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The New Automation Technology Magazine

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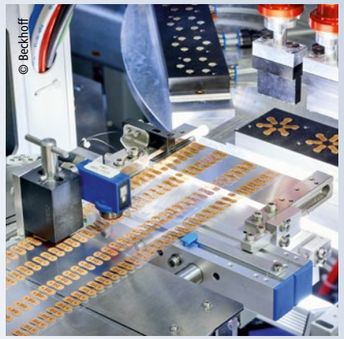

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The New Automation Technology Magazine

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Joint cooperation between the Huazhong University of Science and Technology and Beckhoff China

A successful Chinese teaching platform for the New Engineering Education concept

Modern technology, such as industrial internet, big data, and artificial intelligence, are becoming more and more enmeshed with current manufacturing methods. In order to keep pace with this revolution, which includes new business models, the right university education is essential for our future experts. To this end, the School of Mechanical Science and Engineering at the Huazhong University of Science and Technology (HUST) has developed "New Engineering Education", a national teaching concept, and set up a laboratory for this – the HUST-Beckhoff Joint Laboratory – together with Beckhoff China in 2018.

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The HUST-Beckhoff Joint Laboratory at the Huazhong University of Science and Technology was founded in 2018.

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One example is the creation of a robot remote control platform.

Since it was founded in 2018, this experimental teaching platform for undergraduate, postgraduate, and doctoral engineering students has been constantly developed and improved through ongoing discussions and support from the two partners, HUST and Beckhoff China. In addition, according to HUST, products or technology platforms based on advanced automation technology from Beckhoff are frequently used in the courses. This is especially true for control technology, industrial testing technology, mechatronic drive technology, measurement and control technology, and postgraduate engineering practice.

Experimental teaching of cyber-physical systems (CPS)

According to HUST, the new structure of the degree programs needs to match progress within the industry itself and be based on current requirements, while also considering future developments. Cultivating "New Engineering" experts is important as it enables China to respond to the current industrial transformation proactively. In this context, experimental teaching on CPS has been established at the HUST-Beckhoff Joint Laboratory.

With a focus on cyber-physical systems, teaching aims to build an open and modular experimental platform for measurement and data acquisition, motion control, and real-time data analysis. The EtherCAT Industrial Ethernet system is used to network the relevant experimental devices. Beckhoff's open automation technology, along with TwinCAT as a software platform for edge computing, are used to implement data-driven experiments for data acquisition, real-time analysis, or simulation modeling and support students in applying digital tools and theoretical knowledge, as well as in conducting basic and exploratory experiments. The lab-level edge computing platform has a variety of sensors, robots, and various software tools with numerous communication protocols and is therefore the equal to enterprise-level platforms. Thus, the joint laboratory can also be used to perform complex experiments, e.g. on flexible manufacturing automation and digital twinning.

Chen Bing, associate professor and director of the joint lab at the HUST School of Mechanical Science and Engineering, explains, "The joint lab plays an active role in improving the knowledge and skills of students, researchers, and practitioners in industrial internet and New Engineering courses. Emphasis is placed on the professional requirements for designing, developing, testing, and operating industrial internet platforms, cyber-physical systems, edge computing, industrial big data, and digital twins. In addition, we are building a hardware-in-the-loop simulation environment for industrial internet hardware platforms and a development environment for semi-physical simulations for professional fields. We hope to further pool our professional knowledge and skills in architectural design, solutions, application development, platform provision, and operation and maintenance of the industrial internet platform, and promote the application of EtherCAT technology, in particular through intensive cooperation with Beckhoff China."

Verifying mechatronic drive control interactively

HUST has developed an intelligent control and experimentation platform for mechatronic drives with the help of high-end ELM measurement terminals from Beckhoff. In addition to reviewing classic mechatronic control theory and adding sensors to the drive platform for condition monitoring, these teaching platforms can also perform vibration frequency monitoring and analysis for the drive platform, along with high-speed full-frequency vibration and noise measurement. Monitoring and analysis of vibrations is performed via two methods, namely the higher-level MATLAB® library for frequency range analysis and TwinCAT 3 Condition Monitoring (TF3600), which provide bidirectional verification of the MATLAB® analysis algorithm and the TwinCAT condition analysis algorithm.

Students have access to numerous workstations for a wide variety of projects.

demonstrates reflects the high level of cohesion between theory and practice, as industrial university research is integrated into real applications, making HUST one of the top universities in China. One example of this is an automatic high-speed machine for testing bottle caps. TwinCAT Vision is used for optical inspection to detect and evaluate the material status accurately and quickly. The loading and unloading units essentially function as an automated inspection line on a small scale. The flexible human-machine interface, implemented via TwinCAT HMI, makes operation user-friendly. When students use Beckhoff control technology to build and verify the complete machine functionality, they master motion control programming, image processing algorithms, and HMI creation, while gaining important expertise in engineering design and troubleshooting too.

"We have developed the simplest and most practical teaching platforms in line with the experimental objectives of a variety of courses to give students an in-depth understanding of the theories and their application in practice, and to achieve cohesion between knowledge and action. This platform improves our students' application of what they have learned when they leave campus and start working in companies and research institutes," explains Professor Wang Junfeng, director of the experiment center.

Remote-controlled robotic platform and optical inspection

Under the guidance of their lecturers, students in the engineering practice center finished a design, troubleshooting, and software solution for a robot remote control platform. The hardware platform combines several forms of application technology, such as TwinCAT function blocks and the TwinCAT HMI visualization. During programming, students were able to strengthen their understanding of the functions of motion control applications, human-machine interfaces, and remote data transmission. "The development of this robotic platform was really learning through play for the students. Although the course seemed boring and challenging at first, it turned out to be a lot of fun for everyone. After the experiment was completed, everyone felt very satisfied," said Tao Huang, deputy director of the experiment center.

As the university's flagship program, the School of Mechanical Science and Engineering integrates mechatronics and automation technology into production machinery. According to HUST, the in-house expertise that this

Further development of the joint laboratory

As new products and technology are constantly being brought out, including the XTS and XPlanar intelligent transport systems, the MX-System for control cabinet-free automation, and the ATRO modular industrial robot system, the cooperation between Beckhoff and Huazhong University of Science and Technology is also deepening in the joint laboratory. The lecturers at the joint lab are delighted to be able to include Beckhoff's cutting-edge automation technology into their teaching and research, thus broadening students' technical perspectives: "We believe this is a win-win situation that promotes Beckhoff's advanced technology platform while providing training for talented engineers at local universities." When looking back after many years, the joint laboratory as a training ground for talent will perhaps have contributed to even more junior staff mastering Beckhoff products. For this reason, the development of the laboratory is to be further advanced.

More information:
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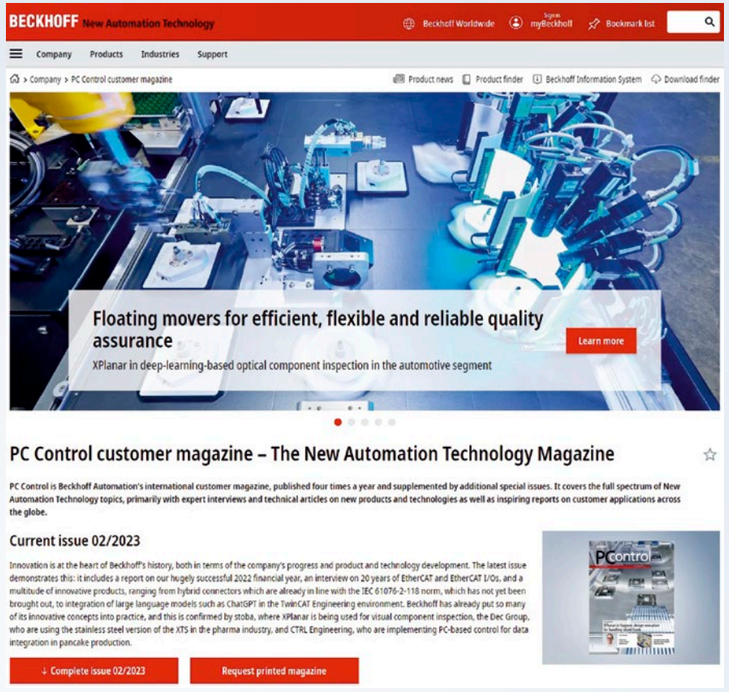
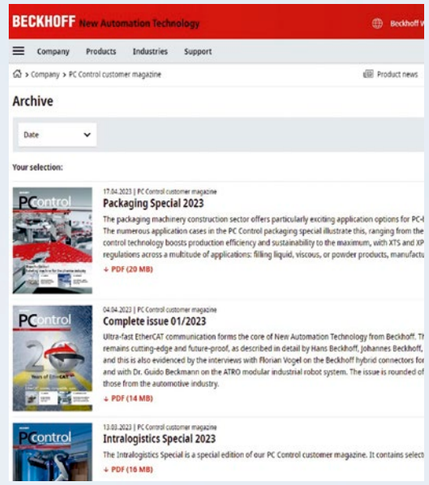


The latest PC Control issue is presented with five scrolling teaser highlights along with a brief description of the content.

Every PC Control magazine since 2001 is available in the archive, which can be found directly below the information on the current issue.



PC Control customer magazine now integrated into Beckhoff website

Discover exciting news and applications via new website

The "PC Control" New Automation Technology Magazine has been keeping you up to date with the latest products and technologies, exciting applications for PC-based control technology, and everything you needed to know about Beckhoff Automation since 2001. And while the printed edition has always been complemented by an online counterpart, the content will now be integrated directly into the Beckhoff website.

The new PC Control website now provides comprehensive information in three different ways:

- the current issue, complete with a brief summary of the contents and five scrolling teaser highlights, as well as the option of PDF download or print issue order
- the archive – complete with all previously published issues as PDF downloads
- the search function – including all PC Control content (selected under "Application report" or "PC Control customer magazine") along with the extensive range of information provided on the Beckhoff website

As the extended search function already suggests, this integration into the Beckhoff website offers two advantages: not only does it make the diverse content of PC Control now available to even more automation enthusiasts, but it is also much easier to offer or find further information. This means that links to relevant products and information media are displayed directly in the search results, and PC Control content is integrated more extensively on the associated industry and product pages.

More information:
www.beckhoff.com/pc-control

Dr. Guido Beckmann, Senior Management Control System Architecture at Beckhoff Automation and Head of the Technical Committee of the EtherCAT Technology Group:

“Even after 20 years, EtherCAT is still the fastest Ethernet-based communication technology on the market, also in comparison with Gigabit Ethernet-based technologies.”

Interview with Dr. Guido Beckmann on 20 years of EtherCAT in the motion control environment

A reliable and flexible approach to precise, highly dynamic movements with EtherCAT

Over the last 20 years, EtherCAT has successfully cemented its position as an ultra-fast communication system, making significant strides across all areas of automation. This feat has been achieved particularly quickly and comprehensively in the motion environment, addressing its demanding criteria in terms of transmission speed, synchronicity, diagnostic options, and various other factors. Dr. Guido Beckmann, Senior Management Control System Architecture at Beckhoff and head of the ETG technical committee, was happy to share his insights and perspective in the following interview.

The 20-year success story of the EtherCAT technology developed by Beckhoff continues, and has established itself worldwide as a high-performance standard for real-time Ethernet communication – notably in the motion area.

Guido, how long have you been involved in EtherCAT development at Beckhoff and what have been your main tasks over the years?

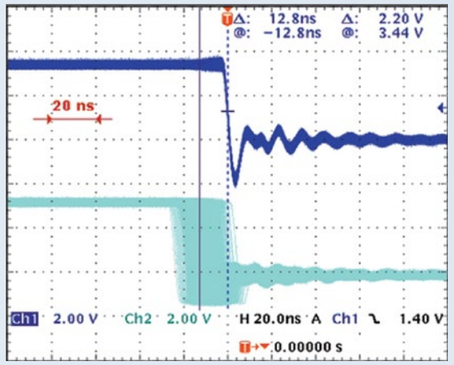
Dr. Guido Beckmann: My Beckhoff career began back in 2006 when I started out in EtherCAT technology management. I already had a strong background in industrial communication and fieldbuses, so when Beckhoff introduced EtherCAT technology in 2003, I was enthusiastic about its features right from the start. I have been head of the technical committee for EtherCAT Technology Group (ETG) since 2007 and am also responsible for various working groups, notably those relating to Safety over EtherCAT technology and drive profiles. On the Beckhoff side, I also evaluate new technologies for control architectures, which includes looking at the properties and possible applications of the 5G mobile communications standard, emerging communication standards in the field of time-sensitive networking (TSN), and the use of OPC UA for manufacturer-independent control communication.

What particular challenges has the motion aspect brought to your work with EtherCAT?

Dr. Guido Beckmann: Excellent performance, flexible topology, and simple configuration characterize EtherCAT as an Ethernet fieldbus with motion control capabilities. In highly dynamic motion applications, the system's fundamental attributes include short cycle times and precise synchronization. This means that, with the help of EtherCAT, the coordinated movements of multiple servo axes can be precisely matched within an application simultaneously with the evaluation of sensor data and the control of digital or analog signal output.

EtherCAT has now asserted itself as the most important motion fieldbus. Which technological features were instrumental in making this possible?

Dr. Guido Beckmann: That's right – it has. We are now aware of over 200 drive manufacturers that support an EtherCAT interface, offering users well over 1,000 different EtherCAT drive devices for their own applications. Fieldbus systems face stringent demands in terms of drive technology, most notably including cycle time, synchronicity, and simultaneity. Typical values for the necessary cycle times lie between 1 ms and 500 µs, with a moderate 2 ms in some applications (in reference to the cyclic position specification with position control in the drive). In extreme cases, however, cycle times of 62.5 µs are also required (for a current control loop closed via bus). While synchronicity describes the temporal jitter during executing the functions in the devices involved (drives and controllers), simultaneity defines the measure of temporal offset of these functions. EtherCAT uses an approach based on what we call "distributed clocks" for synchronization control: All devices have an independent clock as a basis for running local cycles and events. The crucial factor is that all clocks run at the same speed and have the same base time. A special control integrated in the EtherCAT Slave Controller (ESC) ensures that all clocks are guided by a reference clock and are synchronized irrespective of temperature and production tolerances. The necessary simultaneity of all clocks is achieved by means of a run-time measurement of the signal from the reference clock to each synchronized device, which is also supported by the ESC in terms of hardware. Comprehensive measurements have shown that the deviations are well below 100 ns for both synchronization and simultaneity – even for large networks.



Synchronicity and simultaneity in an EtherCAT network (long-term measurement on two devices with 120 m cable length and 300 nodes in between)

High-performance technology should also be as easy to use as possible, which has been achieved exceptionally well with EtherCAT. In relation to motion applications, which attributes are particularly advantageous in terms of aspects such as engineering and diagnostics?

Dr. Guido Beckmann: When it comes to supporting drive technology, key factors of a fieldbus system include the communication protocol and profile used, which are responsible for compatibility and efficient data exchange between controller and drive. The drive profile most commonly used in drive technology is the CiA402 profile developed by CAN in Automation. It was mapped to EtherCAT at an early stage (IEC 61800-7-3) and is supported by virtually all EtherCAT servo drives, which allows them to be automatically detected and integrated into the motion control application. It also meant that the complete tool chain and existing experience with the parameterization of associated drives could be maintained. Unlike traditional fieldbuses, EtherCAT makes it possible to achieve very short cycle times. In response to this capability, ETG introduced new operating modes in the specification to support cycle-synchronous transmission of position, speed, and torque process data. This made it possible to relocate the functionality of the setpoint generator, which was previously integrated into more complex drive controllers, to the central motion controller. It also simplifies the functionality of the drive amplifiers and enables coordinated motion control of multiple (coupled) drives in a machine on the central motion controller.

Dr. Guido Beckmann:

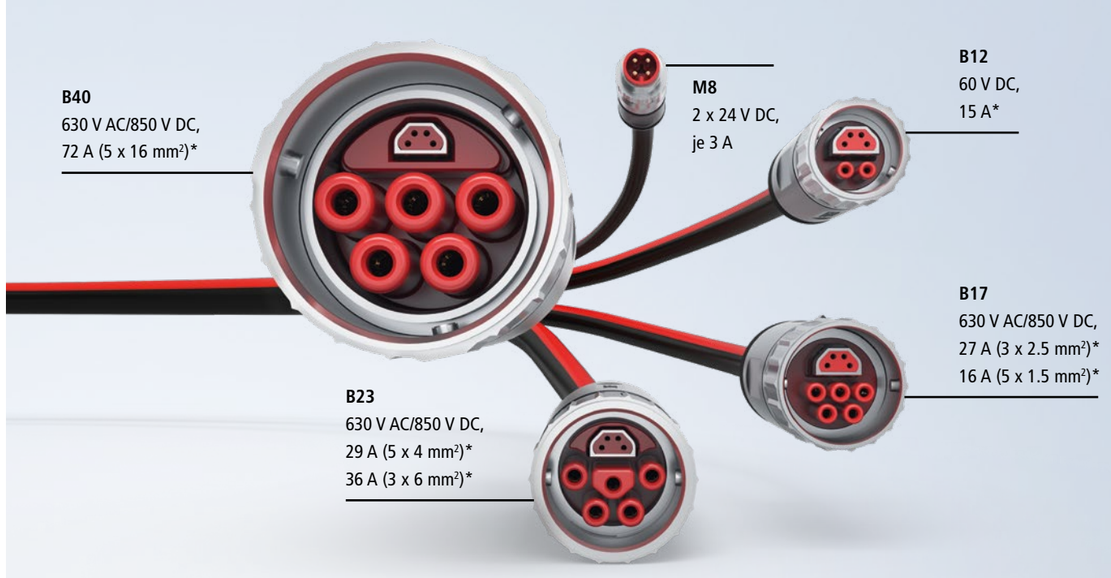
"Excellent performance, flexible topology, and simple configuration characterize EtherCAT as an Ethernet fieldbus with motion control capabilities – and with short cycle times and precise synchronization in highly dynamic motion applications, too."

How important are the OCT (One Cable Technology) and EtherCAT P single-cable solutions for the motion area and what are the specific application advantages, especially with regard to EtherCAT technology?

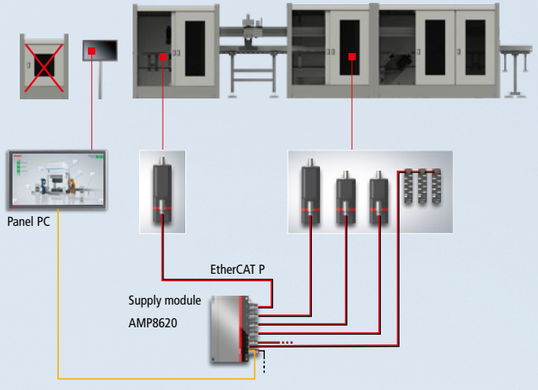
Dr. Guido Beckmann: It is important to distinguish between two different technologies here. With OCT, Beckhoff offers an innovative solution for connecting servomotors to a servo drive. OCT is a modified motor cable that uses the two thermal contact wires for encoder communication, thereby eliminating the need for an additional feedback line. Other solutions with an additional encoder cable or a hybrid cable solution with additional cores are much more difficult to assemble, as well as being more expensive to purchase and install. EtherCAT P is a technology standardized by ETG that combines EtherCAT communication and power in a 4-core standard Ethernet cable. The 24 V DC supply of the EtherCAT P slaves and the connected sensors and actuators is integrated: U_S (system and sensor power supply) and U_P (peripheral voltage for actuators) are electrically isolated from each other with an available current of up to 3 A each for the connected components. All the benefits of EtherCAT are retained, such as the free topology, high speed, optimum bandwidth utilization, on-the-fly processing of telegrams, high-precision synchronization, and extensive diagnostics. For high-power applications such as those as required in drive technology, Beckhoff also provides standardized hybrid cables with bayonet connectors. These integrate an EtherCAT P core with additional cores to supply devices ranging from 24 V sensors through to 600 V drives. Both of these technologies – OCT and EtherCAT P – offer the advantage of simplified wiring within the machine and, above all, a reduced number of cables.

Dr. Guido Beckmann:

"Relocating the setpoint generator functionality to the central motion controller simplifies the drive amplifier functionality and using EtherCAT enables coordinated motion control of multiple (coupled) drives on the central controller."



All Beckhoff hybrid connectors are available in the versions ECP (EtherCAT P, shown here) and ENP (EtherCAT/Ethernet), (*maximum values depending on cable and ambient temperature)



The AMP8000 distributed servo drives use the EtherCAT P one-cable solution and so form the ideal basis for compact and consistently modularized machines.

How important is EtherCAT communication for the decentralized motion solutions AMP8000 and AMI8000?

Dr. Guido Beckmann: This is exactly where the advantages of the EtherCAT P hybrid cables come into play. In these decentralized systems, the concept of control cabinet-free drive technology is consistently implemented. The decentralized motor-integrated servo drives can be connected to a decentralized supply module with one supply port and five motor circuits, and an EtherCAT P hybrid cable is used for communication and power supply to the drives. This all results in significant savings in terms of material, installation space, costs, and installation work.

The Beckhoff Motion range is incredibly diverse and includes the compact drive technology portfolio in I/O terminal format, which is celebrating its 10th anniversary this year. Are there any specific EtherCAT properties that offer notable advantages to this design format?

Dr. Guido Beckmann: In the case of compact drive technology from Beckhoff, the end-to-end EtherCAT communication is definitely worth a mention. Here, the drive amplifiers for servo, DC, BLDC, and stepper motors are designed as EtherCAT E-bus terminals, which means they are connected in an I/O bus segment to an EtherCAT Coupler. The special feature of EtherCAT technology lies in the fact that the EtherCAT frame does not have to be implemented within the bus coupler to be forwarded to an internal backplane bus. Instead, all E-bus terminals contain an EtherCAT slave controller and are therefore independent EtherCAT devices. This means that all the advantages of EtherCAT in terms of performance, synchronicity, and simultaneity are also available for our compact drive technology.

To what extent do the intelligent product transport systems XTS and XPlanar benefit from EtherCAT?

Dr. Guido Beckmann: The key word here is performance. The EtherCAT operating principle offers ample bandwidth for short cycle times. What's more, through on-the-fly data exchange and logical addressing of many (or all) devices in a single frame, the bandwidth of 100 Mbit/s is virtually entirely available in the EtherCAT segment without compromising real-time capability. Another factor is that only one EtherCAT frame is required to set output data, and input data can be read in again at the same position in the frame at the same time, virtually doubling the bandwidth. With the XTS linear transport system, Beckhoff offers a drive solution in which magnetically driven movers move along a path of fully integrated motor modules. The integration of a conventional linear motor with power output stages and position detection into the motor module enables compact and flexible set-up of intelligent transport systems. Since each motor module contains a large number of individual coils and feedback sensors, a vast amount of data has to be transmitted from the controller to each module and back within each control cycle (250 µs) – and that's a task only EtherCAT can handle. XPlanar is a planar motor, which – like rotary motors – consists of multiple stationary, energized coils (in the tiles) and mobile permanent magnets (in the movers). In contrast to rotary motors, however, both the coils and the permanent magnets are arranged two-dimensionally on a plane. The XPlanar tiles are the electrically active part of the system, with the current in their coils causing the movers to float above them. With its bandwidth demands surpassing 100 Mbit/s and exceeding those of XTS, the XPlanar system makes use of the EtherCAT G technology expansion that was introduced in 2018. EtherCAT G builds on the successful EtherCAT concept and is now capable of processing telegrams on the fly at a rate of 1 Gbit/s.

Dr. Guido Beckmann:

> "The outstanding performance of EtherCAT meets virtually all user requirements in countless applications, and in the foreseeable future, the 100 Mbit/s data transmission will remain the physical layer of choice for almost all devices."

The modular industrial robot system ATRO is also based on EtherCAT communication. What advantages does this offer here, in terms of both setting up the kinematics and in robot operation?

Dr. Guido Beckmann: ATRO (Automation Technology for Robotics) represents the latest system in the Beckhoff drive technology range. This modular industrial robot system can be used to assemble optimal robot structures for different applications on an individual and flexible basis: Standardized motor modules with integrated drive functionality, together with link modules in various designs and lengths, enable almost limitless combinations of mechanical elements. The active motor modules are decentralized EtherCAT servo drives. To achieve highly dynamic and precise robot movement and positioning, all motor modules have to be supplied with new setpoints by the controller in short control cycles. The accuracy of synchronizing the movement of all modules is crucial to how accurately a path can be maintained. Their seamless integration into the Beckhoff architecture allows ATRO robots to be combined directly with intelligent transport solutions such as XTS and XPlanar. What's more, the extremely powerful overall package can be configured in a compact machine design, thus minimizing its footprint. All components are fully synchronized through EtherCAT, and implementing highly dynamic pick-and-place applications is no problem, since movements are coordinated on the fly – based on EtherCAT.

End-to-end EtherCAT communication is also available in the MX-System for control cabinet-free automation – both within the underlying baseplate and for the function modules such as the new 48 V/40 A power supply modules for the AMI8100 integrated servo drives, the XTS intelligent transport system, and the ATRO modular industrial robot.

Even after 20 years, EtherCAT is an innovative and future-proof technology. How much potential does it still have from the point of view of motion applications, and what significance will technology expansions such as EtherCAT G and G10 achieve in the medium and long term?

Dr. Guido Beckmann: First of all, I can't emphasize enough that EtherCAT is still the fastest Ethernet-based communication technology on the market – even after 20 years. And this is also in comparison with other technologies that are already based on Gigabit Ethernet. Since it launched in 2003, the outstanding performance of EtherCAT has met virtually all user requirements in countless industries and applications. Some special applications in the field of machine vision, condition monitoring, or even the innovative XTS and XPlanar transport systems require several hundred bytes of process data per cycle for each device. With EtherCAT G, these applications can now be operated with an EtherCAT G master, and additional automation devices or drives can be integrated at the same time. At this point, I have to mention the introduction of what we call the branch concept, where the branch devices enable the integration of 100 Mbit/s Ethernet segments into an EtherCAT G network. This ensures the unique device diversity of the EtherCAT world remains available even when using EtherCAT G, and no 100 Mbit/s device will become obsolete or even unusable due to EtherCAT G. On the contrary, the robust and proven 100 Mbit/s data transmission will remain the physical layer of choice for almost all devices in EtherCAT in the future. The branch concept also offers another major efficiency advantage in that each branch is regarded as an independent EtherCAT segment. By this, I mean that a telegram does not pass through all segments one after the other, but rather the segments at the branch ports are processed in parallel. This significantly reduces hardware-related propagation times in large networks.

Speaking of innovation, are you able to reveal any new motion functionalities that the EtherCAT team is currently working on?

Dr. Guido Beckmann: We have just extended the EtherCAT specification with what is known as a dynamic process data channel (DPC). This makes it possible to temporarily read or write cycle-synchronous process data from a device during operation. For drive functionality, this can be used to record a Bode plot during commissioning to optimize the controller parameters.

This interview was conducted by Stefan Ziegler, Editorial Management PR, Beckhoff Automation

More information:
www.beckhoff.com/ethercat
www.beckhoff.com/motion

With the extension of TwinCAT Analytics, images can now also be conveniently and comprehensively evaluated with the TwinCAT Vision functions in the engineering environment.

Automatic Vision PLC code generation with TwinCAT Analytics

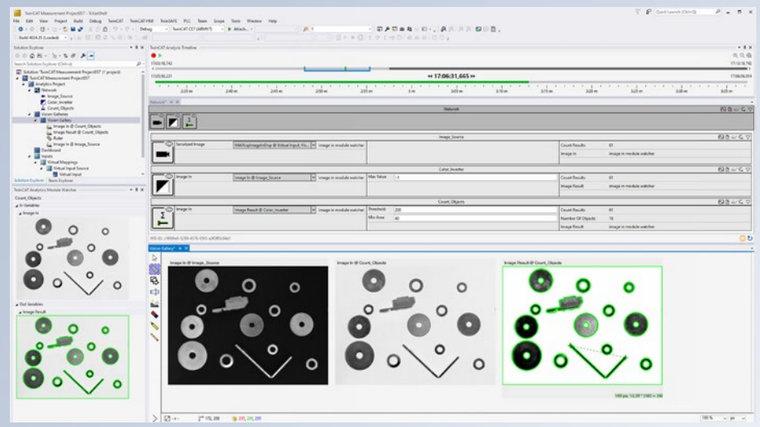
Vision integration into Analytics – simplified engineering and enhanced functionality

Until a few years ago, vision solutions in machines were exclusively stand-alone systems that communicated with the actual machine control system via interfaces. Programming was rather code-heavy via the integration of vision libraries or special hardware that facilitated straightforward configuration. By integrating image processing into machine control, TwinCAT Vision already eliminates the need for interfaces and allows programming to be carried out as usual according to IEC 61131-3. The fusion of TwinCAT Vision and TwinCAT Analytics means both approaches are now combined for optimal engineering, and applications are facilitated by means of simple configuration.

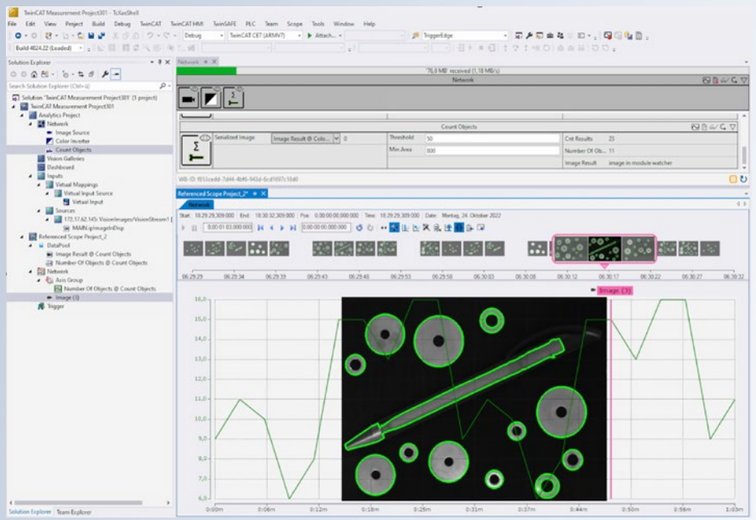
Taken individually, the task distribution between the two TwinCAT products is clear: TwinCAT Vision is designed to create image processing operations in line with machine control. The cameras are configured via a graphical interface in much the same way as a drive axis would be. The image processing itself is programmed entirely in the PLC, for which a very extensive PLC library is available. TwinCAT Analytics, on the other hand, offers many different algorithms for evaluating a machine's process data, such as high-resolution vibrations, status values, and positions of drives. The major difference is in the use of the algorithms. In contrast to working with PLC libraries, TwinCAT Analytics is used on a purely graphical basis in a configuration editor. The algorithms themselves are based on the same PLC libraries and can be used by the Analytics user, once their configuration is complete, for automatic PLC code generation in a newly created PLC project. The entire process is incredibly straightforward and does not require the user to perform any programming themselves.

Extensive analytics functions

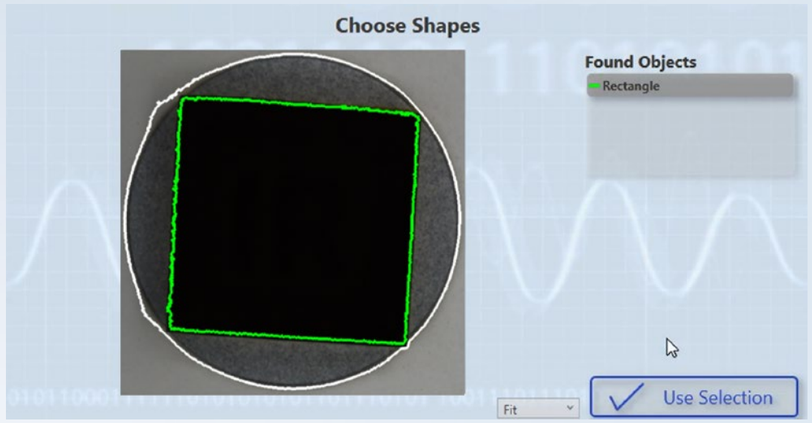
TwinCAT Analytics offers algorithms ranging from very simple to highly sophisticated, including basic edge counters, limit monitoring, and envelopes, through to spectral analysis, correlation functions, and unsupervised clustering methods from the field of machine learning. In total, there are more than 150 algorithms for evaluating process data. These are organized in networks and can be individually linked to form chains, which can be saved as templates for future reuse. Many users take advantage of this possibility in a very application-specific manner, resulting in additional sections in the algorithm toolbox such as those for specific machine modules or mechanical components. As a result, machine module names such as "Module MH_Milling_Long3c" can be listed in the toolbox, providing service technicians with specific algorithms for different parts of various machine types. Together with the TwinCAT Scope software oscilloscope, this data can be not only graphically transferred to processing, but also graphically displayed



TwinCAT Analytics Editor with vision algorithms, module watcher, and image gallery



Vision image synchronized with process data in TwinCAT Scope



Specific window for finding and labeling contours in images

Pascal Dresselhaus, Product Manager TwinCAT, Beckhoff Automation

in the form of time-based line charts, bar charts, or 3D charts. Results of the algorithms can be linked to the charting along with the timestamp by means of simple drag-and-drop actions, allowing events to be sorted and marked with machine cycle accuracy. This applies to both live machine data and historical data where, for example, logical operators can be used to look for specific state associations in the data stream. The result of this is incredible time savings – especially when searching for malfunctions. But the path to true engineering simplicity lies in automated PLC code generation – although what is it even for?

Generally speaking, TwinCAT Analytics with code generation allows analyses to be executed continuously in a PLC runtime environment. This can be the machine control runtime itself or the one on a remote device that runs in parallel to the machine controls and is therefore decoupled from the actual control process. Decoupling such as this offers the advantage that analyses can always be exchanged and updated independently of the process – a common scenario, especially with steadily increasing experience in data analytics. The use of sophisticated algorithms along with machine control itself is also far from standard. Many users hold a respectful perspective toward programming with algorithms such as these and integrating them into the existing control code. What's more, it is a waste of time for users to have to systematically retype things that they have already configured and tested. Therefore, automatically generated code avoids programming errors and saves a great deal of time during the development phase. This is even more obvious when users not only automatically generate the analysis code, but also a web-based dashboard for displaying the analysis results.

Vision integration with clear advantages

Since camera systems are increasingly replacing conventional sensors on machines, and since several sensors can be combined by a single camera system, it is a logical step to integrate the evaluation of image data in TwinCAT Analytics. Added to this is the fact that the low-code approach of TwinCAT Analytics is also widespread in many specialized vision tools, and is consequently an ideal complement for TwinCAT Vision. This makes it an obvious next step to gradually integrate the large number of vision algorithms into TwinCAT Analytics. The advantage here is clear, in that creating a vision application with TwinCAT no longer automatically starts with programming. The required algorithms can be conveniently put together in the configuration process before being run and tested in a non-real-time context. Particularly during the initial evaluation phase of an application such as this, many functions and parameters have to be tried out, and, now, the former constant activation of real-time configurations and downloading of code can be eliminated. Independence eliminates the need to restore a machine state so that new results are comparable to previous ones. This is particularly useful in end-of-line tests where reject identification is required, to name just one example.

In addition to the non-real-time context, the additional possibility of being able to use historical raw image data again and again for optimizing the evaluation and parameters is especially helpful. The output images at the modules of the algorithms, such as color and median filters, can be linked to inputs from other vision algorithms, such as Detect Blobs or Read QR Code. Once the ideal setting for one or more camera systems has been found, the required real-time PLC code based on the TwinCAT Vision library can be generated and downloaded to the control system at the push of a button. The generated PLC code is transparently readable and object-oriented. Its structure is based on the previously configured networks, which allows users to find their way around the generated code with ease. The application will ideally be finished at this point, although specific changes can be made at any time – including a subsequent code compare and merge step. It is also very convenient for users that the detailed documentation of the TwinCAT Vision library can be used to understand the Vision-specific part of the generated code. This functionality alone simplifies engineering significantly, saving a lot of time and the associated engineering costs.

More detailed evaluation via software oscilloscope

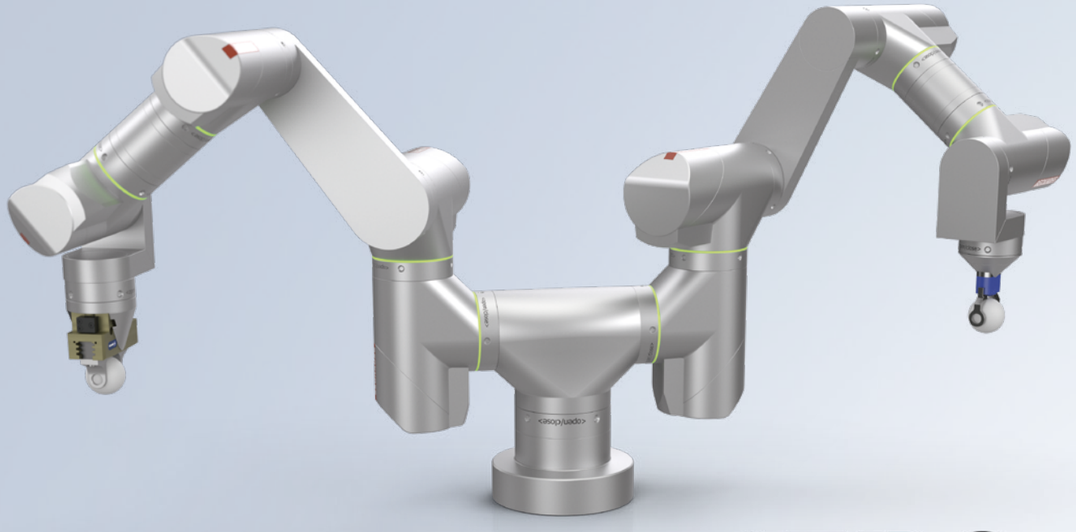
This is far from being the only advantage of Vision integration into TwinCAT Analytics, as other standard TwinCAT Analytics functions are also intended to benefit image data evaluation. These include the ability to drag and drop image data into TwinCAT Scope in the same way as process data. The output image of a Vision algorithm is dragged into the scope and can also be visualized directly in a cam chart on an individual basis. If required, the image can be dragged into one of the process data charts using the mouse. After that, it appears in the background of the chart, with a color-coded marker assigning details such as the processing date and image to the time axis.

Of course, Vision-specific functions have also found their way into TwinCAT Analytics. The goal of continuous product development is to create an interface that ideally supports the user with special elements adapted to the respective algorithm. The way algorithms are implemented in Analytics is as standardized as necessary and as individual as possible. This makes for intuitive elements that facilitate the process of saving found contours that have to be reloaded later for a contour adjustment, for example. Other functions such as the tool window for the module watcher are generalized for all algorithms. Depending on the selected image processing module, the watcher displays input and output images directly. The image gallery, on the other hand, allows individual compilations of multiple input and output images from different algorithms. For that purpose, images from a stream or single images from the hard disk can be loaded and pinned, allowing them to be compared with current images. The gallery also offers a number of standard functions like the color picker, pixel measurement, pixel position, and contrast settings. Additional shapes and labels can be added to each image. An image processed in this way is available for export to various image formats.

Continuous further development

In addition to the gradual expansion of the algorithm, the next development steps relate to the automatic generation of vision controls for the web-based dashboard. The dashboard is used to permanently display image processing results for different user roles, which can be defined in the analytics engineering. Thanks to the platform-independent HTML 5 dashboard, it is not only experts such as developers, application engineers, commissioning engineers, and service technicians that benefit from the combined TwinCAT Analytics Vision solution, but also machine operators and production and operations managers. The latter can call up the most important production data as needed via mobile devices – regardless of location and at any time.

More information:
www.beckhoff.com/twincat-analytics
www.beckhoff.com/twincat-vision



ATRO: Modularity and flexibility also facilitate multi-arm robots

The modular industrial robot system ATRO (Automation Technology for Robotics) from Beckhoff was first presented to the public in 2022. Fast-forward to today, and more link modules are now being added to increase the flexibility of the ATRO system even further, including in the form of multi-arm robots.

The standardized ATRO motor modules with integrated drive functionality are combined with link modules in different geometries, offering users the flexibility to set up a variety of robot kinematics. This results in robotics solutions that are precisely optimized to suit the application in question. The complete integration of the robot controller into the TwinCAT control platform with its extensive automation functionalities also facilitates the whole process of implementing complete solutions for a machine.

As mechanically passive modules, ATRO link modules are used to adapt the kinematic structure or the workspace to the respective requirements. The latest additions to be showcased include a T-shaped link module with two junctions, in addition to both L- and S-shaped models. Automatica 2023 provided the perfect opportunity to present a sample application featuring 2-arm robot kinematics based on the T-module, each with four motor modules (i.e., joints) in the arms. The common main axis could be used as a continuously rotating axis and thus as a moving robot base, since all axes in the ATRO system from the base to the end effector are designed to rotate endlessly due to the internal media feed. The two arms are thus simultaneously guided to different work areas where they can grip, set down, or machine workpieces. The entire structure not only saves space, but also offers a fast and efficient solution. This is because it eliminates the need for the robot to perform any of the typical return travel associated with axis limitations, in which no process execution takes place. The compressed air or energy supply to the two grippers is routed internally in the structure from the basic main axis to the two end effectors through the ATRO interfaces of the modules. The new L- and S-shaped link modules support kinematics with four degrees of freedom, which can be used for tasks such as palletizing. A special feature of one of the new L-shaped link modules was demonstrated at another exhibition: the axes of this robot configuration are designed in such a way that they cannot collide with themselves, which means that the endless rotation of all axes can be exploited to optimal effect. In all (other) robot configurations, self-collision is avoided by software.

Another innovation in the entire Beckhoff system is the implementation of the pluggable and modular MX-System as a robot and machine controller. An MX-System configuration consisting of a power supply, industrial PC, digital input/output, and safety modules allows the ATRO system to be operated completely control cabinet-free. The robot receives its required 48 V power supply and EtherCAT communication via a single hybrid cable from the new MX-System power supply module with 40 A output current. For pneumatic control of the end effectors, the new pneumatic modules are available in the MX-System. The result is a complete, compact, control cabinet-free robot control system that can easily be expanded for further automation tasks within a machine or cell.

More information:
www.beckhoff.com/atro

MX-System: High-performance power supply modules for motion and robotics applications

If control cabinet-free machines are the question, then the Beckhoff MX-System is the answer. The integration of functional modules onto a backplane system creates a waterproof and dustproof composite of metal enclosures suitable for automating a wide variety of manufacturing/production solutions. These systems often include 48 V motion components, for which the MX-System portfolio now offers four variants of a 48 V/40 A power supply.

In line with the basic principle of the MX-System, the new 48 V power supplies are plugged onto a baseplate and supplied with the primary voltage via the standardized system interface without manual wiring. This can be the 3-phase mains voltage or the 600 V DC voltage of the drive system. Like all MX-System function modules, the power supplies become participants in the EtherCAT network via the second MX-System interface. This data interface also offers the possibility of feeding the 48 V voltage into the baseplate. In this case, both the 48 V DC and 24 V DC can be used by the corresponding function modules.

The most common use cases for the new power supply modules are motion applications. Here, the MX-System portfolio already offers function modules that provide 48 V as power voltage for servo drives and stepper motors. Corresponding power supplies with 10 A and 20 A output current were announced with the market launch of the MX-System. While these modules feed exclusively into the backplane, the new 40 A variants are designed in such a way that 48 V DC devices can also be directly attached via connectors on the front of the function module. The following power supply versions are available:

- a module variant with M12 connectors for attaching a total of six AMI8100 distributed servo drives
- a version with two B23 connectors for attaching feed segments of the XTS transport system
- a power supply module for connecting a base module of the ATRO modular industrial robot
- a power supply variant without connectors for direct line connection that feeds exclusively into the backplane

In accordance with the normative requirements, measures for the protection of the lines and cables are integrated into the power supplies for each slot on the output side. Several power supplies can also be connected to a baseplate and operated in parallel to balance peak loads at the outputs, for example. Not only do the front connectors facilitate the power supply to external devices, but they also offer direct connection to the EtherCAT network. Another special feature is the ability of the power supplies to feed regenerative energy directly back into the machine's supply network, such as that generated while the servomotors are braking. This eliminates the need for additional external braking resistors. Like all MX-System modules, the new power supplies also support the Beckhoff Service app for convenient hardware diagnostics.

More information::
www.beckhoff.com/mx-system

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Laser cladding with TwinCAT CNC

High speed and precision perfectly aligned in software-controlled solution

Today, laser cladding is often used for coating rotationally symmetrical components. Ponticon GmbH, based in Wiesbaden, Germany, is expanding its range of applications to include coating and additive manufacturing of any geometries with the pE3D system. The requirements regarding the precise control and coordination of the tripod, rotary/swivel table, and laser would have been difficult to implement without TwinCAT CNC, EtherCAT, and eXtreme Fast Control Technology (XFC) from Beckhoff.

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TwinCAT and a C6930 control cabinet Industrial PC handle the path control and coordination of all axes.

The pE3D system from Ponticon is a real heavyweight, and not just in terms of its potential industrial applications: constructed from solid granite slabs up to 20 cm thick, the base frame, which is over 3 m tall, weighs in at over 7 metric tons. "If you want to build up large components in a highly dynamic and precise process or apply an ultra-thin coating, you need a rigid structure," explains Thomas Horr, Managing Director of Ponticon. In specific terms, components up to 700 mm in diameter and 800 mm in height can be coated with material thicknesses of only 50 to 200 µm, completely rebuilt, or repaired on the system. For the latter field of application, Ponticon recently delivered a manufacturing cell including a pE3D system to the Institute of Production Science at KIT in Karlsruhe, Germany, funded by the EU and the Ministry of Science, Research and Arts Baden-Württemberg (see info box p. 22). With the 3DMD (Dynamic Material Deposition) process developed by Ponticon, laser cladding can be used for the first time for highly productive manufacturing of complex component geometries from virtually any combination of materials. For this purpose, high feed rates with the smallest possible deviations are vital. With a path accuracy of a few hundredths of a millimeter, the pE3D system not only works with precision but also offers extraordinary dynamics, with feed rates of up to 200 m/min and acceleration of up to 5 g, says Thomas Horr.

With the pE3D system, Ponticon combines productivity, precision, and material flexibility in laser cladding.

The high feed rate results from the special design: a parallel kinematic system. Typically, parallel kinematics are very fast but not necessarily precise. By using special mechanical elements, Ponticon has eliminated this shortcoming in its tripod. The rotary/swivel unit as fourth and fifth axis provides additional flexibility for machining complex geometries.

Flexibility combined with speed

For machining in the standard operating mode, the component is clamped on the tripod and moved under the laser unit, which is in a fixed position. In the second configuration as a 5-axis CNC, however, the complete laser head is mounted on the tripod. "To do this, we simply use the frame which was previously used as a workpiece carrier," says Thomas Horr, explaining the clever solution. The component is then clamped on the rotary/swivel unit below and can also be rotated and tilted. This allows powdered metals and alloys to be deposited on surfaces of any shape. The table is needed when, for example, the geometry of the workpiece requires reorientation to achieve overhangs or certain angles, or to build up rotationally symmetrical parts. "Our rapidly rotating rotary axis allows us to achieve feed rates of up to 200 m/min in this operating mode, too," says Thomas Horr.

These key features place major demands on the mechanical structure. In addition, the control system must be able to keep up with the dynamics of the system, particularly with regard to the control of peripheral devices. "The most important thing is to ensure that the switching times of the laser are precise," says Thomas Horr, "so that the laser switches at the right position and melts the material."

Realistic scenario in circular production: Defective areas of a gear are precisely milled out (left), rebuilt using laser cladding (right), and then finally machined.

Laser cladding in circular production

The Ponticon laser cladding system is an essential component of the InRePro research project launched at the wbk Institute of Production Science at the Karlsruhe Institute of Technology (KIT).

InRePro stands for "Inspection and remanufacturing cell with process-integrated multi-sensor technology for a digital-autonomous manufacturing process." The reconditioning of used subsystems and components reduces consumption of resources (raw materials and energy) and enables a new type of circular economy that can be automated and is thus suitable for large-scale production. The aim of the project, which is funded by the EU (REACT-EU) and the state of Baden-Württemberg, is to investigate the circular production of components on an industrial scale.

By combining the 5-axis laser cladding system with a 5-axis machining center, it is possible to implement flexible reconditioning of components. The multi-sensor process monitoring solution integrated into the pE3D system provides immediate information about manufacturing quality during the machining process. For this purpose, corresponding sensors (OCT, quotient pyrometer, WeldWatcher) are integrated into the laser head, which enable monitoring of the melting zone. A tracked 3D laser scanner also offers the possibility of measuring the material deposition results over a geometric area immediately after the process. The system therefore makes it possible to systematically observe and investigate the causes of typical defects in the process for the first time.

The component determines the operating mode: simple components are secured on the tripod and guided under the fixed laser head at up to 200 m/min (3-axis operation); for complex components, the laser is clamped on the tripod and the component is clamped on the rotary/swivel table below (5-axis operation).

The motion sequences can be programmed in G-code or read in from CAD/CAM programs and called up via the CP3924 multi-touch Control Panel.

Thomas Horr, Managing Director of Ponticon: "The kinematic transformation of the tripod in the TwinCAT CNC has taken a great deal of development effort off our hands."

The range of EtherCAT Terminals covers all system requirements, from safety technology (EL6910) to precise control of the laser via EtherCAT Terminals with oversampling function (EL2622) and integration of subsystems via PROFINET (EL6631) and PROFIBUS (EL6731).

Precise laser control via XFC

In this area, Ponticon relies on XFC from Beckhoff in conjunction with the EL2262 oversampling terminals. XFC is based on an optimized control and communication architecture comprising an advanced industrial PC, ultra-fast I/O terminals with extended real-time characteristics, the EtherCAT high-speed Ethernet system, and the TwinCAT automation software. With XFC, it is possible to realize I/O response times of less than 100 µs.

In order to move the tripod dynamically, it must be possible to specify the axis setpoints at high frequency and the actual values must be returned equally quickly. EtherCAT offers the performance needed for this. In addition, Safety over EtherCAT (FSoE) facilitates the implementation of safety requirements.

Path control of the tripod and rotary/swivel table is implemented via TwinCAT CNC. For this purpose, the axis controllers are configured for maximum dynamics and operate with minimal lag. "A lot of development work has gone into the corresponding function blocks that we use for control optimization," emphasizes Thomas Horr.

TwinCAT CNC suitable for system kinematics

The kinematic transformation for the tripod already available in TwinCAT was another reason for Ponticon to use PC-based control and TwinCAT CNC in particular. This meant the developers only needed to configure the kinematics and had no additional development work.

A flexible and modular platform is very important to Thomas Horr: "Particularly in the initial phase, when it is not possible to formulate the task so clearly, what is needed is flexibility, such as that offered by TwinCAT and the licensing model from Beckhoff. We were surprised at how quickly we were able to get everything up and running. And if there were any hurdles to overcome, support was available quickly, such as when there were questions about the implementation of the oversampling terminals. The collaboration with the experts from Beckhoff has been exactly what we had hoped for when choosing our system partner." Prof. Frederik Zanger, Institute Director at wbk, says the same about the collaboration with Ponticon. "The project began during a period of economic uncertainty. Nobody knew what would happen to the delivery times for the various components. Today, we are delighted that everything has been extremely professional and has run smoothly in our collaboration with Ponticon."

Technology transfer to other kinematics

The flexibility of PC-based control will also be useful in future projects. This is because laser cladding is not tied to any particular kinematics. "We are confident that we will be able to port the previous developments on the Beckhoff platform to other kinematics, such as a 6-axis robot." In any case, the corresponding kinematic models are already available in TwinCAT.

More information:
www.ponticon.de/en
www.wbk.kit.edu
www.beckhoff.com/cnc

TwinCAT CNC and drive technology in machining

Precise part machining with CNC robot

Some claim that hard materials cannot be precisely machined with jointed-arm robots – but toolcraft will prove them wrong. Daniel Distler and Andreas Bauer use TwinCAT CNC and PC-based control from Beckhoff to implement robot cells for precise machining of components – including solid blocks of silicon carbide and gray cast iron.

toolcraft understands exactly what the processing industry needs, which processes and technologies work in practice, and which do not. That's because toolcraft not only manufactures on behalf of customers using its 60 CNC machines, but also designs, plans, and builds turnkey production systems for companies in various industries.

Founded in 1989 as a contract manufacturer, the company gradually added further competencies in various manufacturing technologies, including injection molding and mold making in 2005 and additive manufacturing technologies in 2011. In 2015, robotics became the newest technology division at toolcraft. "No matter what technology we operate in, we always want to have the expertise needed to offer complete solutions," explains Daniel Distler, division manager for robotics with a focus on sales and human resources.

The range extends from simple devices to complex systems with integration into existing systems at the customer site. "Connecting machines with new technology to existing controllers at the end customer's site is not always the easiest method, but it works when you use flexible control technology," said Andreas Bauer, division manager for robotics with a focus on engineering at toolcraft.

One automation platform for every application

This is why Andreas Bauer and Daniel Distler rely on PC-based control, including in the production cells with 7-axis milling robots for machining components at CNC level. "The TwinCAT CNC was the first controller with an integrated interface to the Stäubli robot controller (TwinCAT Robotics uniVAL PLC, TF5130). This technology package made a lot of things easier for us when implementing the project," recalls Andreas

With the new generation of machining robots based on PC-based control and drive technology from Beckhoff, as well as improved robot kinematics, toolcraft says it is taking precision to a new level.

Bauer. Using the machining cell designed by toolcraft, one user now mills base frames for wafer production from large silicon carbide and gray cast iron blocks. "toolcraft was already using our TwinCAT CNC in this case," adds Alexander Klos from Sales at the Beckhoff office in Nuremberg.

Initially, the customer was still machining the blocks with conventional 5-axis CNC machines. But milling the hard material produces ultra-fine dust that penetrates every joint, linear guide, and bearing, causing huge problems in a short time. The CNC machines quickly became worn out and required a major overhaul. "We knew that with the TwinCAT CNC we could achieve the required accuracy of 2/10 mm within a machining area of up to 1 m³, as well as seal the Stäubli robots and apply overpressure," emphasizes Daniel Distler. This knowledge comes from various projects in which, for example, robots have been completely dismantled and sealed in such a way that they still function reliably even at water depths of up to 20 m.

The AX8000 multi-axis servo system, in combination with the AX5000 Servo Drive (bottom left), controls the high-performance spindle and the servo drives installed in the axes of the CNC robot.

Complete control and monitoring of the prototype runs on a CX2040 Embedded PC (bottom left) with Intel® Core™ i7 CPU and four processor cores.

Operation and path planning are carried out in G-code, just as the 5-axis CNC, and visualized on a customer-specific CP3921 multi-touch Control Panel.

In the robot, Beckhoff AM8000 servomotors together with the encoders on the drive and output sides ensure precise movements.

The two robotics division managers at toolcraft, Andreas Bauer (Engineering) and Daniel Distler (Sales and Human Resources), together with Alexander Klos from the Beckhoff branch office in Nuremberg (from left to right)

Next-generation CNC robot

The potential of robots in parts processing is enormous, but where should the focus be? "We thought long and hard about where we wanted to go with robotic milling and, of course, how to get there," explains Daniel Distler. The aim was not only to further increase the machining quality and raise it to a new level, but also to ensure that there were no changes for users when creating the machining programs. At the start of the project in 2018, all components of a machining cell were examined in a "best of breed approach": robot, rotary table, tool changer, milling spindle, and, of course, the control technology. Andreas Bauer: "Based on our expertise over the last eight years, we know the exact strengths and weaknesses of the various kinematics and designs." This expertise was applied in collaboration with a robot supplier to develop kinematics that increase stiffness, dust/water resistance, payload, and reach.

The result is the current configuration of a machining cell with a high-end CNC robot based on new kinematics. "In the new generation, toolcraft also uses servo drives and servomotors from Beckhoff in addition to TwinCAT CNC," adds Alexander Klos. The robot was equipped with double-bearing gears on all axes and encoders on the drive and output sides. In addition, the spindle mount was modified. The control technology basis of the milling robot is formed by the powerful CX2040 Embedded PC in combination with the CP3921-1502-0010 CNC multi-touch Control Panel, which is connected to the embedded PC via CP-Link 4 with only one Ethernet cable (CAT.6A). The system is rounded off by the AM8000 servomotors and the AX8000 multi-axis servo system as well as TwinCAT CNC. Other positive side effects of the new design include the internal hose assemblies, which simplify handling. In addition, no separate robot controller is required, freeing up space in the control cabinet and reducing the complexity of the project.

Straightforward conversion of the drive technology

"Although toolcraft started with TwinCAT CNC and TwinCAT Robotics uniVAL PLC, it was quickly possible to switch to another robot type with different mechanics, kinematics, and our drive and servo drive technology," says Alexander Klos, pointing out two important properties of PC-based control – openness and flexibility. For example, it was possible to integrate the drive-side and output-side encoders of the robot axes into the software function blocks of the axis controllers without any problems. And with the integrated Beckhoff portfolio, ranging from CNC to servo drives and motors, toolcraft benefits from completely different optimization options. "Direct access to all parameters and process settings has played a large part in the further improvement of the accuracy," says Andreas Bauer. For example, the low but still detectable hysteresis of the gearing was further compensated via the output-side encoders and appropriate control algorithms. Even when high forces are applied, e.g., during solid milling or depending on the position of the tool center point (TCP) in the working area, the axes are tracked with speed and precision. "And the integration of measurement and calibration cycles ensures consistent properties," adds Daniel Distler.

toolcraft also retains flexibility in its choice of feedback systems and use of other technologies: the servo drives support many encoder interfaces and additional options are available via EtherCAT. "We are always thinking ahead and are considering integrating camera systems to detect and automatically load components," says Andreas Bauer.

Post-processors and coordinate transformation included

It is very important for manufacturing companies to have a functioning process chain, from the CAD drawing to the machining program. As Daniel Distler says: "Our approach is to take away users' fear of operating and programming the robots, while at the same time providing more freedom in machining." PC-based control also helps in this area: post-processors and coordinate transformation are run on the embedded PC in parallel with the path control of the CNC robot. The machining programs can therefore be programmed in G-Code as normal and generated from the usual CAD/CAM programs. Daniel Distler explains: "We want the robot to work perfectly with the user's CAM software." toolcraft also has a flexible control platform for this purpose in the shape of PC-based control.

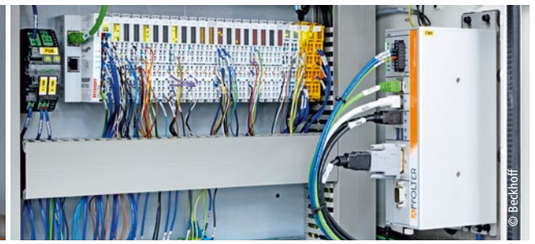
More information:
www.toolcraft.de/en
www.beckhoff.com/twincat

Precise machining of small parts with TwinCAT CNC

Open and flexible – right to the core

Producing large parts with precision is not easy. But how do you produce the smallest components, such as gears and screws for the watch industry or contact pins for connectors, with micrometer-level accuracy and in large quantities? Swiss companies Esco and Affolter achieve this feat in their CNC machines with TwinCAT CNC and servo drive technology from Beckhoff.

Esco mounts the AX5000 Servo Drives under the machine frame to save space.



Control for the lathes: The C6920 control cabinet Industrial PC (right), which runs the TwinCAT CNC for up to twelve servo axes and spindles, and the associated EtherCAT Terminal system (left).

Esco relies on a control solution based on TwinCAT CNC developed by the Swiss Beckhoff Solution Provider Affolter across all machine series.

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Different CNC machine, same control core: Affolter synchronizes three high-speed spindles with PC-based control from Beckhoff in its own machining centers.

In Watch Valley, a region between Basel and Geneva, an ecosystem has developed over several centuries around the watch industry and the smallest precision components for micromechanical devices. Machine builders such as Esco SA in Les Geneveys-sur-Coffrane and Affolter Group SA in Malleray are one important part of this ecosystem. Their CNC machines are used to manufacture the smallest gears, screws, shafts, and other components at maximum precision, practically laying the foundation for the famous precision of Swiss watch movements.

Esco specializes in lathes for the production of parts with high accuracy and impeccable quality in medium and large quantities. As well as turning as their main process, the machines offer additional machining functions. They make it possible for complex parts to be produced on the compact machines.

Stationary material and rotating tools

Unlike conventional automatic lathes, Esco machines are characterized by an individual operating principle: stationary material, rotating tools. This allows the machines to process ring or bar material in a fully automated process without interruptions. "In addition, the proximity of the tools to the workpiece offers advantages in terms of production rate and surface quality," says Vincent Fankhauser, sales manager at Esco. The basis for the precision and the short machining times is the spindle, which rotates at up to 12,000 rpm.

Esco has been relying on PC-based control for the automation of its machines since the beginning of 2020, for which it uses TwinCAT 3 from Beckhoff. "The control and drive technology from our previous suppliers were at the end of their life cycle and we needed future-proof CNC technology that could be easily configured for our different series," says Vincent Fankhauser.

This is where Beckhoff Solution Provider Affolter comes into play. The company manufactures gear hobbing machines itself and, as a contract manufacturer, produces intricate parts for the watch industry and other sectors on around 350 machines. Managing Director Vincent Affolter: "We were always proud of our own control solution, which we developed ourselves for our machines and then had the electronics manufactured." The central component of the control system was an FPGA that calculated all setpoints for all axes in parallel within microseconds. But when the electronic components became unavailable, Affolter was no longer able to maintain its control system, let alone develop it further and integrate additional requirements such as IT connectivity. Fortunately for Affolter, the performance of PC technologies was increasing rapidly.

From FPGA to open control platform

"When analyzing possible control system suppliers in 2016, we quickly found what we were looking for at Beckhoff and started initial tests with PC-based control," says Vincent Affolter. One of his priorities was to retain the flexibility for in-house innovations without the company having to develop hardware again itself. "This is provided by the open control platform from Beckhoff," adds Philippe Abt from Sales at Beckhoff Switzerland. PC-based control and TwinCAT CNC now form the basis for a control platform that Vincent Affolter uses in their own CNC machines and makes available to machine builders such as Esco as a Beckhoff Solution Provider.

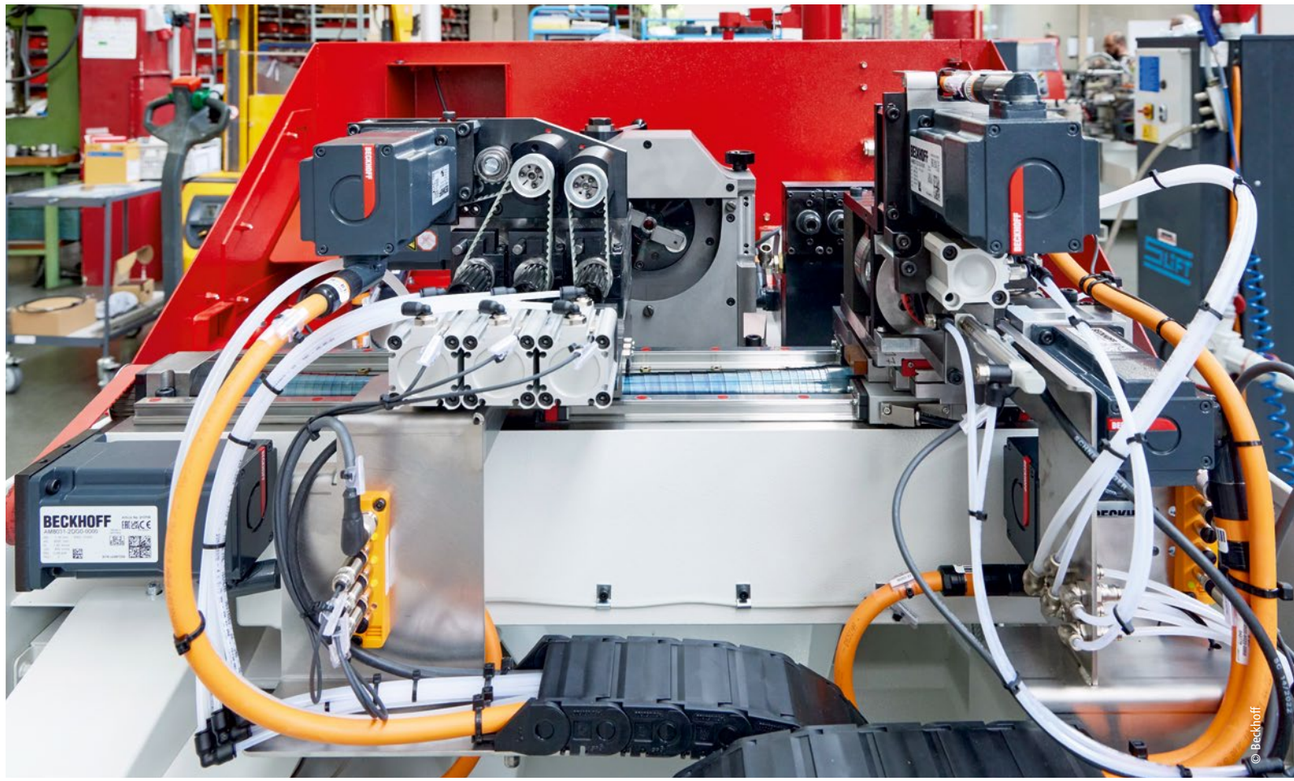
When adapting the CNC solution to the Esco machines, the flexibility of PC-based control became apparent: due to the required machine cycle, there was no time to waste when processing the CNC tasks. "Due to the modular system architecture of TwinCAT CNC, it was possible to achieve the short cycle times required by Esco by configuring it accordingly," recalls Philippe Abt. In order to reduce the computing times for the tasks, any functions that were not required were removed. "The crucial thing for us is that we have always received support in this from the very beginning, and have found and implemented solutions together with Beckhoff. That is not something that can be taken for granted," says Vincent Affolter.

PC-based control suitable for all series

The jointly adapted control concept based on TwinCAT 3 and a C6920 control cabinet Industrial PC works in all Esco machine series and forms the basis for the long-term and safe migration of all CNC machines to PC-based control. In total, Esco has already delivered around 150 machines with TwinCAT CNC-based control technology in various configurations since 2020. As Vincent Fankhauser says: "We are now much more flexible and can put together exactly the computing power and drive configuration we need from the entire portfolio, including safety." With an Escomatic D6 Twin, for example, there are twelve servo axes to be controlled and three CNC channels to be calculated.

The One Cable Technology (OCT) in the drive technology (AX5000 Servo Drives and AM8000 servomotors) saves space in the control cabinet and in the machine, since only one, thinner motor cable needs to be routed. The issue of signal interference in the feedback systems has also been eliminated since the switch to OCT.

Affolter and Esco are currently working on integrating tool monitoring and inline quality control. The roadmap also includes the connection of their CNC machines to MES and ERP systems via umati (universal machine technology interface) and OPC UA. With PC-based control as an open and modular control system, this is set to be another success.



OCT drive technology from Beckhoff solves many problems for Esco, from installation and space savings in the machines to performance.

Beckhoff Solution Provider Vincent Affolter, Esco Sales Manager Vincent Fankhauser, and Beckhoff employee Philippe Abt in the Esco technical center (left to right).

More information:
https://escomatic.ch
www.affoltergroup.ch/en
www.beckhoff.com/cnc

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The modular architecture of the Pipe Titan pipe welding system integrates an existing welding system including recipe management with two welding positioners for flexible use in fully or semi-automation operation to create a productivity-enhancing processing center.

Modular engineering with TwinCAT in pipe welding system for boiler room solutions

Automated welding system nearly triples speed of production

Pipe Titan is the latest robotic welding system from LJ Welding Automation. The integrated PC-based control technology from Beckhoff facilitated the implementation of a modular system architecture, offering a lot of flexibility for changing production processes in fully or semi-automatic operation. For one manufacturer of boiler room systems, Cleaver-Brooks, implementing this system increased throughput, quality and safety.

Dean Jacobs, Principal Automation Engineer at LJ Welding Automation based in Edmonton, Alberta, can describe the world of welding equipment in two words: bolt-on. "People bolt on this subsystem here, bolt on that one there," says Jacobs. "Soon, your welding cell has seven control panels and needs a massive power bar to feed them all." The bolt-on approach was born of necessity. However, as technologies advance and equipment end users demand more modular solutions, the design and maintenance of such systems has become unsustainable.

LJ Welding, however, recognized early on that an integrated approach not only provides a cleaner look, but also a key differentiator in the marketplace. The company provides wide-ranging solutions for welding, specializing in submerged-arc welding manipulators. With customers in more than 50 countries, it serves the most diverse industries. VP of Product Development Tim Robinson says: "Over the last 17 years, we have expanded rapidly, and now we have hundreds of products as well as many custom, application-specific solutions. We

The Pipe Titan welding system from LJ Welding is a turnkey processing center optimized for 2- to 24-inch-diameter pipes. Cleaver-Brooks uses it to assemble pipes for its sturdy, leak-proof boiler systems.

can also tie together multiple pieces of equipment and provide complete turnkey plant design."

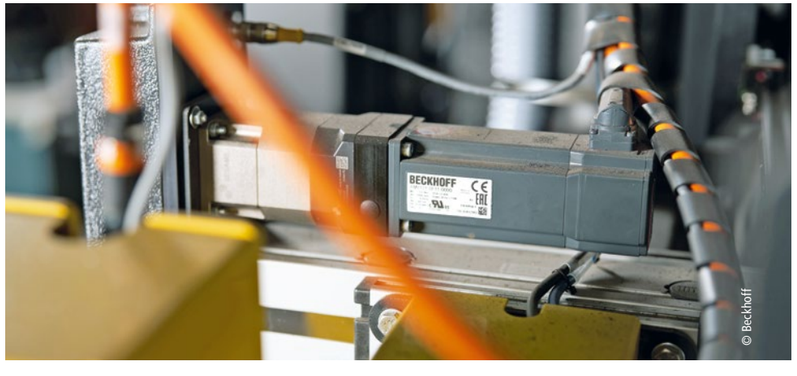
With the new Pipe Titan pipe welding system, LJ Welding offers such a complete processing center. The system is optimized for 2- to 24-inch-diameter pipes. One of the first Pipe Titan systems needed to deliver high-performance pipe welding at the Cleaver-Brooks facility in Stratford, Ontario. EtherCAT and PC-based control technologies from Beckhoff helped consolidate functionality into a centralized control architecture and provide a flexible, fully integrated solution.

Welding is a core competency in boiler manufacturing

Cleaver-Brooks is a global provider of efficient boiler room solutions, with a focus on reducing energy usage, cost and environmental impact. The pioneer of packaged firetube and watertube boilers stands alone in offering an entirely integrated boiler room solution for applications of any size. Cleaver-Brooks had several requirements for Pipe Titan, including reducing costs, improving quality, increasing productivity and enhancing safety, according to Corporate Welding Specialist Joel McLeod.

"Welding is a core competency at Cleaver-Brooks that helps ensure the structural integrity and reliability of our boiler room products and systems," Joel McLeod explains. "We use a variety of welding processes throughout production to assemble and join various metal components in order to create sturdy and leak-proof boiler systems."

The LJ Welding Automation engineering team needed to maintain a clean design with highly deterministic control and system modularity. They also needed automation and networking technologies to support a high-end welder from EWM, according to Dean Jacobs. This welding equipment uses highly tailored programs to limit heat in the workpiece, thus minimizing warping and corrosion in pressure piping. The new welder had to work with the existing recipe management system to guarantee reliable and consistent results.



Center: A CP6700 Panel PC combines the main control CPU of the processing center with a 10-inch touchscreen for operator interface.

Bottom: In the positioners, AM8100 series servomotors rotate the pipes with high precision for accurate welds.

PC-based control supports platform approach

As he has done before, Dean Jacobs turned to Beckhoff to meet the project's challenges. "When I started at LJ a decade ago, it was a blank slate in terms of automation platforms," he says. "A major draw of PC-based control was – and continues to be – the ability to integrate third-party technologies on one platform."

The Pipe Titan uses a CP6700 economy built-in Panel PC as the central machine controller, combining a 10-inch touchscreen for HMI with Intel Atom® processors in the control CPU in one device. The Pipe Titan has two separate positioners, and each has its own CX series embedded controller from Beckhoff. "The positioners have their own controller for simple one- or two-axis applications to rotate the pipe, along with functional safety and an HMI server. This way, they can function as independent machines if needed," Dean Jacobs says. "You can unplug one positioner, take it to the other side of the plant, and use it. We use this modular architecture on all our larger machines."

The modular TwinCAT 3 automation software enables this architecture as an end-to-end engineering and runtime environment. TwinCAT combines all functionality on a comprehensive platform for everything from PLC, HMI and motion control to IoT, analytics and even machine learning. TwinCAT supports programming in all IEC 61131-3 languages and their object-oriented extensions, custom or predefined function blocks, and computer science standards in Microsoft Visual Studio®. LJ Welding leverages Structured Text, JavaScript for HMI development and other languages as necessary. TwinCAT helps the engineering team consolidate to a single tool chain to avoid switching between development environments. It also provides them with advanced source control options, as Benjamin Vandenberg, Automation Engineering EIT, explains.

EtherCAT brings together speed, flexibility and safety

The EtherCAT real-time Ethernet technology's flexibility and scalability proved instrumental to the integrated yet modular design. EtherCAT enables free selection of topology, and hot connect capabilities. The Pipe Titan has multiple E-stops across its modules, which communicate via TwinSAFE, the integrated functional safety solution from Beckhoff. As such, it supports modular machine designs without any hardwired safety controllers to physically adjust, Benjamin Vandenberg explains: "We essentially have three independent safety systems running, each one with an EL6910 TwinSAFE Logic Terminal. They communicate to each other using Safety over EtherCAT (FSoE), and we can simply turn those connections on and off in software using TwinSAFE features. We can add or remove different pieces of equipment as necessary to make it a more adaptable and scalable system."

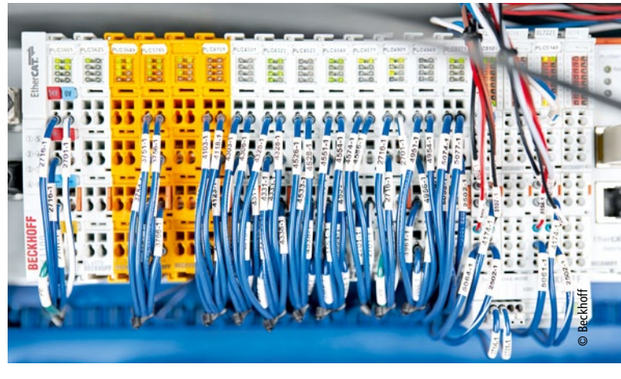
LJ Welding also relies on the vast number of available EtherCAT I/O terminals. The EL7211 and EL7221 servomotor terminals provide a compact motion interface to the AM8100 series servomotors. The EL3255 5-channel potentiometer modules ensure accurate speeds on the positioners when controlled by a hand pendant, variable-speed foot pedal, etc. EtherCAT-compliant third-party devices, such as a VFD on the Pipe Titan, work seamlessly with the EtherCAT controllers from Beckhoff. EtherCAT also supports connection to more than 30 communication protocols with the simple addition of an I/O module acting as a gateway. This promotes greater flexibility in component selection and avoids the poor integration of bolt-on scenarios. "On the Pipe Titan, the EL6224 IO-Link master terminal was particularly useful for connecting a laser displacement sensor, and we've used it in many other applications," Dean Jacobs says.

Welding system delivers impressive results

By leveraging PC-based automation from Beckhoff, the team at LJ Welding implemented a system that surpassed the requirements of Cleaver-Brooks. The Pipe Titan led to impressive performance increases, according to McLeod. Cleaver-Brooks reduced arc time by 63% on average, which is nearly three times faster. The system also led to a 90% reduction in weld clean up time, 10% reduction in rework and 39% reduction in filler metal spend.

"The Pipe Titan welding system allows us to perform tasks faster and more efficiently than manual labor, leading to increased productivity and capacity. It reduces errors and inconsistencies, resulting in higher quality output," Joel McLeod says. "Being mechanized, it can be programmed to perform a variety of tasks and can be easily reconfigured to meet our changing production demands. The Pipe Titan welding system helps reduce the risk of workplace accidents and injuries associated with manual labor, thereby improving employee safety."

TwinCAT accelerated development, and TwinCAT Scope, the built-in software oscilloscope, enhanced tuning of the machine. Using the IPC Security Guideline from Beckhoff, LJ Welding can safely remote into customer machines for maintenance or troubleshooting. But the team isn't stopping there. The next phase for the Pipe Titan and other machines is higher-level connectivity for analytics and continuous improvement. Fortunately, for Dean Jacobs, this is another area where the Beckhoff technology is not bolt-on, but can be expanded flexibly. Standard analytics algorithms, no-code dashboards, secure connectivity via OPC UA and more are all built into TwinCAT.



For adaptation to diverse customer environments, LJ Welding relies on the wide variety of EtherCAT Terminals from Beckhoff.

More information:
www.ljwelding.com
www.cleaverbrooks.com
www.beckhoff.com/twincat

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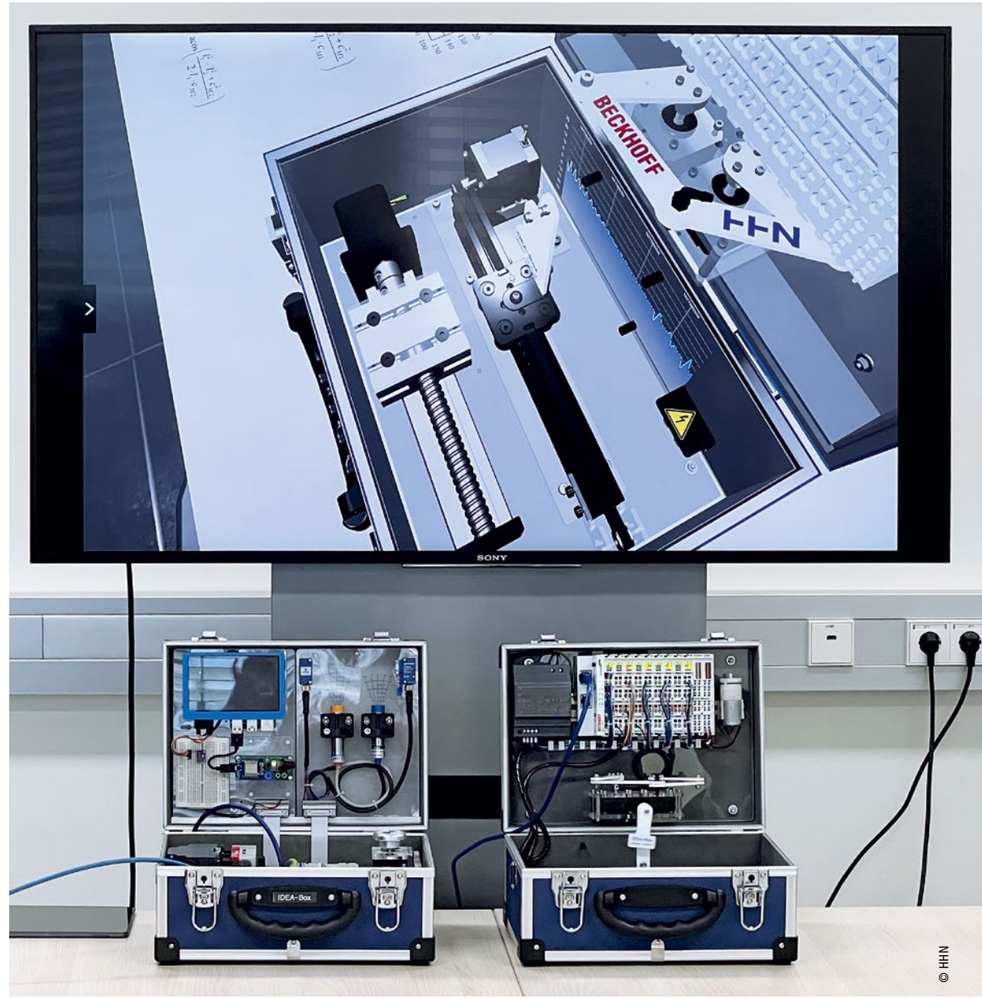

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Small and compact cases: The IDEA basic box (left) with the C6015 ultra-compact Industrial PC and the expansion to include more extensive motion functions (right) – where operation via joystick and even hand tracking is possible.

The IDEA box also allows students to delve into simulation, digital twins, and augmented reality scenarios.

PC-based control at the core of a demo case for university studies

A compact and practical way to experience and understand Industry 4.0 solutions

The IDEA box (Industrial Digitalization in Education of Automation) developed at Heilbronn University of Applied Sciences is designed to introduce students to the topic of Industry 4.0 in a simple and practical way. At the core of the corresponding demo case is PC-based control from Beckhoff, with the C6015 ultra-compact Industrial PC, TwinCAT, and EtherCAT Terminals as a flexible I/O system.

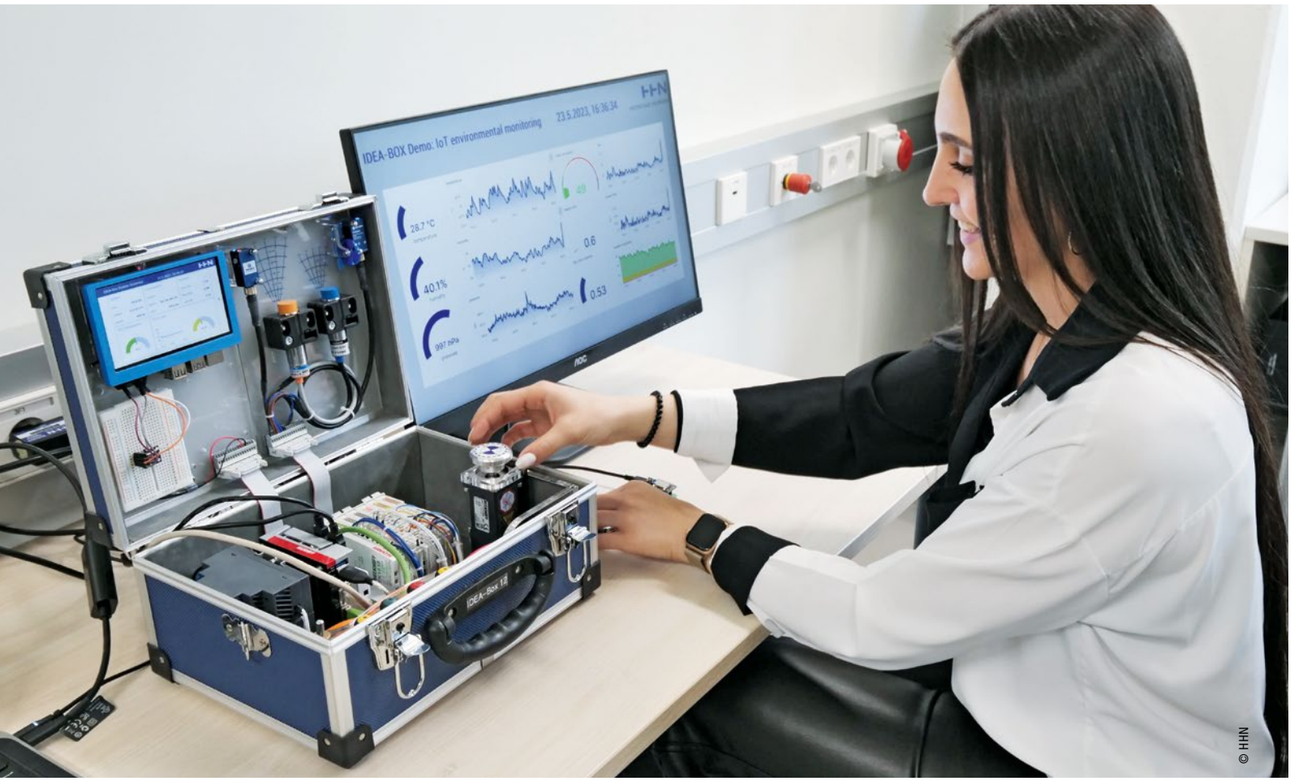
The "magic suitcase full of future technologies" – as Prof. Thomas Pospiech, the initiator of the project, calls it – will benefit students from the technical faculty at Heilbronn University of Applied Sciences (HHN). It enables numerous industrial application scenarios illustrating the increasing convergence of IT and automation to be implemented and solved directly in the lecture hall.

The idea behind the IDEA box

Students build their own electrical circuits with sensors and program the IDEA box so it can read and process the sensor signals. The result may be a graphical display of the development of the measured variables over time, an alarm that is triggered on all IDEA boxes in the lecture hall when limit values are exceeded or not reached, or the activation of a motor in the box. Data communication is transferred to the students' smartphones via the Internet. The IDEA box is particularly intended to enable students to implement their own ideas due to its wide range of possible uses.

Overall, the demo case covers all the basics of conventional automation technology, from data acquisition and processing via capacitive and inductive proximity switches, for example, to simple single-axis positioning tasks. Prof. Thomas Pospiech adds: "Time-critical applications are also possible, allowing students to gain experience at the limits of the control cycle time."

The IDEA box is a small case with a volume of approx. 9 l containing the C6015 ultra-compact Industrial PC, an EK1818 EtherCAT Coupler, and several EtherCAT Terminals (e.g., EL3174, EL7047, and EL7211), as well as a Raspberry Pi single-board computer and the sensor and actuator technology. This allows



Practice-based work in the field of IoT environmental monitoring

students to operate DC and stepper motors in addition to a synchronous servomotor. Various interfaces and slots also enable users' own developments to be connected and networked – for example with microcontrollers. This allows cyber-physical system concepts to not only be explained, but actually implemented by students.

System openness through PC-based control

Another contributing factor with regard to the high degree of flexibility is the expansion options; for example, the two existing modules in the case lid – with the sensor technology or the microcontroller technology – can be replaced by new developments. This makes it possible to integrate new learning content, e.g., with an image processing module, without having to completely rebuild the IDEA box. The communication technology is just as flexible as the set-up, thus providing students with as many technical requirements as possible. For example, the C6015 communicates with the I/O terminals via EtherCAT and with cloud solutions via MQTT. ADS, OPC UA, Modbus, WLAN, and the I²C data bus are also implemented.

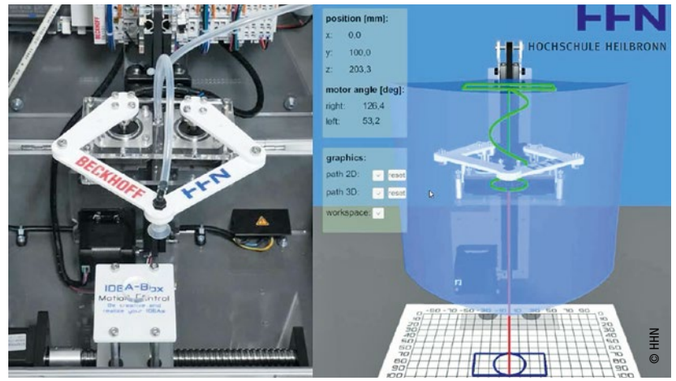
For Prof. Thomas Pospiech, this kind of system openness is essential in order to teach students as broad a spectrum as possible: "In PC-based control from Beckhoff, I particularly appreciate this openness to any software and all technologies that may come our way and therefore have to be taught. The industrial PC is simply ideal for this purpose. Especially since only this IPC can achieve the level of functionality at such a high packing density. Another major advantage is that TwinCAT also allows other software packages, such as MATLAB®/Simulink®, to be integrated easily and in full."

The IDEA box was first used at the start of the 2020 semester, which, according to Prof. Thomas Pospiech, brought a rather unexpected advantage of the extremely compact demo case to the fore: "With the onset of the COVID-19 pandemic, we very quickly switched to online lectures, with the huge advantage that students could simply take the IDEA box home with them and work in the same practice-based way as at the university."

Expansion to include multi-axis motion and robotics

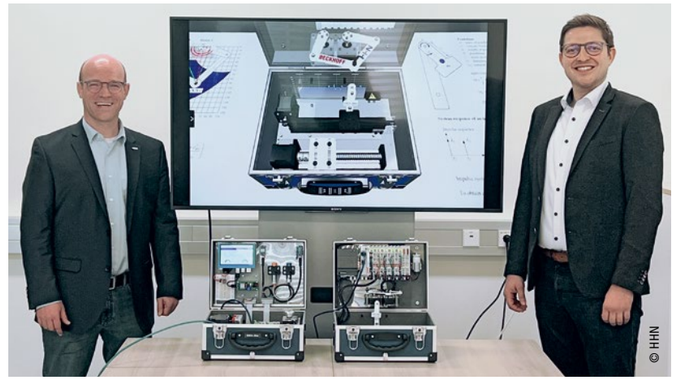
The "Motion Control" expansion box has been developed as a way to teach multi-axis movements and robotics kinematics. It contains the required power supply as well as EtherCAT Couplers and Terminals in the case lid. In addition, there is a single stepper motor, a two-axis kinematic system, and, inside the case, two different linear axes, one of which has a pendulum mechanism. The C6015 provides the control intelligence to the connected IDEA basic box. As Prof. Thomas Pospiech explains: "Using a stepper motor with spindle, for example, the purely mathematical programming can be combined very effectively with the mechanical properties as a way of providing optimal illustration of the

Parallel kinematic manipulator (left) and its digital twin (right, implemented with TwinCAT 3, Unity, and realvirtual.to)



overall mechatronic system, with the aspects of motor, rotary motion, spindle or spindle pitch, and feed or reference run. And this is where a major advantage of TwinCAT becomes apparent, because a wide variety of motors – whether stepper motor or servomotor – are handled in exactly the same way in the software application. This means students can be given the knowledge they need based on one motor, and then they can easily transfer what they've learned to another motor to reinforce it."

More complex functions, such as cam plates, anti-oscillation algorithms, and resonance-free positioning, can also be implemented with the Motion Control box and the linear axis with pendulum mechanism. This is helped by the fact that the modular design is applied systematically, i.e., the axes can be easily exchanged, for example as a way of understanding a control engineering model based on the balancing of a ball. The dual-SCARA kinematics are primarily intended to teach the topics of manual referencing and forward and reverse transformation. By combining multiple axes, the complexity can be increased – for example, the robot kinematics and the spindle axis can be combined into a pick-and-place unit by means of a simple conversion.



Initiator Prof. Thomas Pospiech (left) and Lutz Megerle (right), Beckhoff Crailsheim sales office

A digital twin through model integration

A CAD model of the Motion Control box, which can be linked kinematically to the PLC program, gives students their first experience with a digital twin. For Prof. Thomas Pospiech, this is particularly important when considering the future: "Virtual commissioning of the digital machine twin allows development steps to be brought forward and subsequent processing steps to be run in parallel – a prerequisite for Germany to remain competitive as a production location from a global perspective. And our students should be given the best possible training for exactly that."

According to Prof. Thomas Pospiech, TwinCAT once again offers significant advantages due to its openness: "The oscillation of the pendulum, for example, is not recorded via sensor technology, but is simulated via a corresponding MATLAB®/Simulink® model integrated directly in TwinCAT. A total of five such physical behavior models run on the C6015 ultra-compact Industrial PC, including those for flexible components such as the toothed belt. Communication between the digital twin and the controller runs bidirectionally via TwinCAT ADS." All geometric distances of the moving components or assemblies can be determined through the integration of virtual sensors in the underlying Unity model. For example, collisions can be detected and robot workspaces can be monitored dynamically. The information can be generated in the Unity model and communicated via feedback to the PLC. This information is processed in the controller in turn and corresponding functions are executed so that appropriate actions are taken.

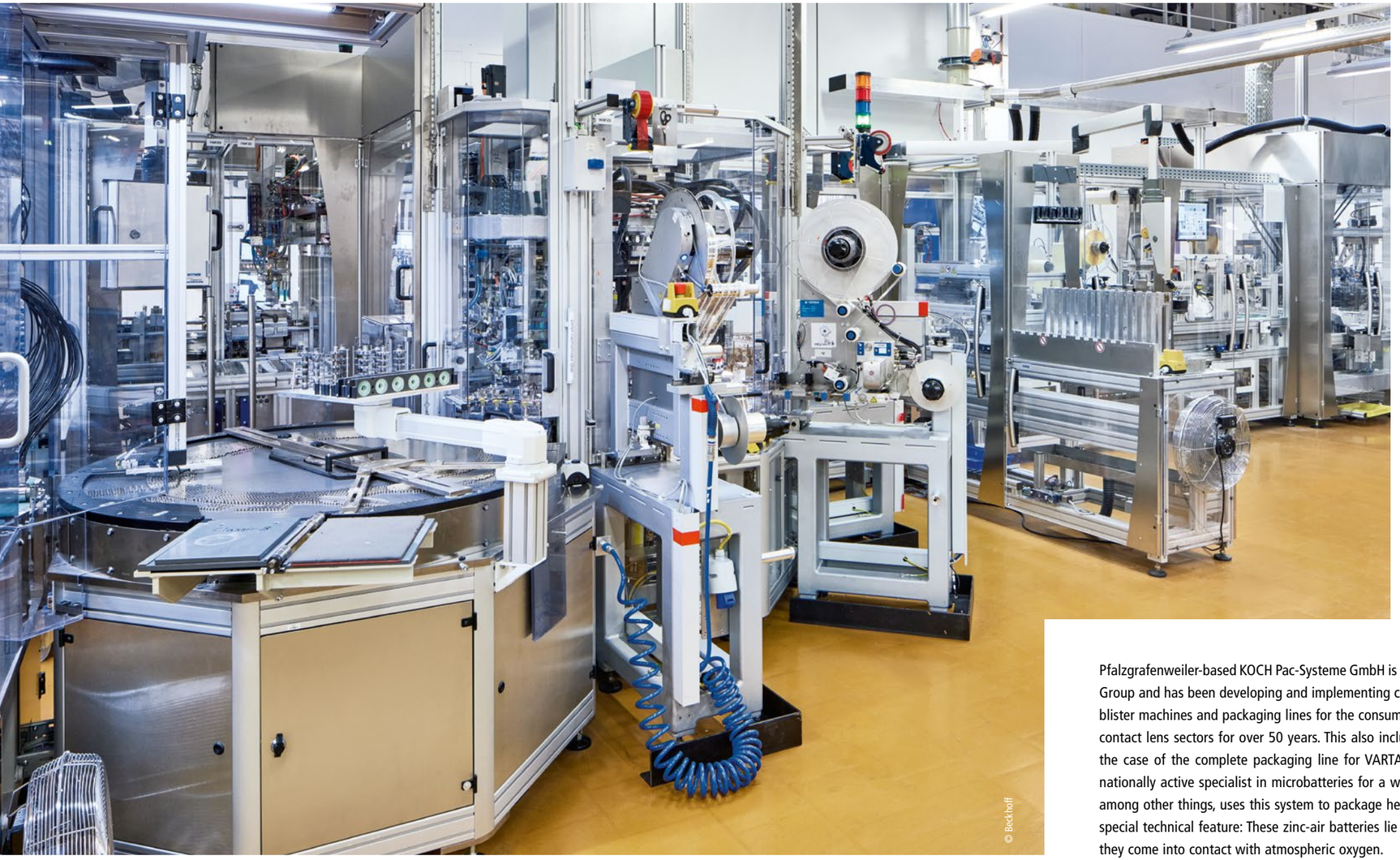
The IDEA box was developed especially for use in a teaching environment. In recent years, however, it has become apparent that the system is also of great interest to the industry as a way to find suitable solutions as quickly as possible in a wide variety of areas. In addition, Heilbronn University of Applied Sciences makes all programs created during the lectures freely available so that the box can be distributed as widely as possible and inspire young people in particular to take up technical professions. Further expansion stages will also play a part in this, including the control of six-axis kinematics via augmented reality.

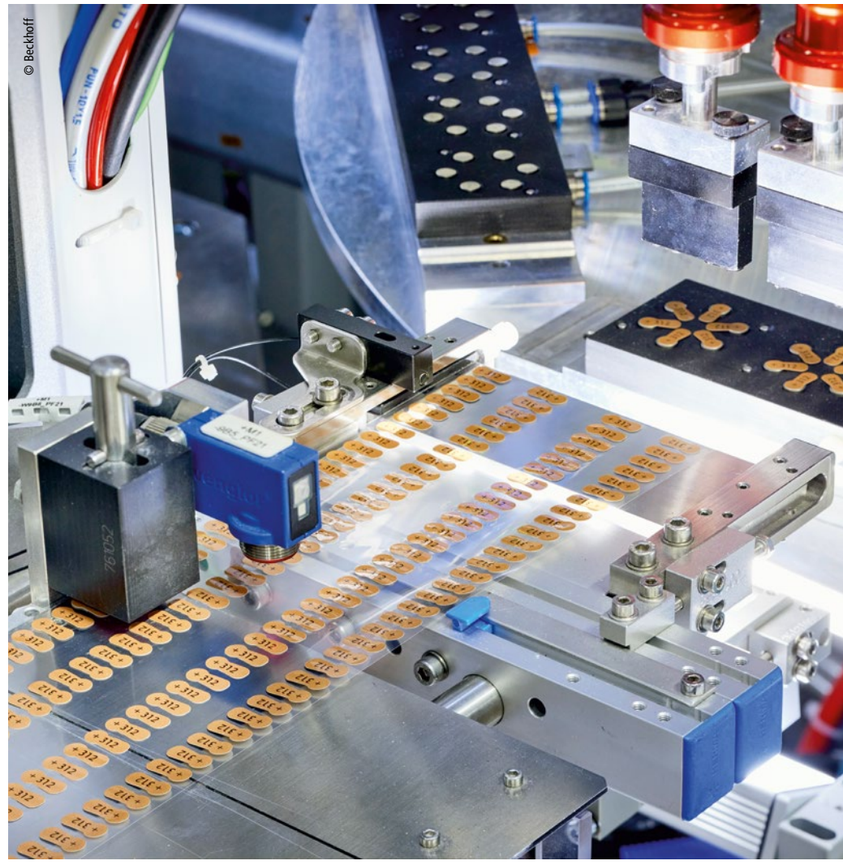
More information:
www.hs-heilbronn.de/en
www.beckhoff.com/c6015
www.beckhoff.com/industrie40

PC-based control and drive technology in a packaging line for microbatteries

Only high-precision labeling reliably puts hearing aid batteries into a deep sleep

When packaging products as small as microbatteries, it goes without saying that precision is just as important as speed and efficiency. This is particularly true of hearing aid batteries, which can only maintain their performance by being hermetically sealed with a label to keep them in a state of deep sleep until they reach the end customer. High-precision labeling processes are key here, and this is precisely where KOCH Pac-Systeme comes in with its packaging line equipped with Beckhoff technology for the end customer VARTA.



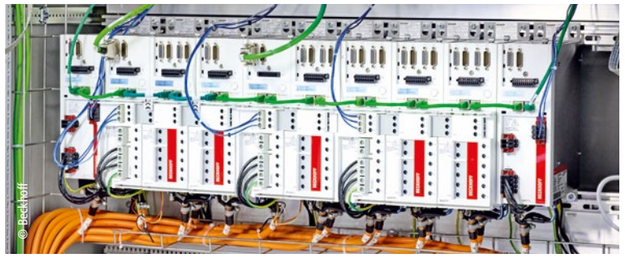


Feeding and applying the label to the microbatteries in the workpiece carrier

A mere overview of the production line, which measures around 20 x 6 meters, gives an idea of the complexity of the packaging process for hearing-aid batteries.

Pfalzgrafenweiler-based KOCH Pac-Systeme GmbH is a member of the Uhlmann Group and has been developing and implementing customer-specific, modular blister machines and packaging lines for the consumer goods, healthcare, and contact lens sectors for over 50 years. This also includes microbatteries, as in the case of the complete packaging line for VARTA in Ellwangen. The internationally active specialist in microbatteries for a wide range of applications, among other things, uses this system to package hearing-aid batteries with a special technical feature: These zinc-air batteries lie completely dormant until they come into contact with atmospheric oxygen.

Klaus Schöbel, Head of Efficiency & Data Management at VARTA, explains exactly what this property of microbatteries means for packaging technology: "The positive terminal of the battery has air holes that facilitate contact with atmospheric oxygen; however, premature contact with air would cause the battery to dry out and lose its available capacity. To ensure the batteries can be delivered to the end customer without a loss of capacity, the holes have to be sealed airtight during the packaging process with protective film in the form of a label, essentially putting the batteries into a kind of deep sleep." Jürgen Welker, Director Automation and Technology at KOCH Pac-Systeme,



The AX5000 servo drives result in powerful, precise, and – in conjunction with One Cable Technology (OCT) – compact motion control.

Left: The delta robot for stacking the blister packs is supported by the AM8000 dynamic servomotors (above) to enable rapid movements.

adds, "It is precisely this technique of being able to apply a high-quality seal with maximum precision that represents the special feature of this packaging line. What's more, a huge amount of development effort has been invested in the transfer technology and optical inspection systems to ensure that only correctly sealed batteries are transported further in the process."

Close cooperation for an optimal solution

The overall machine building responsibility for this sophisticated system lay with KOCH Pac-Systeme, whereby consistent modularization meant that both standard machine modules and specially developed workstations could be used. These workstations were developed in close cooperation with VARTA to create an optimal overall solution. Michael Bühler, Software Engineer at KOCH Pac-Systeme, notes that, "The optical control of the label position on the battery represents a clear example of where the expertise on both sides could be combined. And so, we were able to come up with a self-optimizing, camera-based system that can also handle the enormous variety of around 1,500 packaging types, confirming an extremely low error rate of less than 0.02%."

Klaus Schöbel cites the data link to the ERP system as yet another special feature: "When the relevant production order is scanned in at a packaging line, all necessary production parameters – such as print data or label types and colors – are loaded directly into the machine control system from the higher-level databases. System operators can also count on comprehensive documentation, which is essential for error-free handling given the large variety of types and numerous packaging variants, and ensures batch changes can be made on the fly."

When it comes to flexibly and efficiently implementing specific customer requirements, KOCH Pac-Systeme has to be able to rely on universal and open control technology, as Jürgen Welker confirms: "This packaging line contains a wide range of technologies and machine concepts. After all, it's not just about packaging, it's also about the interaction of product processing and handling, and it is precisely through overall concepts like this that PC-based control from Beckhoff really comes into its own. The open and modular control platform opens up a host of possibilities for us to flexibly integrate any necessary functions, such as packaging, handling, testing, and even third-party components."

From blister to transport packaging

The diverse process sequences within the packaging line equipped with Beckhoff control and drive technology start out with the production of the blisters. These are created from a supplied film, which is heated, shaped, and punched accordingly. The blisters are transported further via a pallet system and loaded with the microbatteries, which have previously undergone electrical checks, as well as visual checks in the plant itself, to ensure correct labeling. In the next step, the blisters are sealed with a card to form individual packs complete with a quality label and the expiration date, which is also verified via cameras. Finally, the system stacks the individual packs in a small cardboard box before these are checked for filling weight and their own respective labels and subsequently grouped to form a larger transport pack.

Klaus Schöbel explains that it is not only this process sequence that has to run as efficiently as possible: "The notable focus with this packaging line, as with every one of our new systems, was also on optimizing changeover times. This is because the numerous packaging variants mean that the systems have to be changed over six times a day on average." Jürgen Welker confirms this, adding, "Minimizing setup times is another important goal for us. We have already achieved significant improvements in this area in recent years. In the case of the new packaging line, there is also the fact that the system performance has

The experts in front of the packaging line for hearing-aid batteries (from left to right): Fabian Jungkunst, Manager of Zinc Air Packaging (VARTA), Michael Bühler, Software Engineer, and Jürgen Welker, Director Automation and Technology (both KOCH Pac-Systeme), as well as Winfried Wolf, Head of Production BU Micro, and Klaus Schöbel, Head of Efficiency & Data Management (both VARTA)

Klaus Schöbel describes the uniform VARTA operating concept based on the CP3216 multi-touch Panel PC from Beckhoff.

Unified production HMI

The diversity of the production processes at VARTA poses challenges not only in the collection of energy data, but also in terms of operating and monitoring the wide range of machinery and equipment. Klaus Schöbel describes the solution: "We have developed a central interface that runs via an industrial PC and works for all systems, regardless of manufacturer. The basis is the CP3216 multi-touch Panel PC with 15.6-inch display, which we get from Beckhoff as a plug-and-play solution complete with a customer-specific software image. The plan is to implement around 300 devices throughout our production processes. These will also serve as communication interfaces between the plants and our cloud applications for material handling or bookings, for example. The system is based on an SQL database, whose key features include the ability to implement a central change history and centralized production control."

increased from 15 to 18 pallet feed cycles per minute compared to the previous system, notably via the highly efficient blister stacking by the delta robot at the end of the system implemented with Beckhoff Drive Technology."

Powerful drive technology with future potential

The PC-based drive technology controlled with TwinCAT NC I ensures fast and precise process sequences throughout the system. The approximately 50 servo axes are implemented via AX5000 servo drives and AM8000 servomotors from Beckhoff. Efficient use of installation space is a crucial factor for Michael Bühler, who points out that, "At KOCH Pac-Systeme, we consistently rely on One Cable Technology (OCT). This saves an enormous amount of material and installation effort, not to mention space, with further advantages including the avoidance of wiring errors and the use of an electronic identification plate. For optimum use of the available installation space, we also use compact drive technology from Beckhoff in our machines wherever possible, especially the 48 V versions of the EL/ELM72xx servomotor terminals or the EP72xx EtherCAT Box modules. In some applications, these already account for over 30% of the servo axes."

Jürgen Welker sees future optimization potential in the motion environment, and particularly in the new modular ATRO industrial robot from Beckhoff: "We see an immense advantage in this technology because our plants are always full of pick-and-place units. ATRO would allow us to save on space considerably compared to the previous mechanical axis systems with servomotors, and in terms of software, machine modularization would be optimally supported and simplified."

Sustainability through system-integrated measurement technology

Sustainability is particularly important in the packaging sector, as Klaus Schöbel is keen to underline: "To take one particular example, we are currently working together with KOCH Pac-Systeme on the possibilities of plastic-free packaging. A second major topic is energy consumption, in terms of not only minimizing it, but also looking at the exact distribution of the respective energy consumption in relation to the individual battery types. The latter in particular is not easy due to our extremely diverse production environment. The measurement technology integrated into the PC-based control system from Beckhoff helps to collect sufficient current data and transfer it to a central database for further evaluation. With the complex integration of non-electrical areas such as compressed air, vacuum, and cooling water, this is certainly another longer-term project."

Jürgen Welker also confirms the importance of sustainability and explains the energy-saving mode of the systems: "In energy-saving mode, almost all field devices are completely switched off and only the control station PC remains ready for operation. This is the prerequisite for being able to start up the systems automatically, according to the work shifts or workloads for example, and in good time before the start of production. It also allows us to ensure our manufacturing processes are as energy efficient as possible."

More information:
www.koch-pac-systeme.com
www.varta-ag.com
www.beckhoff.com/packaging

Beckhoff, the system partner: Never before has the tea-bag packaging machine manufacturer Teepack used so many components from a single supplier in a machine as in the Perfecta 450.

Control of the sophisticated kinematics via TwinCAT NC I and AM8000 servomotors increases the machine cycle as well as flexibility for bag geometry and different packaging materials (e.g., filter paper, wrapping paper, and film).

Servo drives replace mechanical cam plate in tea-bag packaging machine

High-performance motion control increases flexibility and machine speed

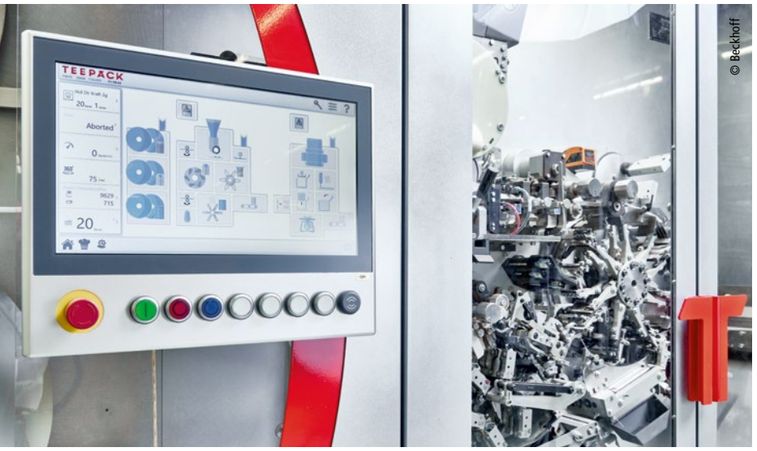
Did you ever stop and think about how tea gets into those tiny bags, or how the leaves stay inside when brewed? Teepack has been doing exactly that since 1948. In what they describe as their masterpiece – the Perfecta 450 – Franz Andel and Sascha Theine rely on PC-based control and drive technology from Beckhoff to set new benchmarks for speed and precision in their tea-bag packaging machines.

The name says it all: Up to 450 tea bags per minute are filled, folded, and sealed with the utmost precision by this top model from the Meerbusch-based manufacturer of tea-bag packaging and form-fill-seal machines. "It's important to bear in mind that absolute speed is by no means the only way to measure things," emphasizes Franz Andel, head of automation technology at Teepack. For Franz and his colleagues, it is vital that the tea-bag packaging machines always produce flawless tea bags, whether from a standing start or with changes in speed. This calls for a great deal of process expertise and precise automation technology.

The production process itself is already tricky enough, and this is compounded by the fact that the filter paper used for the tea bags has to be as thin as possible. "Our customers are looking for sustainable and efficient production processes, which – in addition to an accelerated machine cycle and lower energy consumption – also means minimal material usage," Franz Andel explains, outlining an important market requirement. "The thinner the filter paper, the more sensitive it is to fluctuations in tension as a result of different web speeds in the individual production areas, for example," adds Sascha Theine, who is responsible for hardware and software development at Teepack.

Motion control replaces mechanical cam plate

The higher speed and precision compared to the previous model stems from switching to an electronic coupling of the main axes via servomotors and software. "Previously, we had the main process mechanically linked via cam plates," recalls Franz Andel. In the Perfecta 450, this is now handled by the AX8000 multi-axis servo system and AM8000 servomotors in conjunction with



The CP39xx multi-touch Control Panel with push button extension enables optimum operation and monitoring of machine processes.

The compact AX8000 multi-axis servo system and OCT connection technology save valuable space in the control cabinet.

Dynamic synchronization of all axes, safety, HMI, and individual database application – the complete automation project runs on a single CX2043 Embedded PC.

"With Beckhoff as a platform supplier, we can channel 98 percent of our focus into the application," emphasizes Franz Andel, head of automation technology at Teepack (left) – pictured here with Sascha Theine, electrical design and software development (center), and Wilm Schadach, head of the Beckhoff branch in Monheim, in front of the Perfecta 450.

TwinCAT NC I. "The web tension control implemented with Beckhoff technology across all drive axes prevents the filter paper from tearing – even with dynamic speed changes," says Sascha Theine. Where previously the filter paper transport was rigidly coupled to the main movement, for example, the motion sequence is now controlled by two separate servo drives. "This allows us to vary the paper length of a tea bag, for example, and also to adjust the speed in relation to the other drives," notes Franz Andel. This offers Teepack and its customers more options when processing different types of tea and materials.

With up to 450 tea bags being processed per minute, the actual process is no longer visible to the naked eye: The filter paper is drawn in from the feed unit and passes under the dosing station. Here, the tea is fed from the top and distributed via a dosing station with various dosing chambers on the filter paper. Teepack is renowned for the unmistakable shape of its tea bags: "We were the ones who invented the double-chamber principle," Franz Andel points out.

More surface area, more taste

In contrast to simple tea bags, the tea in double-chamber bags is steeped from four sides, allowing it to release its aromas into the water better on account of the larger surface area. Experts have even recorded up to 30% more flavor for the same brewing time. This is why a cup with the same amount of tea is tastier, or else capable of developing the same intensity with less tea.

Once the portioning phase is complete, the filter paper is folded to form the double-chamber tea bag, which is performed exclusively by means of mechanical forming and folding in the downstream station. This is also where the thread is fed and knotted through the bag. "We manage the whole process without the need for metal clamps," underlines Franz Andel. The individual tea bags are then lined up and packed in the packaging cartons that have already been set up and glued in the Perfecta 450. This not only saves valuable space in production, but also increases process reliability, as the tea packs are already sealed when they are discharged via a conveyor belt.

The software-based axis synchronization also increases flexibility in development and reduces the effort required for fine-tuning the motion sequence. Previously, the process involved calculating, milling, and hardening a cam plate, which typically took three weeks. "Today, kinematics experts can calculate such a curve in two days and give us a table that is loaded into the servo drives in two minutes," reveals Sascha Theine, adding, "This means we only have to wait two days to find out whether the motion sequence fits and where readjustments could still be made." Franz Andel also notes, "We get results much faster and can optimize our processes much better than before." And with a performance increase of up to 20%, this optimization is clear to see.

More time for application creation

The Perfecta 450 is the first machine generation to be implemented completely with the Beckhoff platform. Teepack was looking for a supplier that could offer the entire portfolio of components: PLC, safety, motion, including IPC technology and an operator panel. Franz Andel comments, "Before Beckhoff, we were 60% concerned with the automation system and only 40% with the application. Now, we can devote 98% of our time to the application." This is also due to the excellent support, which even extends to the development department if necessary. What's more, application experts from Beckhoff can also provide support with the implementation and selection of suitable components and systems as required. "Since the beginning of the cooperation, our specialists have provided support in all technical areas for the implementation and optimization of customer concepts," explains Wilm Schadach, manager of the Beckhoff branch in Monheim.

In the Perfecta 450, all applications – from the control and synchronization of all servo drives, safety and HMI, through to data acquisition and database application for monitoring – run on a single CX2043 Embedded PC with a multi-core CPU (AMD Ryzen™ with four cores and a 3.35 GHz system clock). "The ability to still be able to run an HMI and a database along with the demanding motion control application without compromising real-time capability is not something we take for granted," emphasizes Wilm Schadach. In the maximum configuration, up to 30 AM8000 servomotors are controlled via the AX8000 multi-axis servo system or via the servomotor terminals in the ELM72xx series. As for the safety technology, this is system-integrated with TwinSAFE. The entire TwinCAT automation project and the HMI can be flexibly assembled according to the selected machine configuration.

"Flexibility in project planning was a key objective when selecting our automation platform," underlines Sascha Theine. Teepack can scale the hardware to match the machine configuration without having to change the control platform. The benefits of compact automation technology are often underestimated. "Control cabinet volume is a big issue with packaging machines, and we're actually always short on space," says Sascha Theine. This is where the AX8000 multi-axis servo system and the compact ELM72xx drive technology in combination with OCT connection technology provide significant relief in the control cabinet and during assembly. Wilm Schadach confirms these advantages, "Over 90% of our drives are now supplied with One Cable Technology."

Bursting with ideas for the next expansion stage

Further relief for crowded control cabinets can be expected from the distributed drives in the AMP8000 series with integrated servo amplifiers. The head of automation technology also sees the potential for further innovations based on Beckhoff technologies in the case of the carton erector: "XPlanar offers a host of different approaches as far as the different packaging formats are concerned." With the free-floating movers, the cartons could be moved flexibly in front of the glue nozzle to apply individual glue dots, for example. This would simplify the mechanical structure of the gluing station significantly and also reduce the effort required for the heating station. Ideas for the next Perfecta generation include the use of an image processing system for inline quality control. "Integrated into the system and coupled with the machine cycle in real-time via EtherCAT, Beckhoff Vision is an ideal fit," says Wilm Schadach, "especially since the system does not take up any additional space in the control cabinet." TwinCAT Analytics and TwinCAT Scope are also part of the concrete considerations for the next expansion stage. The plan is to collect additional operating data for machine status and key performance indicators. Franz Andel is thinking of aspects such as motor temperatures, motor currents, and torques: "We want to use the correlations to determine knowledge about wear and tear so that we can trigger preventive maintenance if necessary."

More information:
www.teepack.com
www.beckhoff.com/packaging

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Shanghai Yinghua increases the filling capacity of its pharmaceutical powder systems to 450 vials per minute with the XTS linear transport system.

XTS linear transport system creates competitive advantages

Enhanced performance for packaging machine for injection powder

Shanghai Yinghua, a Chinese pharmaceutical packaging system supplier, is responding to the trend toward powdered pharmaceuticals with an innovative generation of machines. The main features of the design include the XTS linear transport system and PC-based control, which engineers used to boost system output to 450 units per minute.

An increasing number of pharmaceutical preparations, including those designed for injection, are now being produced as powders due to the specific process advantages this offers. This method is even suitable for many heat-sensitive substances, since powder production is carried out at low temperatures. Proteins and microorganisms do not lose their biological viability during the freeze-drying process, nor do they become denatured or lose their effectiveness when dissolved in sterile water. Sterile and freeze-dried powders for injection purposes have therefore become a popular option in clinical practice, and the trend is continuing to rise.

Against this backdrop, manufacturers of pharmaceuticals need efficient, flexible, and GMP-compliant equipment for dosing and packaging injection powders. Shanghai Yinghua is a leading manufacturer of injection powder in China and is implementing these systems in its current packaging systems with the XTS linear transport system.

The process for packaging sterile powder for injection essentially comprises the following steps:

- washing, drying, and sterilizing the vials
- treating and sterilizing the rubber stoppers
- washing and sterilizing the aluminum caps
- packaging and sealing the powder in a sterile environment
- sealing, labeling, boxing, and packaging

Shanghai Yinghua faced several challenges when developing the new generation of equipment: fierce competition and constant technological advances in pharmaceutical equipment meant that they needed to offer cost advantages over their competitors. There were also many demanding technical tasks to contend with, such as turning the vials upside down and accurately dosing the powder at a higher filling speed, which are key to higher dosing efficiency and quality as well as lower raw material costs. Regulatory requirements presented a third hurdle, which included establishing how to implement inline weighing in order to meet GMP traceability requirements, instead of weighing individual samples, which was previously the usual method.

Specifications call for complete design overhaul

These requirements could not be met by simply upgrading the traditional machine design. Conventional transport by conveyor belts would make it difficult to meet the specifications of the dosing process, especially since the vials can easily tip over on the belts. If that were to happen, the entire batch would have to be scrapped and the machine would need to be cleaned. This would be a real blow to productivity, as the system would be out of action for quite some time. The relatively low accuracy of the conveyor belt means it would be difficult to position the vials under the filling needles with any kind of precision. There would always have been a risk of powder residue remaining around the mouth of the vial during the filling process, which constitutes yet another criterion for rejection.

By switching to the XTS linear transport system, Shanghai Yinghua was able to eliminate these typical process problems and set new standards in the industry in terms of performance and quality: almost any number of movers can be mounted on the guide rails of the linear transport system with minimal mechanical effort. This offers the flexibility to adjust the filling line to the required production capacities. The movers can be moved individually, in groups, or in sync with each other. When the powders are dosed, the vials can be clamped to the movers, for example, to prevent them from falling. Not only does this speed up the production cycle and reduce the error rate, it also eliminates any downtime for cleaning – an essential prerequisite for achieving unmanned operation.

Dynamics and precision are essential for faster machine cycles

In terms of high dynamics and precision, PC-based control enables the movers to be guided with precision and synchronized with the filling and packaging process. The accuracy of the magnetically driven movers is up to 50 µm, guaranteeing a perfect powder filling process without residue around the vial neck. Mover speeds of up to 4 m/s and up to 10 g acceleration assure the efficiency of the system. The combination of these specific XTS properties – precision, speed, and dynamics – results in an increased output rate of up to 450 vials per minute and gives Shanghai Yinghua a clear competitive advantage.

The company produces various tandem machines for producing sterile powder and freeze-dried powder, which can be assembled into complete production lines with dosing machines, vial washing machines, multifunctional capping machines, and sterilization and drying machines. Customers include more than 200 pharmaceutical factories worldwide.

Notable advantages here include the inline weighing system and the ability to record all operator interventions with an audit trail, which means the systems meet the compliance requirements in accordance with GMP. For Shanghai Yinghua and other Chinese manufacturers, the XTS linear transport system sets a trend that takes pharmaceutical packaging technology to a whole new level.

More information:
www.beckhoff.com/xts

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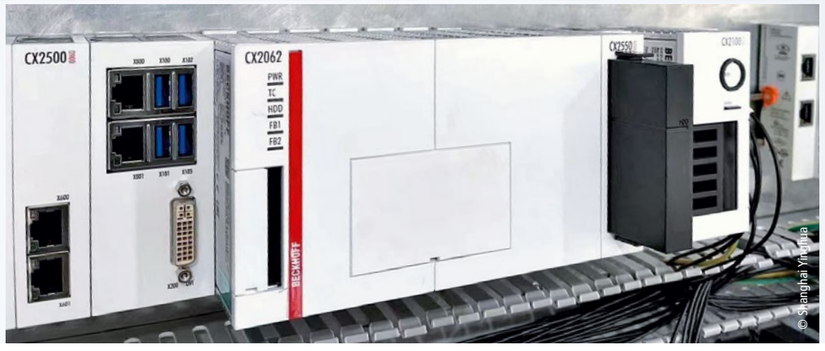
The vertically mounted XTS takes four vials per mover and positions them under the filling needles for the powdered active ingredient quickly and precisely (picture above).



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The control center of the filling system: a CX2062 Embedded PC with Intel® Xeon® CPU (2.0 GHz, 8 cores), HDD/SSD hard disk extension (CX2550-0020), and four independent 1-Gbit Ethernet interfaces (picture left).

PC-based control in the marine and environmental sector

IPC-controlled diving robot collects trash in Venice canals

© Pierre-Elie Herve – TECNALIA

Around 70% of the waste in waters sinks to the bottom of the oceans or decomposes into micro- and nanoplastics – in total several 10 million tons. Based on an AI-based system, the MAELSTROM research project developed an autonomous robot for waters up to 20 meters deep that selectively identifies and collects objects. The system, which is automated with PC-based control, passed its test run in the canals of Venice in September 2022.

As part of the MAELSTROM research project, a cable robot was developed that can remove small particles via suction cups and retrieve waste weighing up to 130 kg from depths of up to 20 meters using a gripper.

If you want to prevent trash from poisoning fragile underwater ecosystems or micro- and nanoplastics from entering our bodies through food chains, you need to both prevent further pollution of water bodies and collect the trash that is already underwater. This is exactly what the European Horizon 2020 – MAELSTROM project aims to do: develop and integrate technologies to identify, remove, sort, and convert all types of marine debris into raw materials. To this end, an international research team with representatives from TECNALIA (Spain), CNRS-LIRMM (France) and Servizi Tecnici (Italy), has developed the "Robotic Seabed Cleaning Platform". Its core component is an underwater robot equipped with a gripper and a suction device that moves flexibly in six degrees of freedom with the help of eight winches.

Using sensors and cameras, the robot detects trash on the seabed, automatically positions itself above it, and can lift objects weighing up to 130 kg (including bicycles, tires, boxes, and nets). Smaller parts or plastic pieces floating in the water are recovered by suction. "Since we operate from the surface and activate grabs or suction cups only when needed, we achieve high selectivity, minimizing the impact on the seabed ecosystem," explains Mariola Rodríguez, project manager of MAELSTROM at TECNALIA.

The positioning winches are synchronously controlled via AX5118 Servo Drives and AM8071 servomotors from Beckhoff. "To ensure robust, accurate, and fast positioning, we chose brushless synchronous servomotors," points out Jose Gorrotxategi, electronics engineer of TECNALIA's Cable Robotics Team. Another advantage can be found in the One Cable Technology (OCT) of the drives, which reduces the wiring effort and space requirements at the winches. The steel cables of the winches allow the robot frame to be precisely positioned underwater and held in place with high stability, despite the sometimes strong currents. Encoders on the motor shafts detect the angular position and revolutions of the cable drums, which indirectly allows them to establish the length of the coiled cable.

Electromagnetic brakes and monitoring of cable tensions by means of force sensors ensure the required safety. If the measured values are outside the permissible range, the cable robot stops immediately and an error message is displayed.

A C6650 control cabinet Industrial PC takes over the central control of all axes and the positioning of the cable robot using various nautical sensors.

AX5118 servo drives control the eight winch drives of the cable robot and the four axes of the base carrier.

Sensor clusters above and below water

For control and monitoring purposes, the frame of the underwater cable robot contains a number of sensors and cameras for manual, automatic, and remote operation. "The cameras and lights allow manual control provided the visibility underwater is not too low," adds Pierre-Elie Herve, mechanical and control engineer of TECNALIA's Cable Robotics Team. The operator can click on interesting locations on the seabed in the camera image, which the robot then approaches autonomously. A pressure sensor on the robot frame detects the diving depth, and an inertial measurement unit (IMU) regulates its position in the water. The distance of the mobile platform to the seabed and its relative velocity to it is recorded by a Doppler Velocity Log (DVL) via four sonar sensors.

Other sensors are located on the pontoon at the water surface, including a pressure sensor to compensate for atmospheric pressure changes during depth control. Two real-time kinematic GPS units determine the position and vertical orientation of the barge in real time. All data from these different systems is incorporated into the control and position regulation of the robot. Based on these values, the robotic platform can perform tasks such as precisely approaching and holding the positions previously selected on depth maps (bathymetry map), which speeds up the robot's work. "This ability has proven to be a key feature in the very turbid waters of the Venetian Lagoon," Mariola Rodríguez points out.

Control and communication of the cable robot

With its total of 12 axes – eight winches and four vertically movable slides on the pontoon masts – the underwater cable robot is controlled by TwinCAT 3, installed on a C6650 control cabinet Industrial PC. This is installed in the main control cabinet located in a control room. In addition to the cable force monitoring, several emergency stop buttons along the system (control room, radio control, and winches) ensure safe operation. The corresponding safety logic is executed by an EL6910 EtherCAT Terminal with TwinSAFE Logic. The servo drives with integrated brakes are integrated into the safety application via AX5805 TwinSAFE drive option cards.

A further four distribution boxes, mounted decentrally on the cable winches, contain the I/O interface modules and the electronics for cable force measurement. The connection between the control cabinet and the distribution boxes is established via Ethercat P. According to Jose Gorrotxategi, "This extension of the EtherCAT technology makes it possible to transmit both the DC supply and the EtherCAT real-time communication in a single cable."

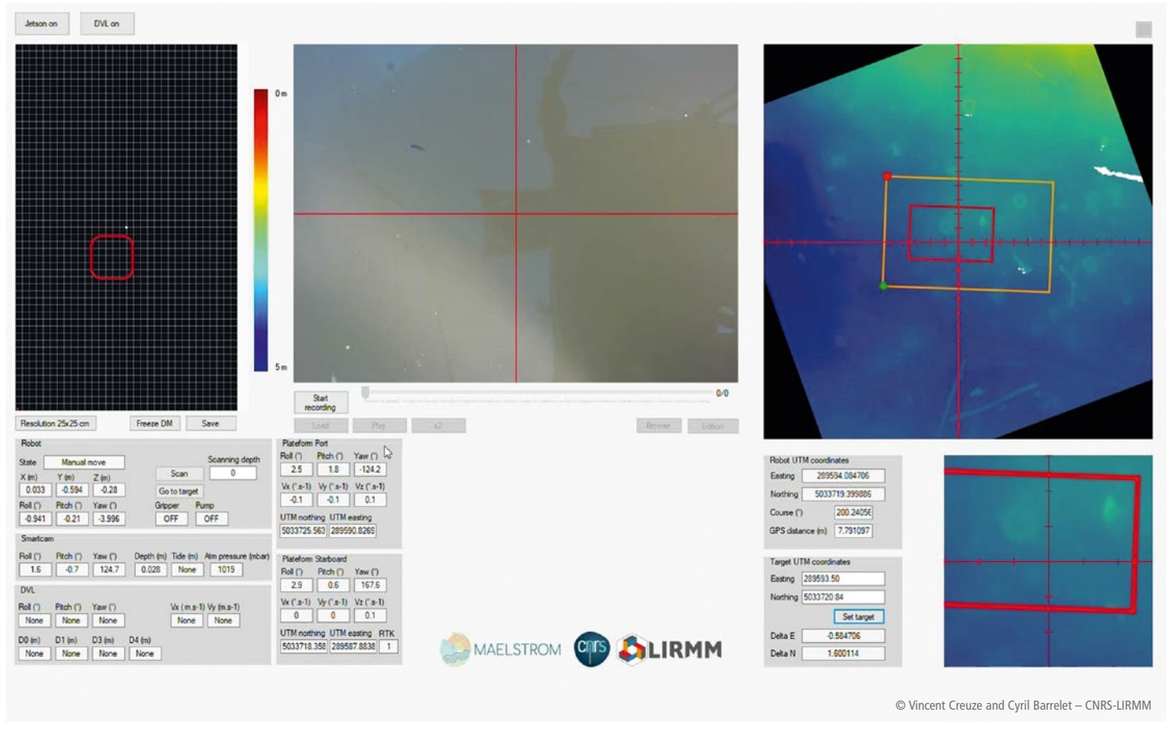
Robot platform control

When controlling the cable robot by joystick, the operator uses the estimated position of the mobile underwater platform and the cameras located on the mobile platform. Using the HMI, the operator can select the various control modes and monitor all functions based on the sensor values – in addition to visual control via underwater cameras.

The camera system for underwater perception mainly enables visual servo control: As soon as the operator sees marine debris (at a relatively short distance from the camera due to the water turbidity), they can click on it in the camera image and the mobile platform of the cable robot will automatically approach the debris.

Also integrated into the HMI is a depth map created with the DVL system and cameras. The operator can select any point in this image, which the mobile platform then moves toward. In addition to manual operation, the rack can also autonomously identify, target, and collect trash. "This works on the basis of artificial intelligence, which is able to identify the marine debris and select the most appropriate removal device," specifies Pierre-Elie Herve.

The software developed for the robotic platform for cleaning the seabed calculates in real time the geographic position of the robot thanks to real-time GPS (real-time kinematic – or RTK) and the inertial measurement devices – devices that measure and report the position or orientation and simultaneously monitor and control the winches. In addition, the position of the robot is displayed on the map of the seabed, which also shows the position of the waste. The robot can move either in automatic mode, with the software then determining the "trajectory in the water", or in manual mode controlled via joystick. While the robot is moving, a camera combined with an acoustic sensor scans the seabed to measure the depth (bathymetry) and detect trash. This data is georeferenced and overlaid on the map in real time.



Display screen with manual control: the operator is shown the bathymetry map. It is centered on the inner basin of the robot platform (orange rectangle). The red rectangle indicates the safe working area where no collision between the robot platform and cables can occur. The lower area represents the tensile stresses of the steel cables.

More information:

www.maelstrom-h2020.eu
www.tecnalia.com
www.cnrs.fr/en
www.lirmm.fr
www.servizitecnicivenezia.com
www.beckhoff.com/c6650

Precise control and monitoring of the machining process is essential for high-quality ornamental stone.

© Diogo Moreira

CX7000 Embedded PC and EtherCAT Terminals in construction machinery for quarrying

Controlling unmanned construction machinery efficiently and reliably

Even if it seems like quarrying construction machinery only has to do rough work, precise and efficient control technology is still essential. This is particularly true for unmanned, remote-controlled machines such as those being developed by the Portuguese specialist Fravizel. Supported by Bresimar, a Beckhoff distributor, the company selected a very compact combination: the CX7000 Embedded PC and EtherCAT Terminals form the foundation of their future-proof and robust control solution.

Fravizel is a Portuguese company with over 39 years of experience in designing and manufacturing earth-moving equipment, as well as machinery for quarrying, forestry, and industry, such as diamond wire cutting and drilling machinery. Present on five continents, the company says its ability to innovate is essential in enabling it to meet the manifold equipment needs of its worldwide and diverse customer base. A member of Fravizel engineering team explains why they implemented PC-based control here: "Beckhoff distributor Bresimar suggested the CX7000 as a potential solution. We were not aware of this embedded PC, so we analyzed it and realized that it is an extremely compact device that has all the necessary processing and storage functions. It was also compatible with the Beckhoff products and solutions we were already using. Our partnership with Bresimar was also very important for technical development, as we received all the support we needed."

A compact and robust control solution

The machines that the CX7000 Embedded PC will be implemented in are unmanned and can only be controlled remotely by specialized operators. This equipment is intended for use in quarries, for cutting and processing ornamental stone. The controls needed to be modernized, so Fravizel began the search for an extremely compact and robust solution, and found that the CX7000 and Beckhoff I/O technology were a great option, which also ensured compatibility with the EtherCAT communication protocol that was already in place. According to the engineering team, the high computing and storage capacity of the compact controller covers all requirements for proper machine operation.

The CX7000 functions as an EtherCAT master, which enables the broad EtherCAT I/O portfolio from Beckhoff to be deployed in conjunction with a very compact and cost-effective device. The controller can thus be used in a wide variety of systems. Automation & Control team states that EtherCAT had already been used in communication between the control components of the machines and proved to be one of the major advantages of the Beckhoff control solution, as third-party hardware can be integrated much more flexibly than it can with other systems.

The CX7000 Embedded PC controls Fravizel construction machinery for use in quarries for cutting and processing ornamental stone, along with other equipment.

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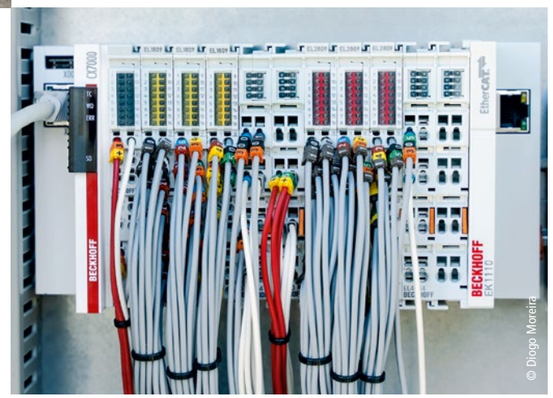

The CX7000 Embedded PC with the directly connected EtherCAT Terminals provides an extremely compact and robust control solution.

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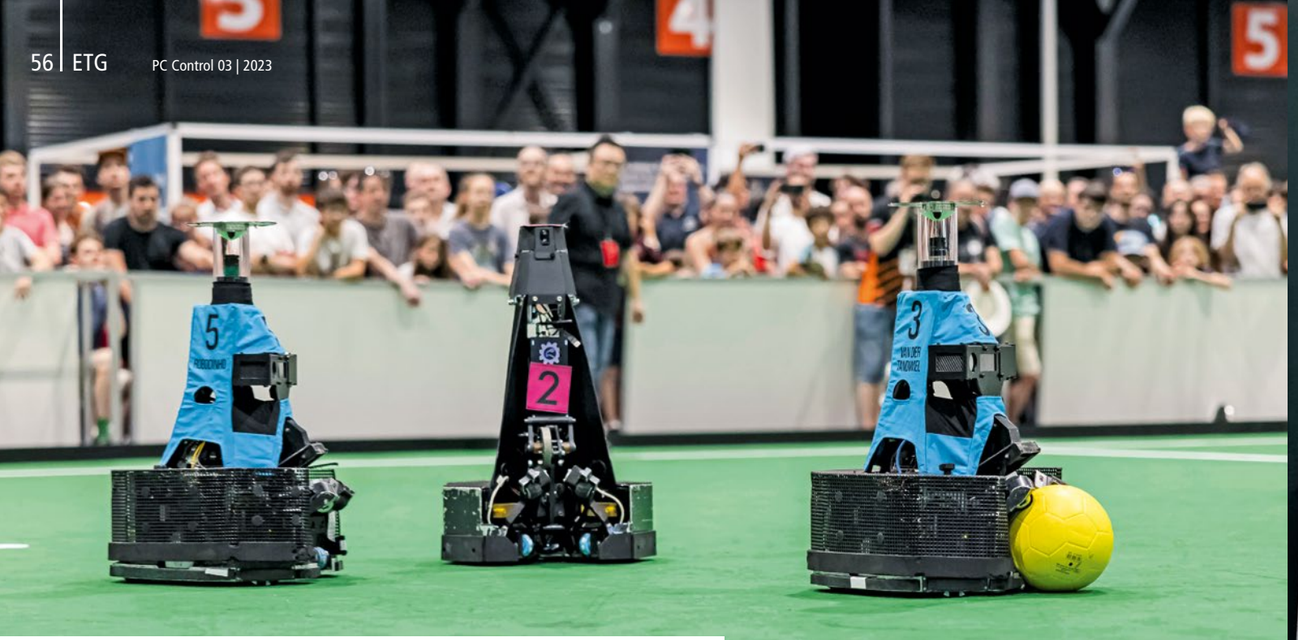
The hydraulic and pneumatic circuits are crucial for assuring proper function of the construction machines. EtherCAT analog terminals, including EL3004, EL3174, EL4032, EL4034 and EL4038, can be used to precisely control the flow and pressure of the proportional valves, which are important variables here, and to record system performance. The EL1809 and EL2809 EtherCAT digital terminals are used, among other things, as command inputs and for sensors, or as outputs for hydraulic/pneumatic solenoid valves and power and control drives.

Machines with extendable arms, central axis rotation and/or lateral displacement also require positioning control for the various machine segments, which is provided by the EL5001 and EL5002 EtherCAT encoder terminals forming a control loop with absolute encoders. To provide reliable pressure monitoring for the hydraulic and pneumatic systems, EL3024 EtherCAT input terminals collect the analog signals from pressure, fill level, inclination, and temperature sensors positioned throughout the machine.

Future-proofing through technology

Looking to the future, Fravizel believes it is critical that a control system has longevity and is also suitable for other projects. If more signal types are required, for example, additional EtherCAT Terminals can simply be added to the CX7000 Embedded PC. According to Bresimar, the CX7000, which unites compact design with high functionality, is perfect for Fravizel and is just the first step into using scalable PC-based control technology from Beckhoff. Maintaining a close customer relationship will help create innovative solutions with added value for the equipment developed, as well as to enable growth and knowledge sharing.

More information:
www.fravizel.com
www.beckhoff.com/cx7000



EtherCAT soccer robots are world champions again!

In the blue jersey: Tech United's EtherCAT robots in the final of RoboCup 2023

© ETG

The Tech United team from Eindhoven has done it again: the autonomous EtherCAT-based soccer robots won the world championship for soccer robots, the RoboCup, in the Middle Size League, the most powerful league in robot soccer. At the RoboCup in Bordeaux, France, the team of 5 autonomous robots defeated the Falcons from the neighboring city of Veldhoven with a 6 - 2 result, making the final a local derby!

Tech United is a multidisciplinary team which currently numbers 46 (former) students, PhD students, and employees of the Eindhoven University of Technology, who are all working on robot development. Their expertise, gleaned from the fields of mechanical engineering, electrical engineering, and computer algorithms, is used to solve problems. The RoboCup stadium on the university campus is Tech United's home base.

Tech United participates in tournaments around the world, such as RoboCup. This is an annual world championship for robots that can communicate and respond to an ever-changing environment. The RoboCup is an open-source competition. After each tournament, all of the knowledge gained is shared among the teams. The rules of the game also change every year to challenge teams to constantly improve and innovate their technologies.

This is the sixth time that the Tech United team has won the RoboCup. This year, the fifth generation of soccer robots, named "TURTLE" (Tech United RoboCup Team: Limited Edition), was competing: this was the first time that no omnidirectional wheels were used. Instead, newly developed drives with swivel axles, which allow the orientation of each wheel to be controlled individually, were implemented. This gives better traction, which significantly improved the acceleration of the robots. Tech United relies on EtherCAT for its communication technology, as they have done since they brought out their first generation in 2005.

The software for controlling the robots consists of four modules: Vision, World Model, Strategy and Motion. The Vision module processes data from the vision sensors, such as omnivision images, to determine the positions of the ball, opponents, and the robot itself. This position data is fed into the World Model. Here, image data from all team members is combined to create a unified representation of the environment. The Strategy module makes decisions based on this generated world model. Finally, the Motion module translates the Strategy module's instructions into low-level control commands for the robot's actuators.

© ETG

The Tech United team wins RoboCup 2023.

ETG surpasses 3,000 members in Asia and 1,000 in America

The continuous growth of the EtherCAT Technology Group (ETG) is showing no signs of slowing down. Currently, the organization has over 3,000 members in Asia and over 1,000 in America, and has achieved significant new milestones. A substantial 42% of the total membership comes from Asia, which is nearly on a par with the number from Europe. With figures like these, it is clear that the Asian members are playing a major role in driving the overall growth of the ETG.

"This growth in membership reflects the acceptance of EtherCAT in the market," explains Martin Rostan, executive director of the ETG. "EtherCAT has firmly established itself as the leading communication technology in the realm of automation technology – and not just in China. Its performance is exceptional, it is easy to use, and cost-effective, and these factors have propelled EtherCAT to become the system bus of choice for the majority of Asian control manufacturers. This makes adopting our technology a logical decision for sensor, I/O, and drive providers. Users benefit from its openness and a wider range of providers and products than any other system. Remarkably, despite already being the largest fieldbus organization for years, our growth shows no signs of slowing down."

Over in the Americas, absolute growth is driven by the most populous nation – the United States – while Canada boasts an even higher membership density relative to its population. What's more, ETG members from the five largest Latin American countries are contributing significantly to the expansion of this technology in a region where user demand holds more sway than that of automation technology manufacturers.

According to the organization's regulations, only legal entities such as companies and universities are eligible for ETG membership.

More information:
www.ethercat.org

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The New Automation Technology Magazine

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