Interview with Hans Beckhoff on historical changes in automation technology

# "What do small and medium-sized enterprises stand to gain from the digitization of their production processes?"

Martin Ciupek, Department Head of Automation at VDI-Nachrichten, a major weekly tech publication, spoke with Hans Beckhoff about the changes in automation technology and the relationships between German SMEs (small and medium-sized enterprises) and US software giants.

**VDI-Nachrichten: What do you think of the current hype surrounding industrial connectivity and Industrie 4.0?**
**Beckhoff:** When we look back in the future from the year 2050 to the years between 2010 and 2020, we'll say "That was the time when we started to connect people and machines with one another over the Internet. This put more information than ever online, as functions were moved onto the Internet and enhanced in so many incredibly different ways that it became possible to use machines more productively and achieve better product quality." In 2050, it will probably be impossible to imagine a machine being able to work properly without being connected to the Internet.

The 'hype' started four years ago, and in the meantime, practical ideas have been transformed into real products. This applies to our company, too. We think it's justified to call this an industrial revolution, even though it is more of an evolutionary process in day-to-day business.

**You have driven change with your company before. How was it when you launched your PC-based control systems and stood up against the monopolies of established automation technology suppliers with their programmable logic control – PLC – systems?**
In 1986, 30 years ago now, we delivered our first PC-based control system. At that time, we had about 30 employees and worked together primarily with SMEs – small and medium-sized enterprises. In fact, it was these customers who first enabled us to develop our PC- and software-based technology. For me, the fact that we initially developed our technologically advanced solutions more with SMEs and not really with big corporations is an important part of my corporate life experience.

**Why is that?**
You have considerably more freedom when you work with that kind of customer. What's most important in those cases is the necessary functionality and not so much the name of the supplier. At that time, we worked with mechanical engineering companies in the wood and window processing industry in particular. With our PC Control technology, we made it possible for these SMEs to simply take a diskette up to a machine, which then produced huge quantities of one-off parts. That in itself was revolutionary at the time.

In 1990, we presented the overall concept of PC-based control for the first time at Hannover Messe, the world's largest industrial trade fair. The solution consisted of an Industrial PC, a high-speed input and output system based on a fiber-optic fieldbus (Beckhoff Lightbus), powerful drive technology and our PC-based PLC and motion control software. Basically, it was the same approach as today, just a lot simpler back then.

**What was the response at that time?**
At first, we were laughed at. People thought we couldn't be taken seriously and what we were offering was not suitable for industrial applications. We kept on working anyway because we could see the possible increases in terms of speed, the number of controllable axes and the scope of the programs that traditional control technology could not match. In addition, we were able to offer complete "IT features" on the machine that conventional control technology couldn't offer at all, or if it could, only at a very high cost.

Through the consolidation of IT technology – i.e. the PC – and control technology, the solutions became much more powerful. The convergence of both these

technology fields provided our users enormous benefits, and this was clearly acknowledged by the leading technology experts. As a result, there were enough customers for us in every branch of industry who were willing to take on the perceived risk of this new concept in order to gain those benefits. That's how PC-based control became a standard.

**However, the real breakthrough didn't come for you right away, either.**

That's right. In 1990, a journalist asked me how long it would take until traditional PLCs would finally be replaced by PC Control. I hadn't been in the business very long at that point, and I said five years, which seemed like an incredibly long time to me in that moment. Five years later, the same journalist came back with the same question. Then I had to admit that, while our company had already tripled its sales, the market share for PC-based control still wasn't very big.

**How do you explain that?**

The problem was that equipment manufacturers with a high market share in traditional industrial control systems had no interest in revolutionizing their own technological base. In addition, they might not have been able to do it anyway, as they would have to prepare their customers for evolutionary change. It's usually the smaller suppliers who are responsible for the revolutions.

**It is often said recently that SMEs are too slow to embrace Industrie 4.0. Do you see that differently?**

Yes. For control technology, as well as for mechanical engineering, I see the German SMEs as innovators and international leaders, as far as we can see being an SME ourselves. Innovation is a core part of the business for technology-oriented companies; if that weren't the case, we wouldn't have so many hidden champions in Germany, many of whom are our customers, by the way.

**PC-based control technology has now made its way into big companies and corporations. What has this changed for you?**

That's true. Today, PC Control is a widely accepted technology. We no longer come up against out-and-out rejection because by now the benefits found with the combination of IT and automation in one device are recognized by virtually every engineer in the world. If you go to the most popular trade fairs today, you'll find solutions based on this concept at about every other booth, where we used to be pretty much alone. We can safely say that the technology has now gained a firm foothold and has become a standard for control solutions.

The basic concept of PC-based control technology is very simple and clearly structured. First of all, PC Control is based on what is arguably the most powerful, yet least expensive hardware in the world. We develop these technologies in-house from the bottom up to meet industrial demands. The motherboards in our control systems, for example, are "designed and made in Westphalia"! Sensors and actuating elements can be easily connected via EtherCAT and controlled quickly, reliably and deterministically. EtherCAT is perfect for PC-based control technology and, above and beyond that, has developed into a truly global standard in automation technology. And by the way, EtherCAT is also an original Beckhoff invention, which we first brought to market in 2003. Our TwinCAT control software then transforms an Industrial PC into a high-powered, real-time machine control system, while still retaining all the familiar PC and Windows features. The software is so flexible that you can put together all types of machine functions in one robust package. Everything is just a click away in

software, whether the focus is on additional drive axes, CNC control channels or even measurement functions. The latter are now much more frequently an integrated part of high-performance machines. As far as I am concerned, this functionality belongs together because it is possible to achieve far better results from the correlation of machine control and measurement data than strictly from external measurement.

With TwinCAT, we are also able to include simulation, and in the future we will also add image processing. That is only possible because we use x86 computers, which can be made virtually as powerful as you need through the use of multi-core technology. The Windows software structure also helps us provide many IT services that a machine otherwise doesn't have.

And of course we shouldn't forget that drive technology is part of the overall concept. We have also optimally integrated our own motors, which we produce in Marktheidenfeld, and the corresponding drives into the control software. That applies in particular to our XTS linear systems, which are based on travelling magnetic fields calculated in the PC and which are currently making new mechanical engineering concepts possible, for example in the field of packaging and assembly.

**What do you consider as the biggest step: the one from traditional control systems to PC-based control or the one from PC-based control to connected control systems on the Internet?**
I'm not sure. Adding a global Internet presence to machines has a great deal of potential. That is sure to make a significant fundamental change in many different areas, but will that result in bigger changes than the developments that came before? That could very well be.

**Industrie 4.0 is about making data available in real-time. How do you define 'real-time'?**
We specialize in automating high-speed processing machines. When controlling very large or slow machines, we talk about response times of approximately 10 ms – a good control system works with a response time of about 1 ms, and exceptionally fast control systems have response times down to as little as 100 µs.

**That's hardly noticeable for people. Who really needs this speed?**
In fact, there are fields of application that make sense for all types of control systems. For electromechanical actuators, as an example, you can profit from the 100 µs cycle times because it allows you to control a hydraulic cylinder more cleanly and easily without overshoot. The same applies to electrical drives, which usually work with 62 µs. These machines also run more smoothly when the cycle times are shorter.

However, the advantages of high-speed control systems are also obvious for even simple machines that only have a forced sequence as their function; at our company we like to call them "piff-paff-puff" machines. The machine has to wait for the control system in every control-related transition because the control system works cyclically, while the machine runs asynchronously. At a response time of 10 ms, the machine loses half the time at each switching point on average, i.e. 5 ms. If there are several transitions each second, that equates to four in a "piff-paff-puff-piff" machine, meaning you lose more than 20 ms per second. When using a control system with a response time of 200 µs, on the other hand, the machine will be almost 2 to 3 % faster than before and will produce more parts. That adaptation is worth it for almost every type of machine.

**Bernd Leukert, Member of the Board of SAP SE, and Hans Beckhoff, Managing Director of Beckhoff, at Hannover Messe 2016**

**What machines need this?**
One of our North American customers manufactures injection molding machines for 'pre-forms' used to produce PET bottles in the beverage industry. The machine previously had a production cycle of approximately 5.8 s and the machine manufacturer was able to improve the cycle by up to 10 %. That's all money in the bank because it improves both the profitability of the machines and the ecological scorecard. With greater control quality, it is also possible to produce high-quality bottles with thinner walls, saving material as a result.

**And what about the required computer hardware? Who produces your chips?**
We buy most of our chips on the global market. We use products made by the leading manufacturers, many of whom are headquartered in the USA, with Intel at the top of the list. But we also use German ICs made by Infineon and European ICs made by ST.

Some chips we develop ourselves, e.g. the ASIC chips for the EtherCAT communications standard, which was developed here at Beckhoff and then licensed for use by third parties around the world. Today, EtherCAT is established as international IEC and SEMI standards, which are used throughout the US and in China.

For us, it's important to have end-to-end expertise inside the company: from IC to circuit and board design, to the firmware and operating systems required, the control and communications software, and right on up to the application knowledge. This makes us able to create very individualized, extremely powerful solutions. I find it essential for technology companies to have this level of extensive, in-depth knowledge in-house..

**Companies are now thinking about working together with large IT corporations. You've already been doing this for a long time with Microsoft. What do you recommend?**
We have been working together with Microsoft for 30 years by now. We've seen a lot at Microsoft and numerous personal contacts have grown out of this. As a German SME with currently €620 million in global sales, we are working with a corporation that makes more than 100 times that in sales. Sometimes that has more of an impact on the type of communication we have than any differences between Germany and America.

**Then you think it's important to build contacts like this in common projects?**

That's right. It's exactly what we are experiencing again with IoT – the Internet of Things – where we have presented solutions based on Azure, the Microsoft cloud, at the Hannover Messe industrial fair. This cloud system offers many new functions that we believe could be useful in machines. Programmers all over the world can use it, for example, to evaluate data more easily than before. We currently have devices available that can very easily connect to the cloud, enabling easy processing of data from our machines in Microsoft Azure. That is a project where we meaningfully collaborate with Microsoft and one we will also present together. That's when IoT turns from mere hype to reality.

**Some SMEs get concerned when they think about the growth of "data monsters" such as Google and Facebook. What are your thoughts on that?**

Data has to be protected by our laws, by contracts and by the necessary security technology. That applies in America just as it does in Europe, and I am sure that outstanding solutions will soon be found here, driven by user and customer demands, as well as by legislation. I advise everyone to assume that as a basic premise when they analyze and think about Industrie 4.0 or IoT or Big Data. The European defensive reflex of "data is not secure so this won't come to much of anything" is a major innovation and imagination killer. One should just think positive first of all, and then it will be possible to discover what great new opportunities are out there.

When comparing the US to Europe, our point of view is that Microsoft, Google, Facebook and similar companies have built up a big head start in terms of knowledge in software-based business concepts. This is sometimes criticized from a European point of view, but they have built up this edge just as Mercedes and BMW have built up an edge in the production of automobiles. That also applies to the German company SAP and its edge in the field of ERP software: this edge is an outstanding starting point for Industrie 4.0 applications because they all have to work together with the ERP system or even be integrated deeply into it. That's why we're happy we were also able to set up a large technology demonstration together with SAP at Hannover Messe 2016.

I can only advise SMEs in particular to understand the head start in knowledge these IT and social networking companies have and to take advantage of it. Needless to say, Internet companies are dedicated to making money with it and we can do that right along with them if we add our own special know-how on the basis of these technologies.

**How do you rate the efforts of the Industrial Internet Consortium (IIC) and the German Industrie 4.0 platform to create common standards?**

There will always be new groups that get together to set new standards that we are all supposed to follow whenever a new wave of technology comes along. We keep an eye on these developments and support them to a certain point. However, I am convinced that the market is always a bit quicker than the development of a somewhat theoretical standard, and that other projects can produce some very different approaches that prove to be just as practical and useful. That's why, as far as I am concerned, a general platform is a correct and honorable starting point, but there is no guarantee that it will ultimately become the accepted standard in the end.

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**What makes you so sure?**

Experience has shown that different solutions can often result from a particular party's economic interests or application-specific features. After all, a process industry enterprise that wants to monitor an oil-drilling platform has completely different requirements than a company that sells machine tools or solutions for buildings. There can be no doubt that many different standards will be created. For manufacturers of automation components, the trick will be the ability to master several of these different standards.

**That reminds me strongly of the search for the one communications standard for the fieldbuses in the automation industry.**

That's right. Several different standards also emerged for the use of Ethernet in industrial communications. In my opinion, there is not just one, but three accepted standards overall: Profinet, Ethernet/IP and EtherCAT. Many other standards also exist alongside those three today and they all have good reason to in their own specific fields. I would be surprised if things happened differently for the new IoT solutions

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