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Beckhoff Automation boosts sales by 13% to 916 million euros

Strong performance in fiscal year 2018: innovations, increased production capacities and an expanding global sales network: Beckhoff Automation generated global sales of 916 million euros in 2018, a gain of 13% on the previous year. This success can be credited in equal measure to innovative technological advances, greater production capacity, and expansion of the company’s sales network.

“With global sales totaling 916 million euros, we had another strong financial year in 2018,” says Managing Director Hans Beckhoff. “In line with this solid business development, the company grew capacity across all departments in terms of facility space as well as human resources, and now employs 4,300 people worldwide.”

Expanding production
“We expanded our production facilities by a total of 40,000 m² in 2018 with new buildings as well as the purchase of additional facilities, and we are now gradually putting this added space into operation,” explains Hans Beckhoff. “Very important is our newly built electronics manufacturing facility, which provides 11,000 m² of space and doubled our primary production capacity.”

Global expansion strategy
Despite a more moderate actual business development in 2019, Beckhoff is pursuing a clear-cut expansion strategy and invests continuously in extending its global sales network As the managing owner explains: “Our goal is to grow by 15% a year”. The company has enlarged its sales organisation in several countries, both by creating new branch offices and by boosting headcounts at existing locations. “Our new subsidiary in Taiwan has started operating; we have set up Beckhoff Mexico; and our long time Korean distributor Tri-TEK has become Beckhoff Automation Korea on 1 July 2019,” Hans Beckhoff adds.

Moreover, Beckhoff Automation has taken over ADL Embedded Solutions GmbH, headquartered in Siegen, Germany, on 1 April 2019. ADL is a specialist company well-known for producing deep embedded applications using motherboards and specially adapted peripherals. Working closely with its customers, it creates tailor-made, turnkey embedded solutions. For many years now it has based its projects on Beckhoff industrial motherboards, and with the acquisition of ADL by Beckhoff, this successful collaboration has progressed to the next stage.

Beckhoff currently has subsidiaries and representative offices in 38 countries worldwide. The company maintains a presence in 75 countries around the world through a network of distributors and its own sales companies.

Success through innovation
In no small part, Beckhoff owes its sustained business success to its rigorous focus on technology, which is evident throughout its product portfolio. The company has again unveiled new, more powerful Industrial PCs as well as Bus Terminals, fieldbus box modules, drive technology solutions and new software functionality at this year’s Hannover Messe industrial technology show. This year, Beckhoff has lined up no fewer than three landmark product launches: the XPlanar drive system, ultra-fast EtherCAT G communication technology, and the first machine learning software modules using artificial intelligence. Hans Beckhoff explains: “XPlanar, which we unveiled in late 2018, is an absolute...”
Hans Beckhoff says: “We have another innovation to report – this time in the field of data communication. For many years now, the EtherCAT system, invented by Beckhoff in 2003, has been a firmly established communication standard worldwide due to its excellent performance and stability. The time has now come to go a step further – by introducing EtherCAT G, which operates at standard Ethernet 1 Gbit/s data rates, and EtherCAT G10, which runs even faster, at 10 Gbit/s. EtherCAT G and G10 deliver new levels of performance that will help our customers to build the best high-performance machines in the world.”

One area of technology with immense potential for the manufacturing industry is artificial intelligence, particularly in the context of machine learning – which was underscored by Hannover Messe’s lead theme of “Integrated Industry – Industrial Intelligence” in 2019. “Beckhoff presented application scenarios designed to clearly highlight and exemplify the specific benefits of machine learning,” says Hans Beckhoff. In addition, the company has introduced TwinCAT Machine Learning, a real-time-capable machine learning solution that is seamlessly integrated into the control technology. It offers machine builders an optimum foundation for enhancing machine performance through capabilities like predictive maintenance, process self-optimization, and autonomous detection of process anomalies.

**Training tomorrow’s talent**

Beckhoff trains young people in a wide range of occupations to safeguard its future supply of talent. Since 2010, the company has also focused on providing industry-integrated bachelor degrees in Mechatronics/Automation, Industrial Engineering, Digital Technologies, Product Service Engineering and Digital Logistics in association with the Bielefeld University of Applied Sciences at the latter’s Gütersloh Campus. For Beckhoff, these industry engineering degree programs have proven to be a worthwhile model: Currently, there are 89 students employed by the company, and, to date, 129 young people have successfully completed degrees and now work in various departments throughout the company. To meet the need for onward qualifications following on from bachelor’s degrees, Beckhoff also supports extra-occupational master’s programs in Applied Automation and Industrial Engineering, again offered by the Bielefeld University of Applied Sciences at its Gütersloh Campus.
Automation expertise on an area of over 5,500 m²

Since the beginning of 2019, the ongoing success of Beckhoff in China is reflected in the new modern headquarters. The 4,045 m² company headquarters was officially inaugurated on 24 January, shortly before the Chinese Lunar New Year. In addition, a warehouse and logistics center with a total floor space of 1,100 m² and a 400 m² service center were set up near the main building.
The new headquarters of Beckhoff China, with over 4,000 m² of usable floor space and state-of-the-art facilities, offers best conditions to successfully continue the previous growth of Beckhoff China – both in terms of sales and number of employees.

The new and significantly larger Beckhoff China head office was opened by Liqiang Liang, Managing Director Beckhoff China, Operations Director Xingkai Ma as well as representatives of Shibe Wisdom Park and the building contractor. Frederike Beckhoff, Assistant to the General Management, and Kai Ristau, Head of International Sales and Business Development, from the Verl headquarters were present on site. More than 260 employees of Beckhoff China, who are based in a total of 26 branch offices, also gained an impression of the representative building.

The new 5-story building is located in the Shanghai Shibe Wisdom Park in the Jing’an district, only about 200 m away from the previous headquarters. The 4,045 m² of floor space not only provides approximately 100 employees with optimally equipped workplaces, but also benefits the customers. On the first floor of the building, for example, a modern 500 m² showroom provides comprehensive information about the wide range of PC-based control and drive technology from Beckhoff with state-of-the-art multimedia support. Users can also obtain specific practical information on all relevant topics in the training rooms on the second floor, which are equipped with the latest technologies. The 400 m² Level 1 service center and the warehouse and logistics center, which has been modernised and enlarged to 1,100 m² – each with over ten employees – will enable even more efficient service support and further reduced delivery times.
Optimally equipped for the future

According to Managing Director Liqiang Liang, the new headquarters, warehouse and logistics center and service center pave the way for the future successful development of Beckhoff China. In addition, the required conditions have been created to further improve the level and efficiency of customer service. In addition to the previously targeted markets, such as wind energy and OEMs in metal processing, photovoltaics, semiconductor and electronics manufacturing, Beckhoff also intends to focus more on strategically emerging industries. These include industrial robotics, intelligent logistics and electromobility. Other future topics that can be ideally covered with PC-based control are big data, cloud computing, artificial intelligence and machine learning as well as 5G and collaborative manufacturing.

In just five months from structural works to relocation, a modern 500 m² showroom was created.

The new offices offer employees an advanced and comfortable work environment.
Using an open ecosystem to facilitate the digital transformation of industry

European vendors found the Open Industry 4.0 Alliance

At Hannover Messe 2019, leading European companies from the fields of mechanical engineering, industrial automation and software – including Beckhoff – announced the formation of the Open Industry 4.0 Alliance with a cooperation agreement. Its goal is to provide a framework as an open and interoperable approach for Industry 4.0 solutions, which also extends to the corresponding services.

The founding members of this alliance for Industry 4.0 are besides Beckhoff, Endress+Hauser, Hilscher, ifm, KUKA, Multivac and SAP. However, the group is basically open to any company, so that other partners – such as up to now Balluff, Gebhardt, Pepperl+Fuchs, Schmidtsche Schack, Samson and WIKA – can also join.

The members of the Open Industry 4.0 Alliance have set themselves a holistic goal: the creation of a standardized, open ecosystem for the operation of highly automated factories and plants with the integration of logistics and services. This is designed to overcome proprietary stand-alone solutions and give a decisive boost to the digital transformation of the manufacturing and process industries as well as logistics. It will be implemented specifically by means of an Open Industry 4.0 framework, which will be based on such existing standards as I/O Link, OPC UA and RAMI.

A holistic view of digital transformation

The aim is to provide an open, standard-based, compatible offer for the entire route from the object in the factory to the services. Users should be able to simply choose from a modular system of compatible and scalable solution and service components. An open framework is intended to ensure that the entire lifecycle of production and logistics facilities can be mapped to connect all internal business processes of a company, such as e.g. production control, warehouse management and maintenance, as well as the cooperation with partners beyond company boundaries.

The framework planned is made up of four modules:

– The “Device Connectivity” module provides the connection to machines and sensors.
– The “Edge” is the central node for all important and locally necessary functions in the factory.
– The third component, the “Operator Cloud”, is the central node in a user’s company that supports all company-centric functions and applications.
– And finally, “Cloud Central” hosts an ontology for the bidirectional exchange of data and information across devices, systems, production facilities and enterprise boundaries.

The first proof-of-concepts were already completed in 2018, others are already under development. Since the presentation, the number of interested companies from the above-mentioned industries has been rising continuously. The founding members are preparing a first exhibition for the second half of 2019.

Further information:
www.openindustry4.com
What are the reasons for the commitment to the new Open Industry 4.0 Alliance? And what tangible benefits are to be achieved for the user companies? Gerd Hoppe, Corporate Management at Beckhoff Automation, provides some answers to these questions.

Why did Beckhoff get involved in the founding of the Open Industry 4.0 Alliance?
Gerd Hoppe: With PC-based control, Beckhoff has always focused on open control technology. That’s why, with a view to Industry 4.0, we welcome the Alliance’s initiative to define and disseminate an open application infrastructure for operators of cloud technologies in the capital goods sector. For the process industry, production technology and logistics areas, it enables considerable simplification over the entire life cycle of systems and production plants.

How does the Open Industry 4.0 Alliance differ from existing networks such as Plattform Industrie 4.0?
Gerd Hoppe: The alliance wants to create an offer in form of an open framework to make it easier for operators, customers and suppliers of complex production and logistics systems to set up digital value-added services. It does not see itself as a competitor to standardization organizations and wants to help establish interoperability for applications across provider and operator domains as well as for existing cloud services and solutions.

Have customers already expressed a need for this?
Gerd Hoppe: Since we collaborate very closely with our customers, we have clearly recognized that the implementation of Industry 4.0 is still very difficult today. Solutions that do not provide compatibility across the many machines, devices and controls on the shop floor mean that a lot of project engineering work is required. Here it will be necessary to take a joint step towards advanced asset management during ongoing operations, with compatible solutions from as many of the market’s leading vendors as possible, in an integrated and open manner.

What does this mean in practical terms for the user?
Gerd Hoppe: Industrial manufacturing as well as the process or logistics industry live in an extremely diverse world today. Accordingly, there are many different suppliers providing products and solutions for factories and production environments. This makes it extremely difficult for operators to combine the relevant machine and process data. However, the benefit of Industry 4.0 comes from collecting a lot of data and merging this information in a very sophisticated and diverse way. And it is precisely this data exchange that can be greatly simplified with a joint solution supported by many providers using a wide variety of technologies. Only in this way can the real benefits of Industry 4.0 be brought to a breakthrough. In addition, completely new services, products and customer benefits that we have not even begun to start thinking about today are certain to emerge in the future.
At Hannover Messe 2019, Beckhoff demonstrated the contribution that PC and EtherCAT-based control technology is making to the implementation of intelligent automation concepts. Current innovations and revolutions were presented in five technology forums: from the XPlanar transport system with free-floating movers to EtherCAT G with a transmission rate of 1 Gbit/s and the new CX7000 small controller with optimized price/performance ratio. Visitors were able to experience the advantages of machine learning through exemplary application scenarios.
Seamlessly integrated, open and real-time machine learning for control systems

Beckhoff now offers a machine learning (ML) solution that is seamlessly integrated into TwinCAT 3 software. Building on established standards, TwinCAT 3 Machine Learning brings to ML applications the advantages of system openness familiar from PC-based control. In addition, the TwinCAT solution supports ML inference in real-time, allowing it to handle even demanding tasks like motion control. These capabilities provide machine builders and manufacturers with an optimum foundation to enhance machine performance, e.g. through prescriptive maintenance, process self-optimisation and autonomous detection of process anomalies.

The fundamental concept of machine learning is to no longer follow the classic engineering route of designing solutions for specific tasks and then turning these solutions into algorithms, but to learn the desired algorithms from exemplary process data instead. With this alternative approach, powerful ML models can be trained and then used to deliver superior or better-performing solutions. In automation technology, this opens up new possibilities and optimisation potential in many areas, including predictive maintenance and process control, anomaly detection, collaborative robotics, automated quality control and machine optimisation.

The models to be learned are trained in an ML framework, such as MATLAB® or TensorFlow, and then imported into the TwinCAT runtime via the Open Neural Network Exchange Format (ONNX), a standardized data exchange format used to describe trained models. The TwinCAT runtime incorporates the following new functions for this purpose:

- the TwinCAT 3 Machine Learning Inference Engine for classic ML algorithms, such as support vector machine (SVM) and principal component analysis (PCA)
- the TwinCAT 3 Neural Network Inference Engine for neural networks, such as multilayer perceptrons (MLPs) and convolutional neural networks (CNNs)

ML algorithms are directly executable in real-time

Inference, i.e. the execution of a trained ML model, can be performed directly in real-time with a TwinCAT TcCOM object. With smaller networks, system response times of less than 100 µs corresponding to a TwinCAT cycle time of 50 µs are supported. Models can be called via PLC, C/C++ TcCOM interfaces or a cyclical task.

Through seamless integration with the control technology, the multi-core support provided by TwinCAT 3 is also available for machine learning applications. This means, for instance, that different task contexts can access a particular TwinCAT 3 Inference Engine without restricting each other. All the fieldbus interfaces and data available in TwinCAT can be fully accessed as well. This allows ML solutions to use immense amounts of data, for example, for complex sensor data fusion (data merging), and it also means that real-time interfaces to actuators are available to enable, among other things, optimal control.

Further information:
www.beckhoff.com/machine-learning
EtherCAT G raises the EtherCAT technology to the next performance level while offering full compatibility with standard EtherCAT and the same ease of use.

EtherCAT G: Ultimate I/O performance for high-performance machines

EtherCAT reaches the next performance level with the EtherCAT G technology extension through its capability to superimpose itself on Gigabit Ethernet for particularly data-intensive applications. Compatibility with the globally established standard EtherCAT, which uses 100 Mbit/s, and the same familiar ease of use are both guaranteed. In addition, the efficient operation of parallel network segments is possible with the branch concept introduced for EtherCAT G.
EtherCAT G uses the 1 Gbit/s data transmission rate of standard Ethernet; while the EtherCAT G10 variant, recently presented as a proof-of-concept technology study, even achieves data rates of up to 10 Gbit/s. The considerable increase in data rates compared with standard 100 Mbit/s EtherCAT significantly increases the possible data throughput. In conjunction with the newly introduced branch concept, EtherCAT G (1 Gbit/s) enables a 2 to 7-fold increase in performance in relation to communication times and up to 10 times the bandwidth, depending on the application. 100 times the bandwidth is even possible with EtherCAT G10.

**EtherCAT G as a fully compatible technology extension**

With EtherCAT G, the proven success principle of EtherCAT can be used to leverage the high Ethernet data transmission rates that are technologically available today — without any changes to the EtherCAT protocol itself. The telegram sent by the EtherCAT master thus continues to pass through all network devices. Every EtherCAT slave reads the output data addressed to it on the fly and places its input data in the forwarded frame, but now with data rates of 1 to 10 Gbit/s. As before, the last device in a segment (or branch) will detect an unused port and send the telegram back to the master. The full-duplex property of the Ethernet physics is utilised for this capability.
The current EtherCAT G product portfolio includes the EK1400 Coupler, the CU1403 and CU1418 branch controllers with 3 or 8 ports respectively, the CU1423 EtherCAT G junction and, for evaluation by developers, the FB1400 EtherCAT G and FB1450 EtherCAT G10 piggyback controller board (l.to r.).

Branch concept for mixed operation with maximum efficiency
EtherCAT and EtherCAT G can be operated within the same network, i.e. EtherCAT G slaves will work in a 100 Mbit/s EtherCAT network and vice versa. However, all EtherCAT G devices will switch back to the 100 Mbit/s mode in such a mixed network. In order to prevent this, the new branch concept makes EtherCAT branches possible, which enable the parallel operation of 100 Mbit/s segments in a 1 or 10 Gbit/s network through appropriate speed implementations. In this way, a branch of an EtherCAT G segment can be implemented on a 100 Mbit/s network, for example, using the new EK1400 EtherCAT G Coupler, thus allowing the extremely wide range of standard EtherCAT Terminals to be used within the EtherCAT G network environment. The 1 Gbit/s speed of EtherCAT G communication segment is retained.

Rollout of EtherCAT G made easy
Exceptional performance and ease of use have always been the hallmarks of EtherCAT communication. The same applies to EtherCAT G. Not only the protocol, but also the fundamental mechanisms and the configuration options remain the same. Only the function blocks necessary for physical access to the communication cables have been replaced by corresponding Gbit/s variants. The master therefore requires no new software, just one Gbit/s port – which usually exists in any case. The existing familiar cable types can also continue to be used: Cat.5e cables for EtherCAT G or Cat.6 cables for EtherCAT G10.

Consequently, EtherCAT G slaves can be operated on an existing EtherCAT master, provided it has the aforementioned Gbit/s port. Several special protocol extensions for EtherCAT G are currently being prepared that will allow for even higher-performance use. However, the extensions required for this on the master side will not be mandatory for the network to be operational.

Moreover, the EtherCAT G branch concept offers another crucial efficiency benefit: minimized propagation delay times. The CU14xx multi-port branch controllers are designed for this purpose and enable the interconnection of several EtherCAT and EtherCAT G segments. The individual branches are addressed with a single telegram from the master, which will then be processed.
simultaneously. This makes much shorter signal propagation times possible and therefore shorter communication and cycle times, because the telegram of a segment travels directly from the branch controller back to the master and not through all other connected segments as well. In most applications, the parallel operation of network segments results in a significantly higher performance increase than a mere increase in the transmission bandwidth would render possible.

Disclosure and availability
In the coming months, the FB1400 EtherCAT G piggyback controller board will be available for the EL9820 EtherCAT evaluation kit. The FB1400 will have an FPGA with a fixed configuration as an EtherCAT G slave controller (ESC). If necessary, customers can then also create and use their own ESC configurations with the planned IP core for EtherCAT G. This will give EtherCAT users as well as master and slave manufacturers ample opportunity to evaluate the new technology. Availability of the EK1400 EtherCAT G Bus Coupler is scheduled for the second half of 2019. It will offer branch controller functionality and enables direct connection of all Beckhoff EtherCAT Terminals as well as all other EtherCAT products in EtherCAT G networks. Further products will follow, such as 3-port and 8-port branch controllers (CU1403, CU1418), an EtherCAT G junction (CU1423), an EtherCAT G10 branch controller (CU1468) and an EtherCAT G10 piggyback controller board (FB1450).

A disclosure and introduction of the EtherCAT G/G10 protocol by the EtherCAT Technology Group (ETG) is planned for this autumn. As with EtherCAT more than 15 years ago, all ETG member companies will be able to use the extension and benefit from it.

Areas of application and performance examples
For most present-day applications the high performance of standard EtherCAT is fully adequate. Accordingly, EtherCAT G communication was developed with extremely large-scale applications and many devices in mind as well as the increasing use of particularly data-intensive devices such as vision cameras, complex motion systems or measurement applications with high sampling rates. Machine vision, condition monitoring or the innovative transport systems XTS and XPlanar all require transmission of several hundred bytes of process data per cycle for each device. In conjunction with short cycle times of less than a millisecond, the high transmission bandwidths provided by EtherCAT G are called for in this context.

The first practical EtherCAT G application is the XPlanar transport system, which was shown for the first time at the SPS IPC Drives 2018. This planar motor system enables motion control and highly precise positioning of passive free-floating movers with six degrees of freedom. Due to the continuous position feedback required for the unique new system, extremely large data
With the branch concept, the mixed operation of EtherCAT, EtherCAT G and EtherCAT G10 segments is possible in one network, resulting in the best-possible overall communication efficiency for the complete system.
The universal EtherCAT features

quantities are produced that have to be transmitted within a few microseconds. This would hardly be possible without the high performance of EtherCAT G.

The following two sample calculations illustrate the boost in performance or the savings in data transmission time that can be achieved with EtherCAT G and the branch concept.

Accelerating communication times: 128 servo axes in 34 µs
- A machine network with 128 servo axes was selected as the initial application.
- A "standard data width" of 8 bytes in and out per device results in this case in a total of 1,024 bytes in and out per cycle. With classic EtherCAT communication through all devices, taking into account hardware propagation delay times and telegram lengths, a communication time of 237 µs will result.
- If the standard EtherCAT devices are now replaced by EtherCAT G devices, the communication time can be reduced to 150 µs just on account of the shortened frame length due to the higher data rate.
- If in addition the branch concept is used and the complete network is divided into eight EtherCAT G segments with 16 servo drives each, a communication time of only 34 µs can be achieved – i.e. communication is now 7 times faster.

Using the bandwidth advantage: scanning 200 analog inputs with 100 ksamples/s
- The following is an existing measurement application – Condition Monitoring – where a 10 km-long conveyor belt is monitored.
- The application consists of 200 analog channels (±10 V) with 100,000 samples/s (10 µs measurement interval) per channel, which have to be scanned with a cycle time of 1 ms.
- The present-day solution consists of four independent 100 Mbit/s EtherCAT networks, each with 26 two-channel analog input terminals with oversampling function (EL3702). Eight telegrams with 1,313 bytes each are required in every EtherCAT network, resulting in a required bandwidth of 322 Mbit/s. Thus, each of the four networks utilises 88% of the available bandwidth.

- If the four EtherCAT networks are now replaced by an EtherCAT G network and the EK1100 Bus Couplers by EK1400 EtherCAT G Bus Couplers (branch controllers), it is possible to continue to use existing standard EtherCAT Terminals. With the same cycle time (1 ms), however, a bandwidth utilisation of only 350 Mbit/s results in just one EtherCAT G network. The remaining bandwidth of 650 Mbit/s enables an extension of the channels and the support of even higher analog sampling rates.
- Further cost advantages are the extremely reduced cabling requirements (one network instead of four) and the reduction in the number of the ports required in the master from four to one.

The universal EtherCAT features

- real-time Ethernet down to the I/O level
- flexible network topologies
- outstanding diagnostics
- synchronisation accuracy better than 100 µs
- exceptionally simple configuration
- low system costs
- maximum performance
- ability to integrate functional safety
- IEEE-802.3 compliance

Further information:
www.beckhoff.com/ethercatg
Enabling PLC programmers to work seamlessly in a single tool environment that supports PLC, motion control, measurement as well as vision functionality streamlines the engineering process and optimizes efficiency.

TwinCAT Vision: Programming real-time solutions in a PLC environment

Fully integrated image processing in control systems

To date, industrial image processing has generally been kept separate from traditional control technology. It is mostly implemented on dedicated PCs or smart cameras by expert engineers using specialized tools and programming languages. However, image processing solutions built in this way not only involve a considerable effort in terms of engineering and support, they are also almost impossible to synchronize with conventional industrial control systems. This has prompted Beckhoff to take a fundamentally different path that fully integrates machine vision, both in its engineering environment and its runtime system.
The Beckhoff approach with image processing is again to concentrate system intelligence in a powerful Industrial PC. This means inexpensive cameras without built-in intelligence can be used for local image capture. In addition, incorporating vision functionality into the software running on the control PC offers substantial flexibility, the only limiting factor being the IPC’s computing power. Unlike solutions that rely on smart cameras, this setup not only permits image data and intermediate results to be displayed directly, in full, by an HMI, it enables images to be stored for more extensive analysis as well.

**Efficient engineering in image processing**

TwinCAT 3 automation software – for PLCs, C++, motion control, safety and now machine vision – is engineered in Microsoft Visual Studio®. This means that automation engineers can work in the same integrated development environment (IDE) as is commonly used to program standard software applications.

One advantage is that this environment is both familiar and widely accepted all over the world; another is that it allows direct access to source code control, database and testing tool interfaces. In addition, the various field buses that TwinCAT supports can be configured straight from the IDE; and with TwinSAFE, safety-related applications can be configured and programmed as well. Motion control with NC PTP, too, is supported, as are the configuration and programming of CNC applications. Incorporating image processing, therefore, was the next logical step. Other solutions on the market generally need to be configured and programmed through their own user interfaces, but with TwinCAT Vision, configuration, calibration and programming can all be accomplished inside Visual Studio®, eliminating the need to learn additional tools or specialized programming languages. Plus, the development environment integrates smoothly with the HTML5-based HMI.

In Visual Studio®, cameras are as easy to configure as I/O nodes. Any camera that uses a GigE Vision bus and conforms to the GenICam configuration standard is supported; this standard also makes it easy for the system to incorporate cameras with specialized capabilities. All the cameras connected to the IPC’s network interface controller can be found with a simple scan, and each camera’s parameters can be retrieved from the relevant GenICam description file allocated to it. As a result, there is no need to manually assign IP addresses or create extensive parameter lists. The cameras are ready for operation after a few moments, and the live images they capture can be displayed in Visual Studio®. All their parameters can be configured manually using PLC function blocks, both at the engineering stage and later, during live operation.

If measurements are to be taken during image processing, cameras need to be calibrated by converting their pixel dimensions into metric sizes. Calibration can be performed using the usual checkerboard patterns or circles; 3D calibration patterns, too, are supported. A single image is sufficient for calibration purposes, and this is an important advantage: if a camera and/or lens needs to be exchanged for maintenance purposes, this makes putting its replacement into operation much easier and thus less costly.
The ability to measure a drilled hole precisely is just one of many use cases in which an integrated, precisely synchronized vision solution can enhance quality and productivity in the manufacturing process.

Synchronizing motion control, robotics and vision applications in real time – in this case, image processing in combination with an XTS linear transport system – can introduce valuable efficiency gains in machine design and process sequencing.

**PLC programmers with vision expertise**

Once a camera has been set up and calibrated, programming itself can begin. Because the vision solution is integrated with the standard control technology, this can be carried out using familiar PLC programming languages. C/C++ and MATLAB®/Simulink® can in fact be used as well. Going forward, this will lead increasingly to PLC programmers being able to write image processing code alongside other programming tasks, because machine vision experts and specialist programming languages are no longer essential. At the same time, image processing will gradually become standard automation system functionality, along with motion control, safety, measurement, and other technologies already incorporated into the control software in recent years.

The process of vision programming in the PLC begins simply by adding a library containing the functions and function blocks needed to capture an image, to render and filter image data, to detect and identify objects, and to measure objects in images. In packaging technology in particular, the ability to recognize and identify codes is a key requirement, and the library also includes functions to handle these tasks.

To transfer an image to the IPC, the image must first be captured by triggering a camera. For the most part, cameras are triggered digitally – e.g. by an EtherCAT output terminal that supports distributed clocks functionality and allows synchronization with an accuracy in the microsecond range. Once the captured image has been stored on the IPC, filtering algorithms are applied. To verify that the filters are indeed working correctly, each intermediate step can be viewed as an image in Visual Studio® or the HMI.

The main search and analysis algorithms can run once the raw image has been rendered. Currently, more than 500 such algorithms are available in a range of categories. These can be switched into and out of the PLC as necessary using online change parameters and/or code, without first having to halt the PLC. Compared to classic C++-based solutions, this is a major advantage when putting systems into operation.

**Maximum synch precision**

The image processing algorithms are executed in the TwinCAT real-time system, and a key benefit is that the vision algorithms can run at the same cycle time as, or in sync with, the PLC, motion control, and measurement applications. Consequently, there is no need to coordinate communication between a non-real-time application and real-time PLC, motion control or measurement processes, which avoids commonly associated problems such as communication delay and jitter.

Integrating image processing on the PLC has another important advantage: PLC programmers can directly process the results returned by an image processing algorithm in the same way as output from an analog sensor. For instance, they can write instructions along these lines: “If the object detected in the image is round, set this digital output to TRUE.” Programmers can also use a full array of familiar PLC debugging features. This means that they can display an image at any time during execution just as if they were monitoring a variable. And if an image is processed in multiple stages, it can be viewed directly in Visual Studio® at each stage. This makes testing algorithms exceptionally quick and easy. Programmers are able to switch parameters online – to shift the region of interest in an image, for example – and then observe the effects directly. Being able to alter parameters online (common practice in PLC programming) means that entire algorithms can be changed out on a running PLC, too. This capability enables image processing solutions to be put into operation and optimized quickly.

Like other peripherals, external devices used by machine vision applications can also be synchronized using EtherCAT and distributed clocks. Most cameras, for instance, have a digital trigger input. If this is driven by a digital output on an EtherCAT Terminal, the images captured can be matched exactly to, e.g., the position of a conveyor belt. Likewise, lighting can be timed and controlled...
extremely accurately – again, based on the exceptional timing precision with EtherCAT. The new EtherCAT EL2596 terminal, designed to control LED lighting, has been developed specifically for applications like this.

**Conclusion**

TwinCAT Vision breaks new ground as the first automation solution to integrate image processing technology in full, both at the configuration and programming level and in real-time operation. It enables PLC programmers to work with common PLC programming languages in a familiar environment to configure, program and commission control applications with built-in image processing. By integrating vision functionality in real time, TwinCAT Vision allows PLC, motion control and image processing applications to be synchronized with highest accuracy; in combination with EtherCAT, it achieves the same timing precision with cameras and lighting. The image data captured can be incorporated into the HMI or saved at any time. The solution simplifies engineering and support, too.

Dr. Josef Papenfort,
Product Manager TwinCAT

Further information:
www.beckhoff.com/twincat-vision
With the support of application-specific mechanical devices, XTS Track Management software can switch XTS movers between multiple XTS systems with ease.
New XTS software functionality enables novel solutions in machine building

In 2012, Beckhoff set a new benchmark in intelligent parts transportation with the introduction of its eXtended Transport System (XTS), which has since been fitted to numerous generations of manufacturing machines. XTS does more than merely replace conventional conveyor belts, instead it enables completely new and innovative machine designs. Working with flexible motion profiles, it allows users to create processing sequences ranging from the very simple to the highly sophisticated and so optimize their entire manufacturing process. As new XTS functionality is rolled out, it is creating unprecedented levels of freedom that customers are turning into novel machine designs in collaboration with Beckhoff. At SPS IPC Drives 2018, among other products, XTS Track Management was unveiled, a software-based solution that further expands the linear transport system’s range of possible applications.
When an XTS system is configured, all motor modules are initially grouped into contiguous segments known as track parts. These may consist either of one single motor module or any number of consecutive motor modules. The track parts, in turn, form building blocks from which a large number of contiguous routes or tracks can be defined. A track may consist of one or more track parts; also, a track part may occur more than once in a given track, and may also be included in multiple tracks.

A PLC application program decides which track each mover should travel along. The movers are controlled using an extensive command set contained in the Motion Control Toolbox. Now though, a position set point defined in a given motion command no longer applies to the system as a whole but to a specific track. During program execution, a move command for an individual mover can be switched to a different track – at any time and on the fly. The only condition is that the track part on which the mover is located when the switch happens must also be part of the new track to which it is switching.

Again, this is best illustrated with a road navigation analogy: A vehicle’s route may be altered at any time, but the road on which it is currently traveling is, of course, always part of the new route, too.

Enabling movers to travel on multiple tracks opens up a wealth of possibilities when it comes to designing transportation tasks for an XTS system. The additional flexibility afforded by the track management functionality creates valuable advantages, both for the machine builders designing systems and for the end users who later operate the machines.
Maximum flexibility without downtime
For several years now, in areas such as the food and cosmetics industry, there has been a sharp rise in the numbers of product variants within manufacturers’ product ranges. Inevitably, this has led to smaller lot sizes and significantly shorter production runs, and as a result is driving up demand for machines that allow flexible format changing. XTS already supports fast, software-driven format changes using product-specific parameter sets. Shapes and packaging sizes can be changed without the need for manual intervention. Now XTS also supports software-based tool changes: With the new track management capabilities, movers fitted with different tools can be fed in and out on a flexible basis, without leading to downtime. With this freedom to select a range of different tools, users can now set up tool magazines and, besides being able to switch to a completely different tool format, they can create custom tool combinations as well.

In addition, the setup described above makes it easy to accommodate maintenance intervals in the production process. For instance, a mover that has reached a predetermined limit for the number of products handled or, perhaps, distance traveled could be ejected and automatically replaced by another mover that has been refurbished. The ejected mover can then be serviced outside the actual production system. This means that machine processes no longer have to stop at set intervals to allow maintenance.

Parts storage but with a small footprint
Production processes often need to halt temporarily once a certain number of steps have been completed – to give products time to cure, dry or cool, for example. To avoid stoppages and maintain a continuous production flow, product buffers can be created to feed the next processing station downstream. This requires additional machine space; how much depends on the size of the product and on the length of the necessary wait in relation to the processing time.

With the new track management, track parts can now be stacked to create compact and efficient product holding capacity while maintaining a small overall machine footprint. Furthermore, in contrast to conventional buffer systems, there is no need to create extra parts handling capacity because the products are stored together with their movers and therefore remain clearly identifiable and easy to control.
Optimized utilization of processing stations

Track management also offers advantages when products need to pass through specific processing stations multiple times. Consider, for example, a coating process in which several layers need to be applied to achieve a specific thickness and a molding cycle is required after the application of each layer. One way to achieve the desired output rate on machinery performing a task like this is to set up a sufficient number of processing stations in series. This approach, though, is costly and the individual processing stations often end up not working at full capacity.

Track management can improve efficiency by separating these processing stations from the main product flow on the primary XTS and putting them on a secondary, self-contained XTS. With this arrangement, products can pass through the processing stations multiple times in succession without having to switch direction. Once the required number of passes has been completed, the products are merged back into the product flow of the primary XTS.

Individual quality control, even at high output rates

One of the greatest challenges facing machine builders is how to incorporate individual quality control into the production process. Now, with the track management capability to flexibly feed products into and out of the process, these quality inspections can be performed without interrupting production flow, allowing high production output rates to be sustained, even with time-consuming, random inspections.

By contrast, in systems where quality control is built directly into the primary production process and multiple products are subsequently extracted in parallel, prior ejection of flawed products must not leave any gaps. To prevent a flawed product from causing all the products before it to run through the process chain again, track management can extract the flawed product and its mover from the product stream. After reworking a product at a manual workstation, for example, the product can simply be returned to the product stream along with a mover, or, if the part is scrapped, an empty mover can be inserted back into the stream.
Flexible product infeed and outfeed with XTS Track Management allows individual items to be quality-inspected and reworked without interrupting the overall production flow. Flawed products, for example, can simply be ejected (bottom).

Further information:
www.beckhoff.com/xts-track-management
The team of experts involved in the realization of the new packaging operating panels (right to left): Pascal Witprächtiger, Director Industry 4.0 – Lifecycle Solutions at Bosch Packaging, Roland van Mark, Product & Marketing Management Industrial PC at Beckhoff, Thomas Schwendemann, Head of Strategic Procurement at Bosch Packaging, Stefan Keller, Area Sales Manager at Beckhoff Switzerland, and René Zuberbühler, Managing Director of Beckhoff Switzerland.
Integrated HMI for Bosch packaging machines in the food industry

Bosch Packaging Technology, Business Unit Food, specializes in packaging systems for the food industry. These systems are used by multi-national food producers, which is why in many cases a consistent, integrated operating concept is essential. The packaging experts therefore developed a new user interface referred to as HMI 4.0, which together with a multi-touch Panel PC from Beckhoff serves as a global operating standard for Bosch food packaging equipment.
Standard hardware with custom adaptations
The control panel from Beckhoff is a custom device that is available worldwide, as Roland van Mark explains: "The key is that all specific user requirements are met, while at the same time optimum customer support is available worldwide. This is achieved through a control panel that largely consists of standardized components.” Pascal Witprächtiger says: “This is particularly important for multi-national companies with production facilities around the world. In this way, for example, even users in China or Australia don’t have to wait several weeks for a special version.”

Primarily, the 15.6-inch control panel from Beckhoff is used in three different versions: the CP3716 IP-65 mounting arm version, with or without keyboard extension, and the CP2716 variant for control cabinet installation. This flexibility in terms of the device range was an important selection criterion for Pascal Witprächtiger: "We prefer the two mounting-arm versions, and we expect these to be used in about 80% of all applications. In the remaining 20% of cases the built-in version is likely to make more sense, for example in situations where a suitable control cabinet already exists, so that the costs for the mounting arm can be saved or benefits in terms of hygienic design can be achieved.” Roland van Mark, Product & Marketing Management Industrial PC at Beckhoff, adds: “A key aspect are the practical application requirements. After all, a mounting arm not only costs money, it also takes up space, represents an additional mechanical unit, and its maneuverability does not necessarily provide added value in all situations.”

In addition to the extension with electromechanical buttons and customer-specific imprints on the glass front, Pascal Witprächtiger highlights a further application-specific aspect: “Our machine design features a particularly attractive mounting arm adapter. Since it is very slim and has a narrow bending radius, the connection level had to be adapted for the panel version with push-button extension. The cooperation with Beckhoff in this respect was exemplary, e.g. when it came to the Windows 10 IoT operating system or the thermal configuration.” Roland van Mark illustrates the underlying basic concept: “The sophisticated device design has clear advantages for us. The suitably dimensioned aluminum enclosure houses the motherboard on one side, the hard disk on the other side, and the connection hardware in the center. All components are thermally decoupled. Through this modularity it is possible to implement special customer requirements, such as the slim mounting arm, easily, quickly and without restrictions in terms of availability.”
Pascal Witprächtiger, it not only provides the required performance, it is also cost-effective, can be operated without fan, and features a graphics engine that is eminently suitable for the HMI application: "The widescreen format is ideal for our machine design and operating concept, and thanks to multi-touch support e.g. for 3D representations, we were able to implement all our requirements. Plus, we are well prepared for future developments. The advanced Windows 10 IoT operating system offers a wide range of options for implementing Industrie 4.0 ideas. Ultimately, we aim for an integrated approach with optimum user interface and rapid troubleshooting capabilities, resulting in maximum machine efficiency."

Pascal Witprächtiger refers to a control system application as an example for the early implementation of an Industrie 4.0 application: "The individual control panels synchronize themselves automatically via Windows Communication Foundation (WCF) technology, without the need for a remote master computer. Each HMI can also display information, commands and recipes from other machines. In this way, end users can benefit from system networking without the need for a costly conventional server system. Troubleshooting in the packaging systems, which can be more than 100 yards long, is also simplified because the machine operator no longer has to walk to a remote control panel, but can check the whole system from a single HMI. The combination of Beckhoff multi-touch Panel PC and our HMI 4.0 user interface forms the ideal platform for all this."

Seamless HMI portfolio with attractive design
Due to the preference for devices with mounting arm, according to Pascal Witprächtiger the availability of a seamless portfolio, including IP 65 versions, was a key selection criterion for Bosch Packaging: "There are not many suppliers in the market who offer such a wide range of devices, and above all encapsulated versions with IP 65 protection. Additional benefits offered by Beckhoff are the attractive design and the excellent product quality, based on the high level of production expertise. Another factor for us was the assurance that the highly scalable HMI range would be able to cover all our future requirements, including any special request we may have."

According to Pascal Witprächtiger, the design also plays an important role: "Although the performance of our packaging machine has top priority, the HMI design – in terms of hardware as well as software – should not be underestimated, not least because HMI 4.0 is much more than just a new interface: it redefines the interaction between humans and machines. The main focus is on simplifying the operation, i.e. the aim is for the HMI to provide only a minimum amount of information, but in each case precisely the information that is required. In order words, the user experience has top priority." Roland van Mark agrees: "Reduction to the essentials is crucial for efficient and reliable machine operation. An attractive, high-performance hardware contributes to fast and targeted operation."

Future potential, including Industrie 4.0
In the Panel PCs used in the Bosch packaging machines, an Intel® Atom™ CPU with four processor cores provides plenty of computing power. According to
Setting the scene effectively for Great Wolf Lodge resorts in small spaces

LA ProPoint, a specialist in entertainment technology, has implemented a new movie theater attraction for the American resort chain Great Wolf Lodge. A frame surrounding the screen is animated with integrated animatronic elements and video projection. For the integration of AV, animatronic and automation equipment, LA ProPoint utilizes the universal Beckhoff technology, which supports entertainment industry standards and enables space-saving installation in the lobby.
Above: A scene from one of the Northwoods Friends cartoons

Left: The Great Wolf Lodge Resort in Bloomington, Minnesota, features the innovative Northwoods Friends Show theater developed and implemented by LA ProPoint.
Spellbinding entertainment can now be experienced in unusual places. Take, for example, the lobby at multiple locations of Great Wolf Lodge Resorts, a well-known chain of indoor water parks with hotel operations in the USA, where guests of all ages are welcomed by an innovative movie theater attraction. Here, the cartoon characters in the Northwoods Friends Show act in a special frame. Animatronic elements integrated into the frame move in precise synchronization with the action sequences and become part of what is happening on the screen. Video projections make the figures integrated into the frame even more lifelike. Following initial installations in four Great Wolf Lodge locations, more are already planned.

To successfully implement the new lobby theaters, an impressive amount of automation and networking technology needed to be installed into very small spaces. The entertainment engineering experts at LA ProPoint, based in Sun Valley, California, handled the design and installation of the project. The company specializes in entertainment and AV installations across North America. High-profile LA ProPoint clients include theme park and theatrical powerhouses like, for example, Cirque du Soleil as well as major sporting venues such as the AT&T Stadium, home of the Dallas Cowboys, and museum installations like the California Science Center.
Leading the convergence of AV and entertainment technologies

"Productions like the animatronic Northwoods Friends Show are so exciting because they demonstrate how AV and entertainment technology continue to overlap," said Richard Adams, Automation Engineer at LA ProPoint. To implement the demanding theater installation for Great Wolf Lodge, LA ProPoint first had to find a control system that would combine the AV and animatronic functions seamlessly and cost-effectively. LA ProPoint was able to leverage expertise developed from a wide range of applications, including automation.

Showtime for automation with Beckhoff

At the end of the development process, the team decided on universal automation with a PC-based control platform and TwinCAT 3 software from Beckhoff. A CP6706 Panel PC handles the real-time control of all functions, including the stepper motor-driven animatronic elements and the AV equipment with TwinCAT. Using Ethernet TCP/IP, the TwinCAT control system connects to three different projectors from two different manufacturers, a Blu-Ray player, a high-end sound mixer and three BrightSign media players. "The most
important aspect backing our decision to use TwinCAT is the ability to program everything in one universal software platform," Richard Adams added.

To establish communication specific to AV and entertainment applications, the TwinCAT SMPTE timecode interface can extract timing information sent by a SMPTE master in order to provide an absolute time reference in the application. "That says a great deal about the suitability of TwinCAT in entertainment applications, and this is significant from a controls engineering perspective because traditional PLC platforms just don’t go there," explained Adams.

EtherCAT Terminals handle the system communication and enable a space-saving installation in a small control cabinet. For example, the EL3702 EtherCAT oversampling terminal acquires the signals from an SMPTE master, while the EL7041 EtherCAT Terminal operates as a compact drive amplifier for the stepper motors. Richard Adams commented: “The EL7041 stepper motor terminal was very easy to connect with the stepper motors for control. Instead of programming, mounting and wiring eight different motor controllers, everything is programmed centrally in TwinCAT and motors are cleanly wired back to DIN rail-mounted I/O.”

The CP-Link 4 one-cable solution connects the Beckhoff controller installed in a small space behind the scenes to a CP2907 Control Panel, which serves as a convenient user interface at the reception desk. The intuitive HMI developed in TwinCAT by LA ProPoint offers easy operation for all resort staff — from front desk personnel to AV and maintenance staff.

**Reduction in development and installation time**

Overall, LA ProPoint viewed its first ever PC-based control application as a success and is already planning further installations. "Programming the stepper motor control centrally in TwinCAT saved about a week in programming and troubleshooting time when compared with alternative approaches," Adams reported.

"In addition to our software development savings, PC-based control from Beckhoff also saved significant time in panel design and installation. We are certain it saved several weeks of design and development time in this regard."
At a glance

**Solutions for the entertainment industry**
Innovative leisure park attraction combines animatronic elements and video projection in lobby movie theater

**Customer benefit**
- PC-based control supports communication standards of the entertainment industry and all control functions.
- TwinCAT considerably reduces the programming time.
- EtherCAT Terminals and compact drive technology enable space-saving installation.
- The affordable and easy-to-handle implementation is to be installed at further locations.

**Applied PC Control**
- TwinCAT 3 for programming with Structured Text, TwinCAT NC PTP for animatronics control, TwinCAT PLC HMI for the user interface, TwinCAT TCP/IP for vendor-neutral communication and TwinCAT SMPTE Time-code for AV device synchronization
- CP6706 Panel PC connected via CP-Link 4 to CP2907 7-inch Control Panel
- EL3702 EtherCAT oversampling terminal and EL7041 for controlling the AV systems and stepper motors respectively

Further information:
- www.greatwolf.com
- www.lapropoint.com
- www.beckhoffautomation.com
Bourne, Massachusetts-based Environmental Operating Solutions Inc. has provided sustainable solutions and technical services for biological contaminant removal in water and wastewater treatment systems in the U.S. and Canada since 2003. President Samuel Ledwell describes the core business of the company as follows: “We currently provide over 550 wastewater treatment plants with safe, effective and environmentally-sustainable solutions.”

The MicroC® line of supplemental carbon sources forms the basis of the EOSi portfolio and represents a non-hazardous and environmentally sustainable option to remove contaminants such as nitrogen, phosphorus, selenium and perchlorate, among others, from wastewater. The MicroC® products contain various carbohydrate, alcohol and glycerin-based supplemental carbon sources, which serve as nutrients for the microorganisms in the sewage sludge used for biological wastewater treatment. These products are subjected to the most rigorous quality control processes.

PC-based control platform as an open and flexible automation platform in water treatment

Clean water is vital in both consumer and commercial areas, including numerous industrial applications, such as mining, petroleum refining and groundwater remediation, in addition to residential applications. Environmental Operating Solutions (EOSi), a provider of products and services used in water treatment, evolved its business model to include the Nitrack® control system, which creates value to plant operators by optimizing the dosage of carbon supplements. The first PC-based control system used in this area is ideal to support functions such as remote access to the processes in conventional plants.

PC-based control offers alternatives to traditional sales models

“Maintaining regulatory compliance at the lowest cost is a common goal for our customers,” says Samuel Ledwell. About five years ago, EOSi began a new initiative to help customers further optimize their use of MicroC® products. This evolved into providing and later developing their own product dispensing monitoring and control equipment. In addition, EOSi process engineers develop customized control strategies for the specific process configurations of clients and offer services to help monitor plant performance.
Nitrack® is the first PC-based control system used to monitor and control biological nutrient removal in wastewater treatment. It collects sensor data from a multitude of inputs and uses this data to control and optimize an unlimited number of treatment processes. The Nitrack® system will dose the appropriate amount of MicroC® based on, for example, the amount of nutrients present in the wastewater system compared to the end-of-pipe target concentration. The Nitrack® systems feature a wide variety of PC-based control solutions from Beckhoff, facilitating simple integration into customer facilities along with improvements in both processing power and remote connectivity options. Remote connectivity functionality enables location-independent plant monitoring by the experts of EOSI or by the operators themselves. However, it also entails special connectivity requirements that conventional process control systems usually cannot meet.

**PC-based control finds the right price-to-performance ratio**

When designing the Nitrack system, EOSI wanted the ability to minimize the amount of hardware required to remotely control certain aspects of the treatment process. The PC-based systems provided by Beckhoff offered the right ratio of price to performance for their needs and were equipped with the required communication interfaces. Randy Pulsifer, Automation & Instrumentation Manager, explains: “The main driver here was to develop the Nitrack® technology on a cost-effective platform that would allow our team of engineers to openly communicate with customer control systems, while at the same time having the added benefit of standard PC software rather than being restricted to software that can only run on industrial PLC systems.”

The core of the Beckhoff control system is a CP2216 multi-touch Panel PC, offering a 2.2 GHz Intel® Celeron® dual-core processor in a compact form factor and custom branding for EOSI. Pulsifer notes: “We gain much greater HMI visibility than before with the 15.6-inch widescreen format, and the device seamlessly integrates with our HMI software.” The Panel PC also runs TwinCAT automation software to handle controller outputs used for important process functions, such as pump speeds. EtherCAT Terminals transmit process variables and other plant information to the C6920 control cabinet IPC, which then passes it along to the plant scada, enabling the necessary processing for continuous optimization of the treatment processes.

“Flexibility is key to the success of the Nitrack® initiative. Considering the long lifecycle of water treatment systems, the ability to simply integrate EOSI systems into plants of all types is vital to enhance product value for customers,” explains Randy Pulsifer. “With the EtherCAT system, we have the ability to essentially keep our control platform static and change the distributed I/O equipment as the needs of the customer facility dictate.” Further enhancing connectivity and data availability, the TwinCAT TCP/IP server plays an important role in the implementation process, given the varied nature of equipment used throughout the plants of EOSI customers. Another important factor in the area of public utilities is security: The system integrates directly into existing plant scada systems while remaining on an independent and secure network.

**Controller flexibility flows from retrofits to future plant designs**

EOSI has been pleased with the Nitrack® system. “The design used in our old system could only control one element of the treatment process. In our first Nitrack installation at a municipal water treatment plant, we control four elements, as well as the HMI, without taxing the CPU of the Industrial PC. We can easily add more control elements if necessary. This robust performance of PC-based control is a huge enabler for our plans to expand the scope of Nitrack installations,” concludes Samuel Ledwell.

Further information:
www.microc.com
www.beckhoffautomation.com
High-performance AX8000 multi-axis servo system maximizes machine throughput

Scanning times in sterile vial transport reduced to microseconds

SVM Automatik A/S, based in Silkeborg, Denmark, utilizes the high-performance AX8000 multi-axis servo system in the design of NESTOR, a transport machine for the pharmaceutical industry. The machine requires only microseconds to handle sterile glass containers for quality control. In addition, it can be converted extremely flexibly and quickly and is much easier to program than previous models.

The small glass bottles pass by on the conveyor belt so rapidly that the eye of the observer can barely recognize the individual bottle. Every minute the NESTOR machine places 660 small, thin medical glass syringes into the inspection machine and removes them again: the sterile glass containers are placed on a tray on the conveyor belt. With incredible speed, robots grasp 10 syringes at a time and lift them safely into the inspection system in order to check the integrity of the glass containers. Once the scan is complete, the containers that pass inspection are transported to the next processing step.

The extremely short throughput times are the key benefit of NESTOR, a machine that SVM Automatik developed with its parent company, the Stevanato Group. The pick-and-place robots perform 11 pick-and-place cycles per second in order to manipulate the delicate glass containers. In addition, the scanning time for each individual part has been reduced to a twentieth of the previously required time span.

Such high processing performance is made possible with the help of advanced servo drive technology from Beckhoff — the modular AX8000 multi-axis servo system and AM8000 servomotors — as well as the high-performance C6920 control cabinet Industrial PC (IPC). This IPC runs kinematics software based on TwinCAT 3, which offered an important upgrade from the previous machine’s software.

Standardized machine platform simplifies tailor-made solutions

With currently about 120 employees and a turnover of around 215 million DKK in 2018, SVM Automatik is regarded as one of Denmark’s largest machine manufacturers. The company, which specializes in the development of fully automatic production machines, was founded in 1974.

When the Stevanato Group took a 65% controlling interest in the company in 2016, the corporate strategy was realigned. Whereas SVM Automatik had previously focused on the development of many different custom machines for a few large Danish manufacturers, the company now supplies custom machines based on standardized modules for a broad range of manufacturers.

"Becoming part of the Stevanato Group has opened our door to the world of pharmaceutical companies. With more identical devices applied in the pharmaceutical industry, SVM has been able to develop a standard machine platform that can be used for a variety of assembly applications. The customers benefit because they get a uniform user interface for their solutions,” says Jens Schou Christensen, Head of Product Management at SVM Automatik, emphasizing: "That considerably simplifies machine controller operability.”

Extremely high performance is essential for success

NESTOR is a transport system that infeeds and outfeeds empty or filled glass containers to the inspection machine. The functionality of NESTOR is useful elsewhere in the process, however. The transport grippers can place workpieces into compact, sterile-operating machines for optical inspection and subsequently forward them to downstream processing stations, such as filling, random sampling, quality control, packaging and labeling.
A pick-and-place robot grasps 10 vials at a time and transports them downstream.
The decisive factor for the plant’s success is the extremely high speed of parts transport combined with sufficient time for a constant test duration.

**Compact and easy-to-handle servo controller**

NESTOR has a footprint of just 2 x 1 m. The two integrated delta robots, with highly dynamic AM8000 servomotors controlled by two compact AX8000 multi-axis servo systems, move with exceptional speed and safety inside a glazed enclosure. The smooth interaction of the individual components – the C6920 IPC, fast servo drive technology and TwinCAT software – ultimately convinced the machine manufacturer to select the Beckhoff solution.

Anders Silkær Mikkelsen, Software Designer at SVM Automatik, further explains: "The new PC-based servo controller enables very fast machine cycle times. It automatically calculates the direction in which the robot grippers have to act. With the high-performance AX8000 multi-axis servo system, the robot arms move faster and with greater precision than before. Moreover, you simply put the drive’s axis modules together with plug-and-play assembly like function blocks. That’s new, and it optimizes both space requirements and costs. The machine is now so flexible that we can quickly convert from 1 ml to 10 ml glass containers."

The solution uses One Cable Technology (OCT), which means SVM Automatik only needs one cable to connect from the control cabinet to the motor. "We can install the drive hardware inside the actual machine. That makes it even simpler to adapt the machine design," he concludes.
Jens Schou Christensen adds: “It was most important for us to be able to reduce the scanning times from the previous 4 to 5 ms down to 20 µs. As a result, the machine is one of the fastest on the global market. We presented NESTOR at the Interphex trade show in New York City and Achema in Frankfurt and received extremely positive feedback. We see great potential in this machine type and expect to sell 10 machines per year.”

Close collaboration shortens time to market
SVM Automatik relies on TwinCAT 3 as the engineering and control software. The integration in Microsoft Visual Studio® allows simpler programming of automation objects. The Danes developed the kinematic software together with Beckhoff. This software controls the four AM8000 servomotors in a delta robot. The close collaboration with the development and support team from Beckhoff proved to be valuable for everyone involved.

“We had close communication with Beckhoff in Germany and in Denmark, and this shortened the path from idea to implementation. The dialog was good the whole time and we got all the support we needed,” says Silkaer Mikkelsen. “There’s no doubt that Beckhoff is right at the top of the range when it comes to automation innovations and support.”

At a glance

Solutions for the pharmaceutical industry
– feeding and transport system inspecting glass vials and syringes in plants

Customer benefit
– processing of 660 glass vials per minute
– scanning time reduced from 4 – 5 ms to 20 µs
– simple machine operation and conversion

Applied PC Control
– extremely short response times with the AX8000 multi-axis servo system and the dynamic AM8000 servomotors
– compact design and space-saving installation in control cabinets
– fast commissioning through simple connection of the desired axis modules
– One Cable Technology (OCT) reduces cabling and connector requirements

Further information:
https://engineering.stevanatogroup.com/svm
www.beckhoff.dk
Compact packaging system with XTS and two peripheral 6-axis robots.
Linear transport system XTS provides the basis for compact and flexible packaging system with minimized conversion times

At the forefront of cosmetics packaging with XTS

End customers in the cosmetics industry require their suppliers to provide them with packaging systems that feature maximum adaptability and flexibility because the market demands ever-faster changes in product presentation and packaging. To meet the needs of cosmetics company Shiseido, equipment manufacturer Unista developed an innovative solution based on the eXtended Transport System (XTS) and other automation components and software from Beckhoff.
The compact machine for closing cosmetics containers is based on XTS technology.

The individually and precisely controlled product transport with XTS makes sure that the high-quality Shiseido cosmetics containers are handled without any damages.
A robot equipped with vacuum grippers places the lids on the containers before they are screwed on by a handling system that is equipped with AMB100 servomotors.

The XTS transports the containers with 11 movers over a track length of 4 m to various processing stations.

An arm-mounted CP3918 Control Panel with push-button extension makes it easy to operate and monitor the machine, which is operating behind glass panels.

Shiseido is a Japanese maker of high-end cosmetics with an international presence. Founded in 1872 in Tokyo, it is one of the world’s oldest cosmetics companies. Its European headquarters and two manufacturing plants have been based in France for thirty years. Machine manufacturer Unista, located in the Nantes region, was selected by Shiseido to develop and build two packaging machines. Since Shiseido uses containers in many sizes and shapes for its diverse portfolio of products in the luxury segment, the equipment had to deliver a maximum of flexibility.

Anthony Forget, Managing Director of machine builder Unista, and David Ranchy from the Beckhoff office in Nantes show the new packaging system (left to right).
Unista has produced packaging lines for ten years and specializes in robot-supported equipment. The newly developed machine model supports many different container types and lot sizes while keeping setup changeover times to a minimum.

**Keyword: Flexibility**

Unista’s goal was to meet the central demand for flexibility without compromising the engineering, the motion controls and the production process. Anthony Forget, Managing Director of Unista France, explains: “To accommodate the broad product portfolio of Shiseido, we needed an extremely flexible machine”. “Unista’s needs were very much in line with the properties of our XTS transport system, which now functions as the machine’s central component and makes the production much more flexible,” says David Ranchy, Sales Engineer at the Beckhoff office in Nantes.

Unista employed an XTS with a track length of 4 m, which enabled them to keep the machine compact and put the available floor space to its best use. The transport solution is supplemented by two 6-axis robots for product handling. The first robot takes care of the loading and unloading. It places the filled cosmetics jars on the XTS, which uses 11 movers to transport them to the respective processing stations. The second robot places lids on the containers and lightly screws them in before they are fully closed with a specific torque and rotation angle at the following handling station. At the final quality control station, the containers are sorted into good and reject units. One of the key requirements involved was protecting the high-value cosmetics containers against any kind of damage to ensure that the packaged products are in line with the high quality standards of the Shiseido brand.

**Benefit: Operational agility**

One key advantage of the XTS in that context is the individual product transport, which is not subject to rigid synchronization between the processing stations. As a result of the individual and highly precise positioning with the movers, the machine delivers maximum throughput paired with gentle product handling.
In addition, the software-based control functions make it easy to adapt the system to changing formats, such as container diameters, on the fly. All it takes is a change in the software parameters instead of a complex and expensive machine reconfiguration.

**A universal hardware and software platform**

Besides the XTS, Unista also employs servomotor terminals and servomotors from Beckhoff for the handling unit that screws on the lids. Other components from the Beckhoff portfolio include EtherCAT Terminals for the communication between the control components as well as TwinSAFE products for machine safety. The benefits are readily apparent. Sourcing all components from a universal hardware and software platform means a single point of contact and fast and easy integration.

The entire machine is controlled by a space-saving, cabinet-mounted CX5140 Embedded PC that runs TwinCAT 3 automation software. The drive technology of the handling unit features an especially compact design. EL7211 servomotor terminals control the dynamic AM8100 servomotors, which are connected via One Cable Technology (OCT). This reduces the cabling costs by 50 percent and gives the machine a very tidy appearance. A CP3918 Control Panel displays Unista’s own user interface.

**Simplified engineering and reduced time to market**

The simple engineering and straightforward commissioning with XTS and PC-based control enabled the experts from Unista to complete a ready-to-operate machine in less than ten weeks, as they say. With its short time to market and high degree of operational flexibility, the XTS application for Shiseido represents a prime example of mechanical engineering in the age of Industrie 4.0 that is at the forefront of cosmetics packaging.

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**Further information:**

- [www.shiseidogroup.com/emea](http://www.shiseidogroup.com/emea)
- [www.unista.fr](http://www.unista.fr)
- [www.beckhoff.fr](http://www.beckhoff.fr)
Whether you realize it or not, the communication network is the single most important technological component of a machine or plant control system. The network ultimately determines the entire control architecture: a relatively slow network requires closing the faster control loops in decentralized devices, while a high performance network enables engineers to freely decide whether to use centralized versus decentralized architectures. In addition, a well-accepted network provides the freedom to select components from a large variety of vendors while a network dominated by a single automation giant reduces the choice to this giant’s products by default, since third party products are either not available or not supported properly by the dominant vendor’s network configuration tool.
So how do control system integrators or machine builders select their communication network, in other words their fieldbus system? We reckon that the majority of users do not actively select their fieldbus at all – they select the control system vendor and whatever bus system this vendor provides will “do the job.” The vendor is selected for a variety of reasons.

- A very common reason is history: “We have always used these products,” or “Our application code is written in the programming language of this vendor and we cannot justify the effort to port over the code.”
- Another one is customer preference: “Our clients want us to use this platform so that their maintenance team can handle the machine.”
- Also the local sales and application engineering team of the vendor plays a most important role: “I am happy with the vendor’s support; they are attentive and responsive and they know what they are talking about.”
- Vendor reputation contributes big time: “My supplier is leading edge and provides innovative technology that keeps me ahead of my competition,” or “They are so big, they must be good.”

And, of course, a lot of other factors are typically taken into account as well: initial price (often more important than “total cost of ownership”), quality, ease of use, performance, and yes, even design.

**High performance legitimizes broad-based support**

But how about those users that start their control system evaluation by taking a closer look at the bus technology itself as the key component of their system? Naturally, these are the types of users that the fieldbus organizations primarily address.

We find that for many of those users that compare technologies at some detail, EtherCAT quickly becomes the favorite: its unique functional principle is compelling and makes it “the engineer’s choice.” With EtherCAT, the Ethernet telegrams are processed on the fly, which means the frames are hardly delayed at all. As a result, an EtherCAT frame comprises the data of many devices both in “send” and “receive” direction within one Ethernet frame and the usable data rate increases to over 90%.
The resulting higher performance then leads to more efficient machines. EtherCAT makes the processing power of an Industrial PC more available for the application, and faster controls provide more accurate results. For example, Husky, a leading injection molding machine manufacturer, reported that by using EtherCAT it was possible to reduce the part weight variation and thus the wall thickness of plastic cups their machines make. As a result, this saves material worth in the 6-digit range per machine, per year for Husky’s customers. But not only closed loop controls benefit from faster communications: in many applications there are so called transitions or step enabling conditions, where one has to wait for a part to arrive, the cylinder to reach its end position, or the pressure to reach a certain threshold. With a faster network, these waiting times are reduced and the throughput of the machine or plant is increased – increasing efficiency a few percentage points can be easily achieved this way.

Also such users understand that EtherCAT is not only fast, but also very precise: thanks to the distributed clocks (DC) mechanism, measurement values can be sampled and outputs set in a synchronized manner network wide – and with a jitter substantially smaller than one microsecond. This accuracy is ideal for synchronized motion control applications and for the integration of measurement tasks within the same network.

EtherCAT is versatile: master-to-slave, slave-to-slave and master-to-master communication is supported. It is also convincing that EtherCAT is inexpensive: On one hand there are the software-implemented masters on standard Ethernet ports, on the other there are the highly integrated yet low cost slave controller chips. The cabling efficiencies also save money, since EtherCAT does not require switches or other active infrastructure components and uses standard Ethernet cabling and connectors. Even engineering efforts are reduced, since network tuning is not required anymore and because the diagnostic features of EtherCAT technology provide exact error localization, reducing troubleshooting time.

Besides low cost chips and hardware it is important to stress again another crucial factor enabling low component prices: worldwide acceptance of the technology. This ideally means a wide selection of products and thus competition among the suppliers.

**Flexibility and openness boost functionality**

Users of EtherCAT also capitalize on the flexible topology that simplifies planning and installation. EtherCAT networks have no practical limitations regarding the topology: line, star, tree, redundant ring and all those combined with a practically unlimited number of nodes per segment. Even wireless technologies can be integrated and the “hot connect” feature allows users to connect and disconnect nodes or entire network segments during runtime.

System integrators and machine builders also increasingly want to integrate functional safety in their control architecture – and not just to simplify wiring. Conventionally, safety functions were realized separately from the automation network, either by hardware or using dedicated safety bus systems. Safety over EtherCAT (FSoE), on the other hand, enables safety-related communication and control communication on the same network and ETG members are capitalizing on this in the form of exciting new safety solutions.

For many potential users, the migration from a legacy bus system to EtherCAT can seem challenging. EtherCAT addresses this with a large selection of fieldbus gateways. With these components one can integrate existing devices with a legacy fieldbus connection into an EtherCAT network and establish interfaces...
to "neighboring" or higher level systems. Migration from previous systems is smooth and at the same time the previously complex interface requirements of the central controllers are omitted: other systems are simply integrated via EtherCAT and no longer via PCI, cPCI, PCIe and so on.

With EtherCAT networks, there is also no need for manual address settings via dip-switch, rotary switch or similar configuration tools at every device: at boot-up, the addresses are assigned automatically. Even if devices are added later, the original addresses can be kept – EtherCAT masters can also feature automatic topology recognition with which they can compare the actual network configuration with the one expected by the application program. After device replacement, all parameters can be downloaded automatically.

When selecting a fieldbus network, true openness means future-proof implementation. That said, almost every fieldbus and Ethernet technology claims to be "open". With EtherCAT, however, openness does not only mean international standardization (IEC, ISO), availability of commercial (as well as shared and open source) master and slave software and chips from several suppliers. It also means implementation support that is free of charge, clear guidelines regarding interoperability, master and slave implementations for a wide variety of operating systems and controllers, openness of the configuration tools (including third party devices) and specifications for the application interfaces. EtherCAT technology is not only fully Ethernet-compatible, it is also characterized by openness "by design": the protocol can transport other Ethernet-based services and protocols on the same physical network. Such web technologies are tunneled via the EtherCAT protocol, so that the real-time characteristics are not impaired. Therefore, all web technologies can also be used in the EtherCAT environment: integrated web servers, e-mail, FTP transfer, etc.

**An answer for all users**

So we find that both groups of users – those that base their network decisions on their choice of control vendors and those that take a closer look at the bus technology itself – are increasingly moving toward EtherCAT. In summary, EtherCAT is characterized by outstanding performance, very simple wiring and openness for a wide range of devices and other protocols. EtherCAT sets new performance standards and provides, thanks to Ethernet and Internet technologies, optimum vertical integration. With EtherCAT, topology complications are a matter of the past – and expensive infrastructure components are a dying breed.

Further information:

[www.ethercat.org](http://www.ethercat.org)
Trade shows 2019

**Europe**

**Germany**

Husum Wind
10 – 13 September 2019
Husum
www.husumwind.com

EMO
16 – 21 September 2019
Hanover
www.emo-hannover.de

Meorga Ludwigshafen
18 September 2019
Ludwigshafen
www.meorga.de

FachPack
24 – 26 September 2019
Nuremberg
www.fachpack.de/en

Motek
07 – 10 October 2019
Stuttgart
www.motek-messe.de/en

K
16 – 23 October 2019
Düsseldorf
www.k-online.com

Meorga Landshut
23 October 2019
Landshut
www.meorga.de

**Austria**

Building Technology Austria
18 – 19 September 2019
Vienna
www.bt-austria.at

**Belgium**

Bedrijven Netwerkdagen
20 – 21 November 2019
Hasselt
www.bedrijvennetwerkdagen.be

Bedrijven Contactdagen
04 – 05 December 2019
Kortrijk
www.bedrijvencontactdagen.be

**Czech Republic**

MSV
07 – 11 October 2019
Brno
www.bvv.cz/en/msv

**Denmark**

Hi
01 – 03 October 2019
Herning
www.hi-industri.dk

**Finland**

Puumessut
04 – 06 September 2019
Jyväskylä
www.puumessut.fi

Alihankinta
24 – 29 September 2019
Tampere
www.alihankinta.fi

Avita AudioVisual Expo
02 – 03 October 2019
Helsinki
www.audiovisualexpo.messukeskus.com

Teknologia
05 – 07 November 2019
Helsinki
www.teknologia.messukeskus.com

**Italy**

Smart Building Expo
13 – 15 November 2019
Milan
www.smartbuildingexpo.it

**Norway**

Aqua Nor
20 – 23 August 2019
Trondheim
www.aqua-nor.no

**Sweden**

Euro Expo Sundsvall
11 – 12 September 2019
Sundsvall
www.euroexpo.se

Euro Expo Kiruna
06 – 07 November 2019
Kiruna
www.euroexpo.se

Euro Expo Luleå
27 – 28 November 2019
Luleå
www.euroexpo.se

**United Kingdom**

SPE Offshore Europe
03 – 06 September 2019
Aberdeen
www.offshore-europe.co.uk

PPMA
01 – 03 October 2019
Birmingham
www.ppma-totalshow.co.uk

**Euro Expo Ålesund**

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www.bvv.cz/en/msv
Africa
South Africa
KZN Industrial Technology Exhibition
24 – 26 July 2019
Durban
www.kzminustrial.co.za

Asia
China
AHTE
03 – 06 July 2019
Shanghai
www.shanghaiahte.com
InfoComm China
17 – 19 July 2019
Beijing
www.infocomm-china.com
Cippe Shanghai
28 – 30 August 2019
Shanghai
http://sh.cippe.com.cn
Industrial Automation Show
17 – 21 September 2019
Shanghai
www.industrial-automation-show.com
China Wind Power
22 – 24 October 2019
Beijing
www.chinawind.org.cn

India
Automation Expo
25 – 28 September 2019
Mumbai
www.automationindiaexpo.com
Engimach
04 – 08 December 2019
Gandhinagar
http://rdcglobal.com

Indonesia
Manufacturing Indonesia
04 – 07 December 2019
Jakarta
www.manufacturingindonesia.com

Japan
MECT
23 – 26 October 2019
Nagoya
www.mect-japan.com
Japan Pack
29 October – 01 November 2019
Tokyo
www.japanpack.jp

IIFES
27 – 29 November 2019
Tokyo
www.iifes.jp

Singapore
Industrial Transformation Asia Pacific
22 – 24 October 2019
Singapore
www.industrial-transformation.com

Taiwan
Taipei International Automation Exhibition
21 – 24 August 2019
Taipei
www.autotaiwan.com.tw

North America
Canada
Canadian Manufacturing and Technology Show
30 September – 03 October 2019
Toronto, ON
www.cmnts.ca

USA
Digital Industry USA
11 – 12 September 2019
Louisville, KY
www.digitalindustryusa.com
Pack Expo
23 – 25 September 2019
Las Vegas, NV
www.packexpolasvegas.com
Automotive Testing Expo
22 – 24 October 2019
Novi, MI
www.testing-expo.com/usa
Fabtech
11 – 14 November 2019
Chicago, IL
www.fabtechexpo.com

Further information:
www.beckhoff.com/trade_shows