

Software CNC causes a stir in the machine tool industry

32 path axes fully under control



Frank Saueressig, CNC product manager and manager of the Beckhoff branch at Balingen, Germany.

→ Since the introduction of TwinCAT CNC at the end of 2002, Beckhoff has been highly active in the CNC market, offering complete functionality for complex motion control as a pure, PC-based software solution. In an interview with freelance technical journalist Nikolaus Fecht, CNC-expert Frank Saueressig reports how the “newcomer” has since caused a stir in the machine tool sector.

PC-Control: What characterizes powerful software CNC that can compete with a classic, hardware-based controller?

Frank Saueressig: At the heart of our CNC software is the complete TwinCAT automation system, which converts any Windows-compatible PC into a real-time controller with a multi-PLC system, NC axis control, a programming environment and an operating station. Within the framework of this automation system, the TwinCAT NC I software module (interpolation) has been demonstrating for years that path control can be realized as a pure software solution.

The Beckhoff product philosophy is characterized by continuity and openness, meaning our system features integrated, open interfaces from PLC to CNC, both horizontally within the control level and vertically to the field and command level.

And TwinCAT CNC now represents the proverbial “dot on the i”?

Frank Saueressig: Correct. In the current configuration it is a powerful, software-based CNC that can simultaneously interpolate up to 32 axes or spindles in a single CNC channel, or distributed over a maximum of 10 CNC channels. Due to its performance capability, TwinCAT CNC can master demanding and complex tasks and can match any currently available classic hardware CNC. A further advantage of the TwinCAT system is integrated fieldbus coupling with different systems.

How was TwinCAT CNC received in the machine tool sector, which has a reputation for being rather conservative?

Frank Saueressig: It has been received very well. For example, with prestigious machine tool manufacturer, Grob located in Mindelheim, Germany, we have realized complete manufacturing systems with several machining stations and cen-

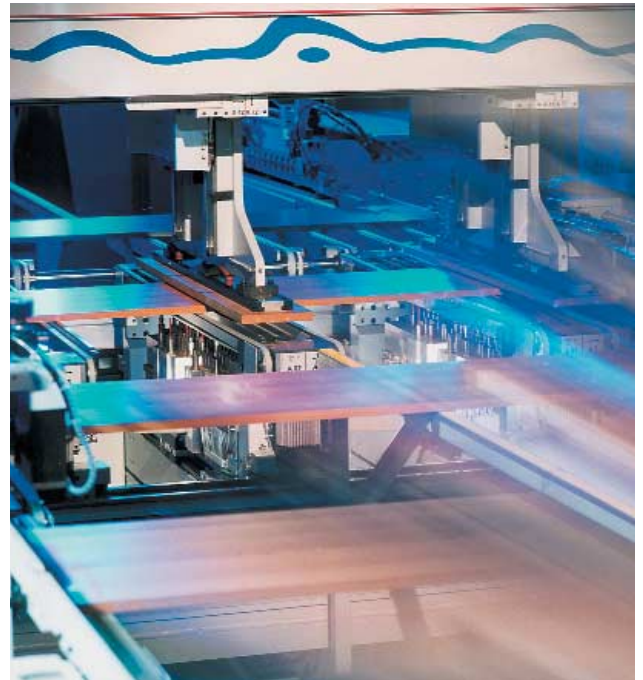
ters as a pilot plant entirely based on TwinCAT CNC. At the fieldbus level we already use real-time Ethernet, partly even WLAN. In other words, with this system the machine tool manufacturer is utilizing everything that is feasible with PC control technology. However, this type of networking is still an exception, because for many customers from the machine tool industry - particularly the automotive sector - EDP communication goes much too far. One of the often-heard reservations is, “Our IT department wouldn’t allow this kind of thing.”

This means that if you want to sell PC-based controllers with associated EDP networking, you first have to convince the IT department that the technology is safe?

Frank Saueressig: That’s true. This is why we offer configuration of a safe network as an engineering service. This is where our long-standing know-how as a technology leader for IPC, I/O and automation comes in. Also, as pioneers of PC-based automation, we are closer to the IT world than more traditional automation companies.

Real-time capability in machine tools is particularly important in applications where highly dynamic movements have to be reproduced and controlled with micro precision. The user cannot tolerate delays of even a few microseconds. Does your CNC meet these requirements?

Frank Saueressig: Real-time capability is ensured in principle through the TwinCAT real-time core offering maximum speed and deterministic features. Furthermore, today’s PC processors offer plenty of computing capacity for dealing with rapid CNC position control functions, for example. A typical example is a classic processing center with five interpolating axes, one controlled spindle and one



CNC channel. With an 850 MHz Pentium III processor, the position control cycle time is 500 μ s; with a 4 GHz Pentium 4 processor, the calculation time is reduced to 260 μ s. But this is only a part of the story. We also offer a very fast software PLC, distinguishing our solution from many hardware concepts that force a very fast CNC to wait for a slow PLC.

This means that with your concept you not only reduce the machining times, but also the idle times?

Frank Saueressig: Correct. Quite often - during a tool change, for example – the CNC has to wait for the “completion message” from the PLC, which typically operates with cycle times of 20 to 150 ms. Our software PLC responds within 1 to 2 ms.

This is where central control with a single computer that does not have to wait for information from semi-intelligent components pays off. Case in point: Our software CNC controls 20 interpolating axes, 12 controlled spindles and 10 channels in 1.8 ms on a customary Industrial PC with a P4 chip. This is even less than the processing time of a SERCOS bus, which controls axes with a cycle time of 2 ms. Because PC processors are getting faster and faster, the computing capacity of our system also increases continuously.

Which bus systems can be controlled with TwinCAT CNC?

Frank Saueressig: In principle, all common bus systems - for example SERCOS, Profibus DP/MC, Lightbus, Real-Time Ethernet, and in the future EtherCAT from Beckhoff.

For classic networking we use the world's most widespread Ethernet architecture, for which standardized cables and connectors are available. We network compo-

nents together and with EtherCAT in the future, also within the field level, using standard Ethernet technology, especially since this is the most cost efficient and simplest option. Our PC motherboards already feature one or two Ethernet connections as standard.

Some users are still sceptical towards software-based CNC: Allegedly hardware CNC is still required if many interpolating axes are used.

Frank Saueressig: This is no longer the case. For applications with many interpolating axes, there are two options: For example, we can operate our CNC in synergy with a SERCOS bus in such a way that parts of the control run in the drive. The CNC deals with interpolation and path planning, and the drive deals with position control. On the other hand, if Profibus MC, Lightbus or EtherCAT is used, the CNC also deals with the complete position control.

Neither variant is an impossible task for the CNC. Furthermore, if additional axes are connected to the fieldbus - unlike with a hardware solution – no additional axis modules are required. All that is required is sufficient computing capacity, as offered by any modern Industrial PC.

What do you say to critics originating from the PLC technology world who say that the software CNC is not powerful enough?

Frank Saueressig: For the TwinCAT PLC, this allegation is simply not true. In fact, it was the software PLC that has prepared automation for PC control technology. Furthermore, our solution differs from those offered by other suppliers through our axis control origins. Our software PLC was able to control axes right from the start in 1986 and enabled quick processing times. I see this as a big advantage.



Frank Saueressig: "Car manufacturers are also talking about Beckhoff. We have already gained experience in many applications in chassis and body shell plants, and we are increasingly invited to automotive company discussions about planning new systems or factories. As an alternative to the traditional control sector products, potential clients closely examine our modern, PC-based solution and we feel uniquely qualified to respond to complicated challenges faced by their engineers and managers."



What do you make of the argument by PC opponents that interrupt handling is not advanced enough and slows the PC down?

Frank Saueressig: We have this problem under control, because we developed a real-time core in-house that is not dependent on the typical interrupt handling of the motherboard.

In the machine tool world, CNC developers usually program either in G-Code or in StepNC. Which programming language do you use?

Frank Saueressig: We use classic CNC programming in G-Code, i.e. according to DIN 66025. The PLC is programmed according to IEC 61131-3. While DIN 66025 is quite old, it is the only existing standard. In the long term, we expect to be able to link G-Code with graphic user interfaces. We are monitoring the StepNC situation with interest, but are not using the code yet.

In practice, both techniques are used, for example, in the multi-spindle automatic lathes from Schütte. While the operator can also use G-Code, instead of the cryptic commands he usually uses graphic elements.

What about simulation, where the synergy of the CNC with the proposed machine tool is checked in advance, for example?

Frank Saueressig: Machine manufacturers often have their own simulation programs, which they use to test the synergy with our CNC. We don't have any problems with that, since the CNC is already purely software-based. The manufacturer of the simulation software will usually request the necessary programs from us. We rarely offer simulation as a service.

What are your reflections on the development of TwinCAT CNC over the last one and a half years? What was the reaction of your customers?

Frank Saueressig: I feel that we have enlivened the industry. While previously, TwinCAT CNC was already quite successful with machine tool manufacturers, like Schuler or Müller-Weingarten who had their origins in metal forming, we were not the classic CNC manufacturer for machining. We entered the machine tool sector with our proven PC control technology and, with many years of CNC experience from special purpose machine construction and woodworking machines, formed a production engineering point-of-view that is similar to metal machining. As a result, many manufacturers trust Beckhoff to control their machine tools.

Are there any concrete application examples for TwinCAT CNC from the machine tool manufacturer sector at this stage?

Frank Saueressig: Going back to machine tool manufacturer Grob, they have successfully converted the control of a new, complete manufacturing system to PC control technology. Grob is regarded as one of the technology leaders in the machine tool sector who can stay ahead of the competition by trying something completely new with a PC control provider such as Beckhoff. Grob presented their manufacturing systems at the end of 2003 at an internal event, no doubt causing some tremors in the world of machine tools and in that of established control technology. Since then we have been talking to many large machine tool manufacturers and also to the automotive industry.

We see good opportunities for the application of TwinCAT CNC, and not only in the automotive sector. Other opportunities come from Beckhoff customers in the metalworking sector who already use other modules from the TwinCAT system family. Because of this, we are confident that Beckhoff will see continued CNC growth in the machine tool sector.