Automation and motion control solutions for the packaging industry

PC Control drives innovation in packaging machine design

With PC-based control and EtherCAT technology from Beckhoff you can manage and monitor the entire packaging process, from individual packaging machines to complete packaging lines. Michael Jost, Roland van Mark, Michael Pfister, Uwe Prüßmeier and Frank Würthner – all Beckhoff experts in the field – explain from various perspectives the role PC Control plays as a driver of innovation for the design of packaging machines.

PC Control from Beckhoff offers a complete automation solution for all packaging tasks, from forming, filling and sealing to collecting, boxing, labeling and palletizing.

What are the most important current requirements in the packaging industry, and how do they affect the world's machine builders?

Frank Würthner: Packaging technology requirements vary from industry to industry. For example, the needs in the consumer goods industry are different from those in the food or pharmaceutical industries. What they all have in common, however, is an increased focus on quality, flexibility, and most of all, resource efficiency. In particular, the packaging machine industry must accommodate the trend to minimize the use of raw materials and other resources, which means delivering maximum sustainability and reduced manufacturing costs. The best way to do this is with eXtreme Fast Control (XFC) technology from Beckhoff, which, as the name implies, can implement process sequences with extreme speed and precision. When sealing blister packs, for example, XFC helps users minimize the consumption of plastic film, which can lead to significant cost savings considering the large quantities involved. At the end of the day, PC Control opens the door to many potential innovations and new ways forward in machine design. This is due in large part to the high performance of PC-based control technology and the openness of TwinCAT towards established IT tools and high-level programming languages as well as the integration of measurement and simulation technologies. PC Control is particularly well-suited for applications where products must be packaged at very high speeds or applications that involve complex motion control interactions. Additional safety benefits are provided by the fully integrated TwinSAFE solution, ranging from the TwinCAT Safety Editor and Safety-over-EtherCAT to TwinSAFE terminals and drive-integrated safety technology.

Frank Würthner, Business Management
Packaging, Beckhoff:

"PC-based control technology provides the ideal foundation for high-performing, flexible and resource-conserving packaging processes."

Quality management and traceability are becoming more and more important, particularly in the food and pharma industries. How does this affect the machines and automation technologies in general?

Frank Würthner: "Good manufacturing practice" (GMP) is the key. Needless to say, any packaging machine must make it possible to properly manage quality and workflows in accordance with GMP guidelines. Our TwinCAT automation software provides the best possible support for this approach with features like the TwinCAT Database Server which facilitates communication with all relevant databases.
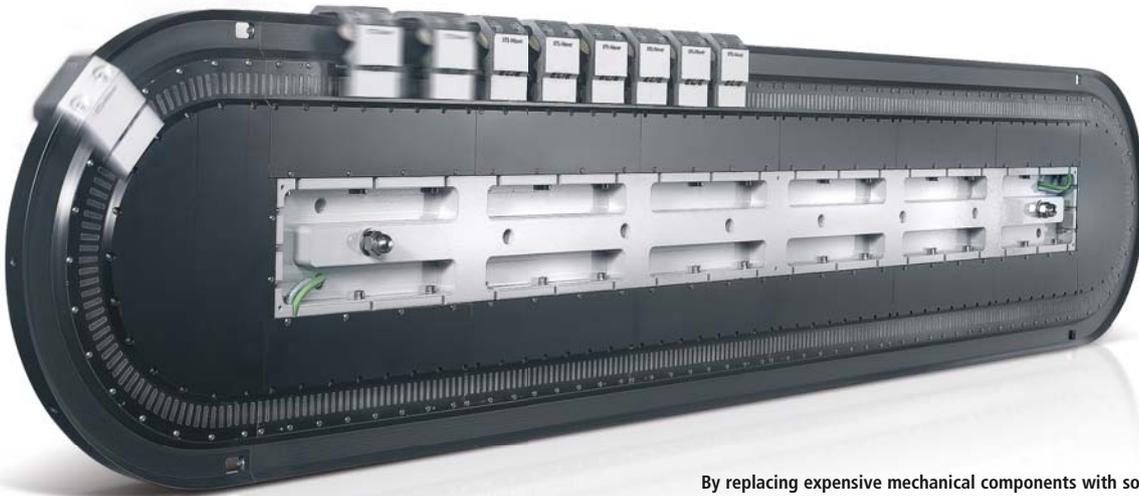
By replacing expensive mechanical components with software functionality, the eXtended Transport System (XTS) opens the door to new capabilities in packaging machine design.

A completely new approach is the eXtended Transport System (XTS), which combines the benefits of rotary and linear drive principles in a single system. What does this entail for packaging machines?

Uwe Prüßmeier: Where rotary systems hit a wall previously, XTS now adds the properties of a linear drive system, thus opening the door to a new world of solutions for highly dynamic machine concepts. Particularly in the packaging industry, the combination of clocked processing with continuous flow delivers great benefits. With the compact design of the XTS, machine builders can create much more space-efficient systems. In addition, our TwinCAT automation software delivers easy engineering capabilities, because all "movers" in an XTS system are mapped as "normal" servo-axes, and software functions like automatic buffering, and collision and jerk avoidance have already been integrated. With flexibility regarding lengths and curves, the design features all the benefits of direct drive technology such as high accuracy and dynamics, low vibration tendency, freedom from wear, and low energy consumption.

The systems are becoming more flexible and complex, but should still be easy to operate. What roles do the new multi-touch Control Panels and Panel PCs from Beckhoff play in this context?

Roland van Mark: The packaging industry in particular places great value on Control Panels with an attractive design and a high degree of functionality. That's why our new multi-touch panels are a great success. Another great sales point in this context is our long experience with customer-specific HMIs, i.e. customer-specific touch-screen solutions – from the design of the panel front to standard keyboard extensions to a completely new generation of housings. That's why nearly all machine developments now also include new and innovative operating concepts with multi-touch features. Examples include the ability to zoom into the process and rotate components more effectively as well as the freedom to use several fingers, for example, to change several parameters at the same time. Features like these are considered clear advantages for the end customer.

Uwe Prüßmeier, Product Manager Fieldbus Systems and Drive Technology, Beckhoff:

"XTS now also offers a 'fast mode' for dynamically moving a fixed group of multiple movers."

EtherCAT communication features exceptional performance and flexibility. What benefits does it deliver to makers of packaging equipment?

Michael Jost: The packaging industry is characterized to a large extent by its dependence on cycle times. What matters most is how many products you can package per minute or second, which is why an extremely fast communication system with outstanding synchronization capabilities represents true innovation. This is precisely what EtherCAT offers, especially in connection with XFC (eXtreme Fast Control) technologies like "distributed clocks" for synchronized system time, "time stamping" for user data, and "oversampling" for checking process data multiple times within the communication cycle. The flexibility of the EtherCAT system provides additional benefits. On the one hand, you can select the best possible topology – star or ring – for each machine type. On the other hand, you can integrate special functionalities like safety, measurement technology or condition monitoring directly into the control system via the modular

Roland van Mark, Product and Marketing
Management Industrial PC, Beckhoff:

"Nearly all new packaging
systems also include inno-
vative multi-touch operating
concepts."

EtherCAT I/O system. One example that's particularly interesting for packaging applications is the integrated weighing technology you can implement with our analog EL3356-0010 input terminal.

Packing technology relies on highly dynamic motion control. What features does Beckhoff drive technology offer in this context?

Michael Pfister: For the packaging industry, Beckhoff offers a complete portfolio of drive solutions ranging from 50 W to 120 kW, i.e. servo drives, motors, and matching planetary gear units. The AX5000 servo drives are available in single-axis models and as space-saving dual-axis models in a single housing. The innovative AX bridge solution simplifies the DC link system, which eliminates the need for expensive braking resistance. The drives, which feature EtherCAT by default, can also be fully integrated into safety concepts via the AX58xx TwinSAFE cards. In the secondary-packaging field, you typically require more low-power applications. Here we also offer an optimized portfolio with our EL72xx servo drive terminals with ratings of up to 250 W as a complement to our AX5000 servo drives. Our motors in sizes 1 through 7 are also ideal for packaging applications because of their low rotor inertia, compact dimensions and smooth

housing design. Implementing multi-axis packaging applications is no problem. In addition, all motors can be equipped with absolute encoders, which simplify synchronization. With our AM8800 series and the matching AG2800 planetary gear units, we also offer drive technology in "hygienic design" that complies with EHEDG Class 1. The AISI316L (V4A) motors with protection class IP 69K are well-suited for extra-demanding applications, for example, in the food industry. Another truly innovative feature in terms of machine design and cost reduction is the One Cable Technology (OCT) available in our motor and drive products.

What characterizes a PC Control solution for the packaging industry from a practical viewpoint?

Frank Würthner: With PC Control we offer all the components you need for a practice-oriented packaging solution. On the hardware side, this ranges from Control Panels, control cabinets, Panel PCs and our extremely broad I/O spectrum, also in high protection categories, to our especially dynamic servo drive technology. We also accommodate special requirements, such as stainless-steel housings, FDA conformity and EDEDG certification. On the software side, we offer many packaging-relevant libraries within TwinCAT, such as dancer control,

Michael Jost, Product Manager Fieldbus Systems and EtherCAT, Beckhoff:

"For packaging technology, which is characterized by its dependence on short cycle times, the extremely fast EtherCAT communication system with its outstanding synchronization capabilities is a significant driver of innovation."

camming, print mark control or cross-cutters. The PackML OMAC standard is also fully supported. What machine builders especially like about PC Control includes outstanding software and hardware scalability, openness for integrating their own expertise (for example, a specific closed-loop temperature controller), and its extremely powerful EtherCAT communication capabilities, especially when XFC technology is involved.

Michael Jost: Since synchronizing the various workflows is particularly important in packaging processes, packaging machine builders benefit from the speed of our data transmission, especially with the XFC technologies. EtherCAT enables easy and precise sensing of the positions within the packaging process with a standard I/O module. With the EL2521 pulse train output terminal, for example, you can simulate encoder signals that used to be external. Another concrete advantage for the machine designer: The EtherCAT I/O system is extremely compact and saves a great deal of space in control cabinets. Examples include the HD EtherCAT Terminals with their enhanced signal density and the EtherCAT Box Modules in protection categories IP 65, IP 66 and IP 67 for installation outside of control cabinets. Then there are also the EQ series IP 69K modules in 4-, 8- and 16-channels versions, which are ideal for hygienic design

applications in V2A housings with widths of only 39 mm or 72 mm.

Roland van Mark: As far as the practical benefits of our multi-touch devices are concerned, the focus is clearly on the highly ergonomic and safe machine operations they make possible. In addition, the Control Panels and Panel PCs feature an elegant, low-depth design and an optimized price-to-performance ratio with cost savings of up to 28 percent compared with previous units. This means that even price-sensitive packaging applications can offer added value with innovative operator interfaces. We offer these panels in a broad range of models for a uniform look and feel on the machine, or even as customized versions at the cost of a standard single-touch device. Additional cost and design benefits can be leveraged with the new CP-Link 4 connection technology. With this single-cable solution, which lets you install Beckhoff multi-touch Control Panels up to 100 meters (330 feet) from the Industrial PC, the video signal, USB 2.0 signal and power are transmitted via a standard CAT.6A cable, which reduces the cabling and installation costs significantly. Another benefit is the ability to install purely passive displays.

Michael Pfister: The AX5000 EtherCAT servo drives are ideal for high-speed machines, because with their current control of up to 62.5 µs, you can implement the fastest possible positioning tasks. They are supported by the AM8000 motors, which make even extreme acceleration possible with low rotor inertia in combination with their up to five-fold overload capability. Our One Cable Technology (OCT) delivers additional benefits in real-life applications. The average packaging machine today has eight moving axes. If you can cut the number of cables down by half, you also cut costs while opening up new avenues in machine design. Even with lengths as short as 5 meters, OCT is less expensive than the traditional feedback system while delivering 10 times the resolution, a fully integrated electronic name plate, and motor diagnostics.

Uwe Prüßmeier: Especially considering the XTS, the main advantages come from replacing mechanics with software functionalities. This enables the machine builder to implement motion profiles much more flexibly while eliminating expensive mechanical components. It also reduces the development time. If necessary, subsequent functionality enhancements can even be delivered to the end customer via remote access. This reduces costs significantly, because you can use the XTS as a standard element for wide ranging and diverse tasks. The modules are easily integrated into the machine, and any application

Michael Pfister, Product Manager Drive Technology, Beckhoff:

"In terms of cost reductions and design options, our One Cable Technology represents a real milestone for the packaging machine industry."

modifications involve only additions to the mover. Packaging applications that have already been implemented include filling bags, sorting product streams, synchronizing asynchronous product streams with a cyclical product stream, intelligent and dynamic product carriers, and the inline assembly of packages.

What benefits do these features deliver for the end user's packaging process?

Uwe Prüßmeier: XTS makes it easy to implement lot sizes of 1 or special runs such as „5-plus-1" packaging, because the mechanical modifications for a product are largely made by adjusting parameters in TwinCAT. This results in much faster product changeovers. You can simply save the parameters for a product and call them up for another run without having to make any mechanical modifications. It also requires less maintenance and cleaning, which means that you don't need highly skilled workers for these tasks. Additional savings are provided by predictive maintenance capabilities, because a direct drive "knows" all current operating values, such as the power input of each mover. This enables it to recognize overloads and vibrations at a very early stage.

Universal multi-touch panel series: Among the new items that Beckhoff is presenting at Interpack are the CP3915 and CP3918 Multi-touch Panels, which are optimized for packaging machines.

Interpack News 2014

What will be the focus of the Beckhoff presence at Interpack 2014?

Frank Würthner: At Interpack 2014 we will show all the advantages of PC Control as a flexible and scalable control solution for packaging lines. As a special focus, several XTS solutions will demonstrate the innovation potential of PC Control for the packaging machine industry. Other major topics include increased engineering efficiency with TwinCAT 3 and the role packaging machines play in Industry 4.0 scenarios.

Uwe Prüßmeier: With regard to XTS, our visitors expect to see many enhancements and adaptations in detail, most of which were developed in close collaboration with machine builders and end customers. One such example is the so-called "fast mode" as an advanced development of the energy-optimized "queue" function, which lets you form a group of several movers at equal distances and with very high speed.

Roland van Mark: We will also present our very flexible multi-touch panel range with the CP2xxx and CP3xxx Control Panel and Panel PC series at this year's Interpack. The many housing models, either "built-in" style for cabinets or other versions for installation on mounting-arms feature screen sizes ranging from 7 to 24 inches in 16:9, 5:4 and 4:3 aspect ratios as well as in landscape or portrait modes. These are supplemented by a broad range of processors up to 4th generation Intel® Core™ i processors. We will also demonstrate the capabilities of CP-Link for remote installation of multi-touch panels as well as the fanless CX5100 Embedded PC series with the latest Intel® Atom™ CPUs, introducing multi-core technology in what we consider "medium-range" controllers. Another highlight is the CP39xx multi-touch Control Panel with an IP 65 housing and a display that is laminated for extra shatter protection.

Michael Jost: Our innovations include the EL2522 pulse train output terminal in a 2-channel version, which – unlike the 1-channel terminal – features a third differential output as a reference pulse signal. Another highlight is the EL9576 brake chopper terminal, which can be used in connection with stepper motor terminals, DC motor terminals and servo motor terminals to store back currents or discharge feed-back energy via a ballast resistor. The servo motor terminals, which are available with a resolver or in OCT versions, also include an advancement: the double-width (24 mm) EL7211 with its effective current output of up to 4.5 A significantly expands the areas in which terminal-based servo drive technology can be used.

Michael Pfister: The new AM811x and AM801x servo motors with their scalable output ranging from 50 W to 250 W feature single-turn or multi-turn encoders with 15-bit resolution and One Cable Technology. With a flange of 40 mm, they are designed for extremely small spaces. Industry-standard rotating quick-connectors simplify cabling efforts. The available lengths and an optional zero-play permanent-magnet brake cover a broad spectrum of applications. Especially the combination of AM811x motors with the new EL7211-0010 servo motor terminal for an output of up to 4.5 A$_{RMS}$ at 50 V DC represents an exceptionally compact and affordable servo system.

With the introduction of the CX5100 Embedded PC series, Beckhoff makes multi-core technology now also available for controllers in the medium performance class.