustic technology

Müpa Budapest provides space for three expressive arts: music, fine art and theater. The festival hall boasts a multifunctional theater with what the operator claims to be one of the world's leading acoustic designs. Hungarian company Színpad Automatika Kft. was commissioned with modernizing and further developing the stage and acoustic technology in the festival theater in 2019 and relied on PC-based control technology from Beckhoff in the process.

Müpa uses over 250 mechanically operated stage and acoustic systems. Some of the systems have their own controllers and operating units. There are also smaller groups that share control systems. In the concert hall, approximately 150 systems can be moved from one control panel, and the main computer for the theater also controls more than 40 systems. Színpad Automatika has been looking after most of the systems since 2014. The Budapest-based specialist focuses on stage construction, maintenance and development of stage devices and new device installations. It also designs new mechanical systems together with the Müpa Main Engineering department.

Upgrade with TwinSAFE integration
In 2019, work began on modernizing and optimizing the proscenium (front stage) control system. Some parts had already been in operation for almost 15 years, which was a reason for replacement in itself and provided a great opportunity for modernization. After evaluating systems from different suppliers, Színpad Automatika opted for PC-based control from Beckhoff, as Managing Director József Bálint explains: "When it came to general control technology requirements, we needed a deterministic system with a sufficiently high capacity to carry out synchronization tasks and more flexible programming compared to PLC devices. With its PC-based control technology, Beckhoff fulfills all these criteria and also offers a wide product range, comprehensive support, high levels of flexibility in terms of programming and connectivity as well as seamless integration of safety technology with TwinSAFE."

"In the festival theater, we operate eight stage systems using one user interface. The largest stage system is used to raise or lower the orchestra pit, which can be used as a cavity, forestage or auditorium. This lift comprises three motorized parapets to separate the area from the auditorium. Two stage lifts, a loudspeaker holder and an acoustic panel holder installed overhead cover this smaller stage area in front of the auditorium's safety curtain," explains Gyula Cseh, head of stage technology at Müpa.
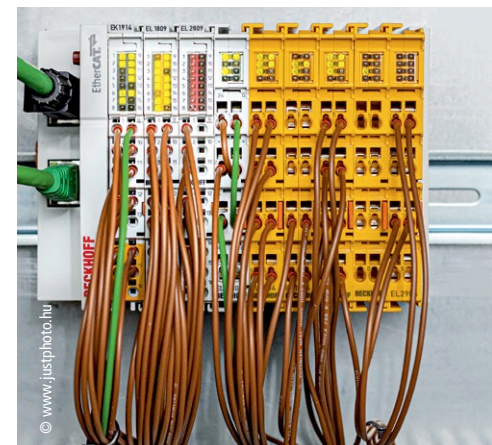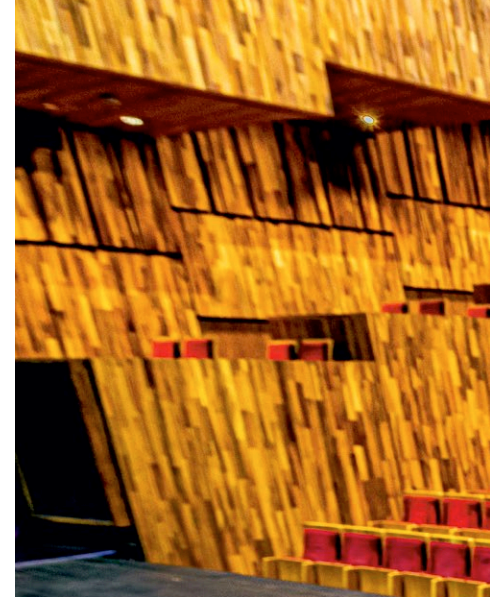
EtherCAT and TwinSAFE Terminals in the control cabinet for controlling the orchestra pit

With the previous system, only the orchestra pit itself could be controlled and positioned. This has now been extended to the four systems of the upper stage area, which could previously only be moved at one or two speeds and without an indication of the height or magnetic field control. Since the modernization, all five of these areas have been controlled via the ultra-fast EtherCAT real-time communication system. With this, it is possible to synchronize the existing island controllers and also transmit safety-relevant data between the controllers and the TwinSAFE EtherCAT Terminals. A CP6600 built-in Panel PC with touchscreen and the TwinCAT 3 PLC software runtime form the central control unit. "The biggest challenges in the project were the group operation of safety switches, pinch protection sensors and emergency stop keys, as well as the fact that the controllers are located in three different rooms. TwinSAFE from Beckhoff proved to be a good solution here. The EL1918 EtherCAT digital input terminal that provides TwinSAFE Logic is installed in the control panel, while the other TwinSAFE I/Os are located directly in the relevant control cabinets on-site," explains József Bálint.

Gyula Cseh adds: "One advantage of the new system is that we can now move and position these somewhat cumbersome stage systems at the same time and in any combination. This increases efficiency and accuracy significantly during

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Theater at Müpa Budapest with the Beckhoff CP6600
built-in Panel PC integrated into a control panel

preparatory work. What's more, we can save nominal values with specific designations in the controller and call them up to reach the required target positions quickly and precisely. In line with the development strategy, the long-term goal from the outset was for the operators to be able to save all necessary information in the automated systems themselves during technical maintenance of the individual productions and then be able to call up the relevant data from here during recurring shows. Our expectations have been met in all areas."

During the development of the new proscenium control system, the four manual stage lifts in the backstage area were also automated. The operator now selects the required direction of movement on the touchscreen of the CP6600 Panel PC and can then move the lifts in groups at the touch of a button. What's more, all relevant information, e.g., to protect against overloading and to monitor the rope tension, is shown on the display.

PC-based control promotes flexibility

With a view to further developments, József Bálint summarizes: "We have had very successful experiences with Beckhoff technology up to now and have further developed our system so that it can be scaled up to several hundred axes if necessary. Depending on the number of axes, the synchronization tasks

are carried out by a suitably powerful controller. We benefit particularly from the broad and finely scalable Beckhoff IPC range in this regard. In a typical configuration, the CP6600 (10.1") or CP6606 (7") built-in Panel PC with ARM Cortex™ A8 processor is used, both of which are ideal for controlling up to 10 axes. For a larger number of axes, the C6015 ultra-compact Industrial PC with Intel Atom® processor is the perfect choice. TwinCAT 3 is used consistently as the control software." Real-world examples of applications using the C6015 are the scalable 14-axis controller for the Szigliget theater in the city of Oradea and a scalable three-axis controller for the Csiky Gergely Hungarian state theater in Timişoara, both in Romania.

More information:
www.mupa.hu
www.szinpadautomatika.hu
www.beckhoff.com/entertainment-industry

Safety over EtherCAT

Confirmed by TÜV: Safety over EtherCAT meets extended requirements of IEC 61784-3:2021

After the fourth edition of IEC 61784-3 was published in February of this year, TÜV SÜD Rail GmbH has officially confirmed that the EtherCAT protocol for functional safety, Safety over EtherCAT (FSoE), meets all of the extended requirements of the IEC standard without any changes.

Safety over EtherCAT was already internationally standardized within IEC 61748-3-12:2010 in 2010 as FSCP 12 (Functional Safety Communication Protocol) and is still valid today in the original edition 1.0. The review by TÜV SÜD now confirms that the FSoE protocol also meets the new normative requirements of IEC 61784-3:2021 Ed. 4.0 without any changes and is therefore still suitable for use in applications up to a Safety Integrity Level (SIL) 3. Full compatibility with devices from 2010 onwards is thus still ensured.

The FSoE protocol is based on the so-called black channel approach, in which the transport medium is not included in the safety consideration and therefore does not place any requirements on the nature of the communication system itself. Safety over EtherCAT therefore not only exists on the basis of EtherCAT but is also frequently routed via other communication protocols and media, for example for machine networking via standard Ethernet or for connecting mobile machines via radio transmission.

Dr. Guido Beckmann, Safety over EtherCAT expert at the ETG

Dr. Guido Beckmann, ETG expert in the IEC working group WG12 on IEC 61784-3, said: "We actively support the work of the IEC in order to discuss and help shape new findings and requirements for secure communication. The security measures of the FSoE protocol were already cleverly chosen at the very beginning so that they also meet the new requirements of IEC 61784-3:2021. For EtherCAT device users and the many suppliers of the technology, this guarantees stable and open safety-related communication with the greatest possible investment protection."

IEC 61784-3 defines the general requirements for functionally safe communication profiles in industrial networks. The new edition IEC 61784-3:2021 has essentially been extended by two normative requirements. Firstly, a model has been introduced that estimates the residual error probability for timeliness, authenticity and data integrity in a secure logical connection. Secondly, the standard now requires the safeguarding of explicit and implicit mechanisms in a safety protocol. In this case, the implicit mechanism does not transmit all the data corresponding to safety measures but uses data that is known in both the sender and the receiver to calculate the complete CRC signature. In the case of Safety over EtherCAT, for example, this corresponds to the incrementing cycle counter.

ETG semiconductor working group held its 19th meeting

Recently, the EtherCAT Technology Group (ETG) held the 19th meeting of its Technical Working Group (TWG) Semi. This working group develops device profiles for the semiconductor industry and included the topic of its work in functional safety with Safety over EtherCAT (FSoE) during the online meeting. In addition, the integration of the EtherCAT Conformance Test Tool (CTT) into automated device acceptance was an important topic.

The TWG Semi of the EtherCAT Technology Group meets semi-annually in plenary sessions and in many sub-working groups. This has resulted in a set of specifications for using EtherCAT in semiconductor applications that has contributed significantly to the success of the communication standard in this industry. This success can also be seen in the continued willingness across the industry to participate in the TWG Semi: More than 70 participants registered again for the most recent online meeting, who dedicated themselves to working on existing and new EtherCAT device profiles in the course of numerous sessions.

In addition to the work on device profiles, selected topics are always examined in more detail at the TWG Semi meetings. One of the key topics at the most recent meeting was Safety over EtherCAT (FSoE) technology, which was presented to participants in detail by ETG safety expert Dr. Guido Beckmann. Based on this, the meeting covered relevant use cases in the area of functional safety for the semiconductor manufacturing machines referred to as "tools" as well as the associated devices to be worked out in the future. Florian Essler, who has been supporting the work of the TWG Semi from the ETG side since 2011, explains: "Today, we consistently see a deep understanding from manufacturers in the semiconductor industry with regard to EtherCAT. Bringing Safety over EtherCAT into this ecosystem will address another particularly powerful aspect of EtherCAT. This will make a big contribution as the major machine builders in the industry can make significant advancements with the integration of functional safety in their machines." Another topic was the enhanced features of the EtherCAT Conformance Test Tool (CTT), which contribute to increased test automation as well as greater test coverage – including tests for Safety over EtherCAT.

So far the TWG Semi of the EtherCAT Technology Group has developed 14 so-called Specific Device Profile (SDP) documents with more than 20 device profiles for the semiconductor industry. In addition, new projects are constantly in development, so that in the meantime there is a corresponding overview document with the SDP Design Guideline, which describes how a Specific Device Profile is written, what has to be considered in the implementation and how to handle more complex questions in the profile definition.

EtherCAT Compendium: first chapters are online

The EtherCAT Compendium provides a comprehensive and coherent description of the EtherCAT technology with its technical details, system, implementation as well as user aspects. It complements the formal specifications with easy-to-read, applicable and application-specific know-how. The compendium is in progress, first chapters are already online now. The EtherCAT Compendium is available for all ETG members and addresses general interested readers, developers and support engineers as well as test engineers, students and scientists. The work is divided into several sections. with the first chapters to be published being parts of the Technology Details section. Other sections that will follow are "EtherCAT Introduction", "System Aspects", "Implementation Aspects" and "User Aspects". The EtherCAT Compendium can be downloaded from www.ethercat.org/compendium.

EtherCAT Interoperability Testing Week continues its success in Asia

After the virtual developer meetings from the EtherCAT Technology Group (ETG) in Europe and the USA were very well received in the first half of 2021, two additional EtherCAT Interoperability Testing Week events were also held in China and Korea. During the weeklong digital events, participants were able to listen to exciting presentations by ETG experts, clarify open questions about their individual EtherCAT applications and exchange information with other participants on a wide range of development topics. In total, more than 120 people from China, Korea, Singapore and Taiwan participated in the events. Dr. Guido Beckmann, who is responsible for the EtherCAT Interoperability Testing Weeks at ETG, summarizes: "The plenary webinars as well as the individual expert sessions have shown us that the event format is a good opportunity to exchange experiences and ideas, to enter into discussions with the developers and to decisively advance the EtherCAT technology and its interoperability." The virtual EtherCAT Interoperability Testing Weeks were established during the worldwide coronavirus pandemic to provide developers who attend regular EtherCAT Plug Fests under normal conditions with a new opportunity. While they certainly cannot replace the in-person meetings, the webinars allow developers to receive high-quality support in planning and implementing their EtherCAT devices and applications.

EtherCAT.

Exhibition dates 2021*

Europe

Germany

Husum Wind
14 – 17 September 2021
Husum
www.husumwind.com

FACHPACK
28 – 30 September 2021
Nuremberg
www.fachpack.de

messtec + sensor masters
28 – 29 September 2021
Stuttgart
https://messtec-masters.de

Vision
05 – 07 October 2021
Stuttgart
www.messe-stuttgart.de/vision

MEORGA MSR-Spezialmesse
27 October 2021
Landshut
www.meorga.de

FMB
10 – 12 November 2021
Bad Salzuflen
www.fmb-messe.de

productronica
16 – 19 November 2021
Munich
www.productronica.com

SPS
23 – 25 November 2021
Nuremberg
https://sps.mesago.com

Austria

SMART Automation Austria
19 – 21 October 2021
Linz
www.smart-linz.at

Belgium

ABISS
07 October 2021
Kortrijk
www.abissummit.be

Czech Republic

MSV
08 – 12 November 2021
Brno
www.bvv.cz/en/msv

Denmark

hi Tech & Industry Scandinavia
05 – 07 October 2021
Herning
www.hi-industri.dk

WindEurope Electric City
23 – 25 November 2021
Copenhagen
www.windeurope.org/ElectricCity2021

Finland

Alihankinta
21 – 23 September 2021
Tampere
www.alihankinta.fi

Verkostomessut
06 – 07 October 2021
Tampere
www.verkostomessut.fi

Teknologia 21
09 – 11 November 2021
Helsinki
https://teknologia.messukeskus.com

Pohjanmaan Teollisuus
24 November 2021
Vaasa
www.pohjanmaanteollisuus.fi

The protection of employees, customers and visitors is our top priority; due to the COVID-19 pandemic, below listed exhibition dates are subject to change without notice.

Great Britain

PPMA Show
28–30 September 2021
Birmingham
www.ppmatotalshow.co.uk

Italy

Smart Building Expo
22–24 November 2021
Milan
www.smartbuildingexpo.it

Norway

OTD Energy
20–21 October 2021
Stavanger
www.otdenergy.com

Asia

China

SCIIF
27–29 September 2021
Shenzhen
www.sciif.com

CWP
18–20 October 2021
Beijing
www.chinawind.org.cn

CeMAT ASIA
26–29 October 2021
Shanghai
www.cemat-asia.com

CIPM
02–04 November 2021
Chengdu
www.cipm-expo.com

Industrial Automation Show
01–05 December 2021
Shanghai
www.industrial-automation-show.com

Automotive Testing Expo
13–15 December 2021
Shanghai
www.testing-expo.com/china

Japan

MECT
20–23 October 2021
Nagoya
www.mect-japan.com

Taiwan

Automation Taipei
15–18 December 2021
Taipei
www.chanchao.com.tw/AutomationTaipei

United Arab Emirates

ADIPEC
15–18 November 2021
Abu Dhabi
www.adipec.com

North America

United States

FABTECH
13–16 September 2021
Las Vegas, NV
www.fabtechexpo.com

PACK EXPO Las Vegas
27–29 September 2021
Las Vegas, NV
www.packexpolasvegas.com

INTERPHEX
19–21 October 2021
New York City, NY
www.interphex.com

The Assembly Show
26–28 October 2021
Rosemont, IL
www.assemblymag.com/the-assembly-show

More information:
www.beckhoff.com/exhibition

PCControl
The New Automation Technology Magazine

www.pc-control.net