Hans Beckhoff talks to
Open Automation

Leading the way to Industry 4.0

Open PC-based automation, increased connectivity, fast I/O terminals, TwinCAT automation software, and efficient drive technology provide a superior technological foundation for the Industry 4.0 movement. Open Automation magazine spoke exclusively with Hans Beckhoff, Managing Director of Beckhoff, about strategies and new developments.

2014 marked an important anniversary for Beckhoff: "25 years ago, we implemented the first applications with our fiber-optic-based Lightbus, one of the first fieldbuses," Hans Beckhoff recalls. This fast communication solution is still used and supported today. The company's products, systems, and solutions cover a broad mix of industrial application areas. This provides an ideal control platform across the entire mechanical engineering industry, as well as in building and energy automation, measurement technology, process engineering, process technology, and even entertainment engineering applications. "With respect to our turnover, we see equally positive development in almost all market segments this year," says the Managing Director, happily. "We are developing our company by leading the evolution in global automation trends. The products that result from this process make new and optimized solutions possible for our customers in the most diverse industries."

Automation platform equipped for Industry 4.0

How does that fit with Industry 4.0? "Automation is a high-tech industry that makes long-standing investment goods more intelligent," explains Beckhoff, the graduate physicist. "This enables a steady evolution, accompanied by smaller and sometimes larger revolutions." He does not regard the automation of lot

size 1 production as a new part of the current revolution: "As far back as 1986, we equipped a machine with a PC-based controller that produced windows in a single-product lot size."

Now, as the automation technology industry embraces the catchphrase "Internet of Things", the convergence of Internet technologies affects a number of areas, frequently referred to as the fourth industrial revolution, or Industry 4.0. "The term 'revolution' is often taken to mean that this happens directly, immediately, and on the spot," Beckhoff continues. "However, an analysis of the progression from the first to the third industrial revolutions has shown that the associated technical changes took decades." In the opinion of Hans Beckhoff, Industry 4.0 is also a revolutionary development – a technological quantum leap that will, however, take some time to reach full industry adoption. "In the year 2040, when one looks back at the years 2010 to 2030, this development will likely look once more like a fast-progressing revolution," the Managing Director adds. "With our range of open, PC-based automation solutions, we are ideally equipped for Industry 4.0. PC-based control technology has always driven the convergence of IT and automation technology (AT), so it naturally promotes greatly expanded Internet connectivity." On top of that, the

Beckhoff: revenue of 500 million euros projected in 2014

The economic situation is extremely positive for Beckhoff this year. "We are expecting growth of approximately 15 %, so we will achieve a turnover of approximately 500 million euros," Hans Beckhoff reports. "From a geographic point of view, all areas have contributed to this robust growth, although the strongest growth was in Asia." However, the company also grew by almost 10 % in Germany.

International expansion also continues at a rapid pace: "The branch office in the Czech Republic, which only opened at the beginning of March 2014, already has six employees," says Beckhoff, offering an example. Further representative offices were opened this year in Saudi Arabia, Egypt, and Indonesia. "However, we are also expanding in all countries where we currently have a large presence," he adds. "In the USA, for example, we have already moved into new headquarters, and the new headquarters office of Beckhoff Finland will be inaugurated at the beginning of 2015." In the meantime, Beckhoff is represented in 33 countries with subsidiary or representative offices, and in approximately 70 countries altogether.

How is the current economic situation? "There is a discrepancy between the increasingly critical general economic reporting in Europe and our incoming order levels, which remain positive globally," the optimistic Managing Director replies. The production facilities at the Verl global headquarters are therefore being expanded. "A total of 2000 m² production and storage area has been added," Beckhoff reports. The production of EMS motherboards is also being extended. "We are adding two additional production lines, for an eventual total of 13," he continues. "Assembly capacity will grow to 1.2 billion components per year, amply preparing the company for the next 20 % to 30 % of growth." After that, the new Beckhoff headquarters campus will be in the spotlight. "We have over 150,000 m² of space in reserve, ready for further strong corporate growth," says the Managing Director, looking ahead to a bright future.

computers support standards-based communication with the Cloud. "As one example, Beckhoff Automation utilizes Microsoft Azure as an open and flexible platform for this type of communication," he adds.

"A direct connection to SAP or ERP and MES systems is also possible from our PC-based automation platform," Hans Beckhoff continues. "We presented a technology study last year, highlighting how Google Glass is an exciting advancement for machine monitoring and operation. This 'wearable HMI' clearly illustrates that with PC Control, new connected technologies can be adapted immediately; benefits can be quickly seen within convergent solutions if the correct basic technologies are available. Thus, discussions with our users provide strong evidence that we are already in the midst of Industry 4.0 with currently implemented applications."

"The leading-edge cluster 'it's OWL' (Ostwestfalen-Lippe, 'OWL') has also developed successfully," according to Hans Beckhoff. A total of 174 companies, universities, scientific centers of excellence, and economically-oriented organizations in Germany's East Westphalia-Lippe region, each focused on the field of intelligent technical systems, came together in 2011 and are now regarded as pioneers paving the way for Industry 4.0. "It's 'half-time' for Industry 4.0 at the moment. The individual projects have been very successful, thus further subsidies have been granted by the German government." Hans Beckhoff is convinced that the leading-edge cluster initiative will lead to an investment boom in the entire East Westphalia region. "There is also a great deal of international interest. Collaboration among the partners is strongly encouraged, providing many small and mid-sized companies, as well as universities, with new, high-level contacts with similar philosophies that would not have been available to them previously."

Efficient and modular engineering

Particularly in the case of flexible manufacturing concepts, it is important to automate development work and to support the reusability of software modules. This type of consistent software modularization is made possible with TwinCAT 3: "Combining software modules simplifies software design and relieves the programmer of routine or mundane tasks," emphasizes Hans Beckhoff. Beyond that, an efficient and fully-stocked toolset is required. This is available in TwinCAT 3 with object-oriented programming according to IEC 61131-3, C+ and C++ compilers, as well as the seamless integration of MATLAB®/Simulink®. This establishes a great deal of freedom in the choice of the programming languages. The best tools for the job can be selected when needed. Another major feature found in TwinCAT 3 is the integration of Visual Studio® into the programming environment.

"In addition, complete remote control of the engineering system, as well as the automatic generation of code and configurations, is possible using the TwinCAT Automation Interface," Hans Beckhoff explains. "Depending on the degree of automation, the manual creation of control projects and the associated errors can be reduced as a result. TwinCAT Automation Interface is a disclosed interface that also supports modern script languages such as Windows Powershell or

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IronPython, in addition to the standard Microsoft .NET programming languages. "We use tools such as the Team Foundation Server (TFS) from Microsoft for version management," Hans Beckhoff continues. Projects can be efficiently planned, created, and managed; additionally, modules can be reused using this Windows platform for collaborative software projects. The Managing Director is convinced that programming within the world's most developed software engineering platform will continually lead to greater benefits for users. "In the software development area, we leverage a promising, widespread, and rather powerful platform," he emphasizes.

"For decades now, Microsoft and Intel have provided the most powerful platforms for IT. Thus, we know these platforms are the perfect fit for our PC Control technology," Hans Beckhoff comments. "The Intel processors are a major enabler for the PC-based automation systems from Beckhoff. For example, the new generation of Bay Trail processors is used in the CX51xx Embedded PC series, in the Panel PCs from the CP27xx and CP37xx series, as well as in the C6915 control cabinet PC. Each device series also provides users with options for single, dual or quad-core versions." Beckhoff notes that Bay Trail is "a most suitable processor generation, especially for automation, because it is designed in such a way that the cache memory is directly assigned to the CPU core, leading to outstanding performance in multi-core applications."

Scientific Automation:
"The world's most powerful machine controller"
Increasingly powerful control systems are required for centralized control solutions in modern, flexible production facilities, as well as in individual high-performance machines. Therefore, under the working title "Big Iron", Beckhoff will debut the C6670 – the most powerful PC that the company has ever built. Back in the mainframe era, "Big Iron" was a colloquial expression used to describe the most powerful specimens. The high-end model from the C66xx control cabinet PC series will be available with 12, 24, and even 36 cores and will cost between 6,000 and 15,000 euros. The RAM is planned to start at 128 GB, extendable up to 2 TB. "Moore's Law still holds true, as 36-core processors have been announced for this year," says Beckhoff, adding that, "In the year 2020, there will likely be IPCs for machines that cost just as much as present-day controllers, but are 8 to 16 times more powerful and bring along a memory size that is inconceivable today." With the "Big Iron" project, Beckhoff continues to pursue the philosophy of "Scientific Automation", i.e. the implementation of all control functions of the machine in software, from motion to vision to engineering algorithms, all computed on an extremely powerful multi-core CPU. "TwinCAT 3 allows us to use all available cores efficiently by assigning individual control tasks to them, providing the opportunity to present what is likely one

of the world's most powerful machine controllers in the C6670," says the proud entrepreneur. "At SPS IPC Drives 2014, a high-performance application will be presented, controlled by a 'Big Iron' PC with 24 cores – providing a significant range of benefits for the application." This will be a highlight among all the trade show exhibits this year in Nuremberg, Germany.

In addition to high processor performance, PC- and EtherCAT-based control technology is optimized for extremely fast communication. "Our eXtreme Fast Control technology (XFC), introduced in 2008, shortens control cycle times in standard machines, increasing efficiency and preserving resources," stresses Hans Beckhoff. "This applies to a large range of applications, from injection molding machines to presses, and from machine tools to assembly machines." If far more parts can be produced on the same machine, the benefits will obviously stack up quickly: "Companies will realize higher performance generated in the same machine footprint, as well as increased production with less energy consumption. Overall, fewer machines are required in plants and amortization periods are drastically reduced as a result," he says, outlining just a few of the XFC advantages.

With XFC, Distributed Clocks and timestamp I/O signals allow engineers to achieve I/O response times of less than 100 μs. "That is a holistic approach," explains Beckhoff. "Fast, local pre-processing of I/O signals, on the other hand, is only a special case and is not constructive." With XFC, absolute accuracies of 100 ns (nanoseconds!) can be achieved. "With our XFC technology, we can easily meet even the fastest requirements."

"Due to the expected extreme increases in the performance of PC Control technology, every industry will be called upon to implement its specific 'killer application'," Beckhoff continues. "At the same time, fast cycle times are only part of the equation, as live calculation of complex mathematical algorithms is often required. The seamless integration of image processing may provide an answer. Where fast and efficient machine controllers are concerned, customers are essentially limited only by their imaginations in designing their applications."

Bus Terminals for circuit boards
I/O systems provide an ideal solution for flexible data transfer at the input and output level flexible automation concepts for plants and machines would hardly be possible today without them. Up until now, Beckhoff has offered modular I/O systems for use in control cabinets or in machine mounted formats with EtherCAT Terminals (IP 20), Bus Terminals (IP 20), EtherCAT Box (IP 67 or IP 69K) and Fieldbus Box (IP 67).

The company recently developed a completely new I/O form factor for the SPS IPC Drives: "Our EJ system consists of I/O modules with the functional range of a Bus Terminal that can be plugged into circuit boards," Hans Beckhoff explains. The basic circuit board serves as the wiring level for the highly modular EJ series EtherCAT I/O solution, which was first developed in customer projects. Also, the solution is made available via auxiliary electromechanical functionality, allowing the inclusion of any desired plug interface.

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"The new EtherCAT plug-in modules will mainly be used in series applications," according to the Managing Director. "In the large-scale production of standard machines, for example, part of the control cabinet can be implemented in PCB form. Our new system offers advantages above all in series production with prefabricated wiring harnesses instead of manual wiring." Completely different applications are also conceivable, such as energy measuring stations. "We are introducing our electronic Bus Terminals for circuit boards for all main types of signals," Beckhoff announced. Requirements extending beyond that can also be accommodated quickly. "Our new EJ system enables the machine and I/O levels to be more connected, even without the intervention of skilled personnel."

New items for established I/O systems will also be presented at the trade show. IO-Link, one such new item, is frequently referred to as the "last meter" on the way to Industry 4.0. Consequently, Beckhoff is now equipping the Fieldbus Box series with IO-Link technology. "We see increased momentum in the market where IO-Link is concerned," adds Hans Beckhoff.

Solving age-old drive challenges with innovative technologies
With the eXtended Transport System (XTS) linear motion technology, Beckhoff supplies a drive solution that makes new machine concepts possible in many areas of mechanical engineering. "Our XTS is a marvelous mechatronic kit for solving the limitations of traditional linear drive technology," notes Beckhoff. Numerous new applications have already been equipped with the XTS worldwide, and new software libraries for the XTS will be presented at the trade

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show. In addition, several different XTS applications can be seen live. "What's new is that XTS now supports curves of up to 22.5 degrees," he adds. "This means that XTS can facilitate geometries such as those of a Carrera track."

The ultra-fast AX8000 multi-axis servo drive is another new product innovation that will be unveiled at the SPS IPC Drives trade show. "Our new standard compact drive based on EtherCAT is equipped with efficient FPGA and ARM processors," Hans Beckhoff states. "The new multi-channel current control features enable sampling and reaction times of less than 1 µs in the control of current, offering speed control cycle times as low as 16 µs – depending on the configured switching frequency."

"Each AX8000 drive integrates a TwinCAT runtime, which is also programmable in sub-functions of C, IEC 61131-3, and in MATLAB®." A special connection mechanism reduces commissioning time for the AX8000.

On a related note, the Managing Director is quite satisfied with the servo motor production in Marktheidenfeld, Germany. "We doubled the production numbers of motors this year," notes Hans Beckhoff. The Marktheidenfeld location will therefore be further expanded. Hans Beckhoff also hints at exciting and interesting developments in the coming year that certainly have the potential for small revolutions. Overall, he sees the company as well on the way toward reaching Industry 4.0 goals.