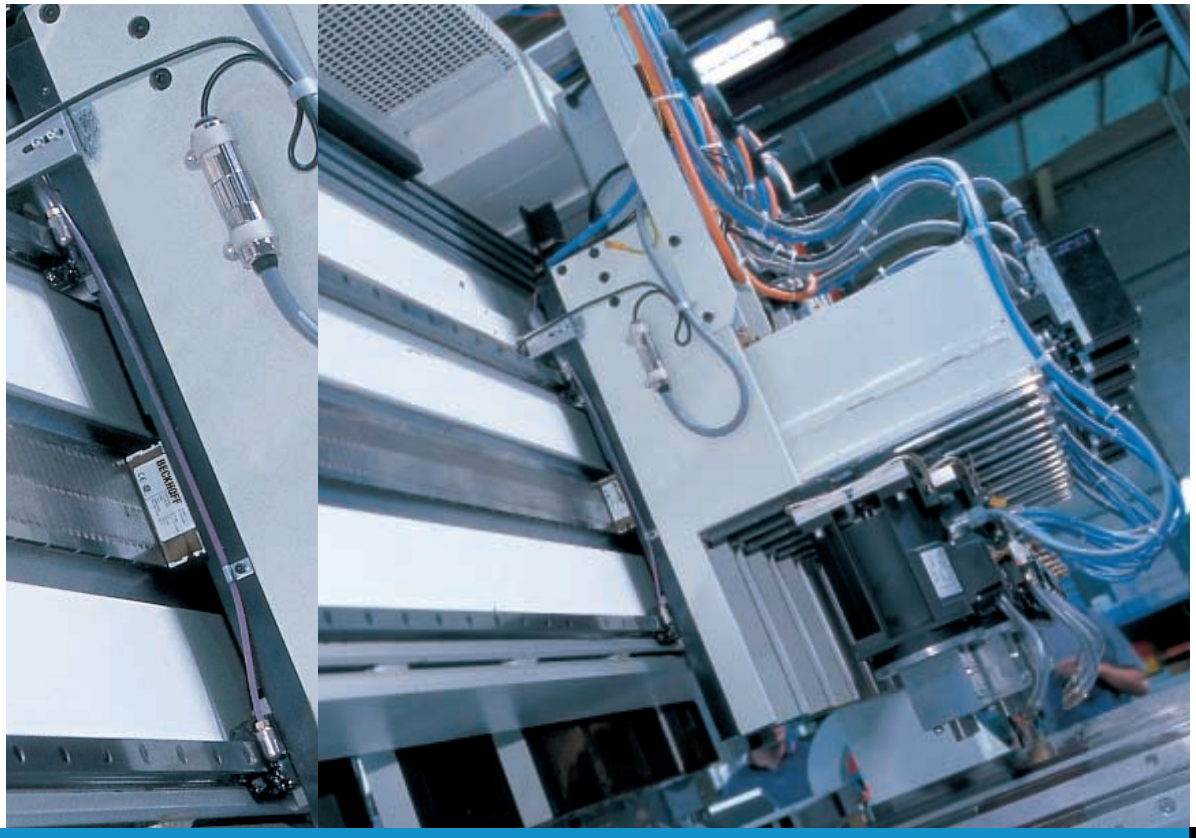
Direct drives from Beckhoff perform positioning with precision and economy

The developers at Koch made use of the Beckhoff know how to achieve a rapid conversion from rotary to linear motion.



Ask the average consumer what a variable, adjustable wooden slatted frame is and you will probably get a blank look, even though it might be providing them a peaceful night's rest. Ask a Koch engineer the same question and you will probably hear how the SBFD-B-NC machine using Beckhoff linear motors and PC control is making the above frames faster, better, and cheaper. Fitted with modern Industrial PC controller equipment, the 31 linear motors in particular belonging to an SBFD-B-NC machine ensure that the drilled holes and milled slots fit correctly.

As a manufacturer of special woodworking machines, Koch Maschinenbau, based in Germany cannot waste time if they want to build 500 frames per hour. Well, maybe they can afford a little time because they are committed to using the Beckhoff advanced Industrial PC technologies. Beckhoff has a history of helping Koch save time with such technologies as simulation of commissioning on a PC and remote servicing/diagnosis using standard Windows software. In the search for yet more time savings and better optimization, a technique has been developed to improve the positioning of drilling heads by means of rotary drives in the machining stations. Leo Gövert, control technology manager, immediately thought of the linear drives used in the electronics industry to position circuit boards accurately for SMD components to be mounted. Because their automation partner, Beckhoff, are also active in that sector, the idea was born: a design for the SBFD-B-NC machine was developed jointly. The Koch management gave the green light, and an extraordinarily powerful woodworking machine needing minimum servicing and fitting times was developed.

From the very start of the solution development, effort was focused on improving the machine's positioning. The rotary drives used on the toothed racks were replaced by linear drives, so that the positioning process could be faster and more precise. The machine, which measures about 10 m x 15 m, divides the wood for the slatted frame simultaneously into head, middle and foot sections. The operator then selects the processing steps for a right-hand or left-hand part. Finally, the chain conveyor transports the wooden blank in the Y-axis to the nine machining stations one after another. In the conventional solution, drills and milling machines mounted on overhead carriers, moved by means of toothed racks, make

In the woodworking plant for slatted frames, 31 linear motors driven by Beckhoff AX2000 servo drives ensure correct placement of the drilled holes and slots. All the drive data passes along four Lightbus rings for further processing in the IPC.

the drilled holes and slots that have previously been programmed. This is where the rotary drives were to be replaced by linear drives, so that the positioning process could be faster and more precise. Generally speaking, linear motors are suitable for use wherever the rotary type of construction comes up against mechanical limits, or where a special drive behavior in terms of dynamics, synchronism or acceleration is required.

Direct drives bring a 10 percent cost advantage

"This seemed to us to be the right technology," claimed Gövert, "because it is still true that the overhead carriers at the individual stations must accept up to nine drills and move them into position." The Beckhoff AL2000 linear motors are ideal for this task. They achieve travel velocities of up to 10 m/s, and can do this with a high acceleration. "From the management point of view, the comparable individual direct drives could then be forgotten, because all the linear motors in one station share a single magnetic track, making them more economical", explained control expert Gövert.

Gövert concedes that the attachment of an external measuring system does eat into the cost advantage to some extent, "but the bottom line is that with eight drives, there is a saving of 10 percent." In addition to economy, Koch was also sharply aware of the technical features, including the following particular points:

- Linear servomotors are not subject to mechanical wear,
- Linear servomotors allow positioning to be carried out very quickly without overshoot,
- They are easy to commission,
- A number of motors can perform their operations simultaneously on one track.

"For the machine constructor, this benefit should not be underestimated, because in the absence of a crown gear the travel distance can be almost unlimited", adds Oliver Bexte, responsible at Koch for software engineering. He sees the time advantage as the major item on the plus side. The biggest difference is not in the actual machining of the workpieces, but in setting up and refitting the heavy drills. The required positioning accuracy was tightened from 1/10 mm to 1/100 mm. The repeatability offered by linear technology is also impressive. Bexte is convinced by the technology, explaining that "in a practical test, we drove several hundred times against a dial gauge, and a comparison showed no difference in positioning accuracy". The fact that this all takes place without the transient phenomena familiar from rotary drives means that setting up with uncomplicated control parameters is a great deal simpler.

The instrumentation is also easily managed

The instrumentation techniques applied to Koch's special machine was also crucial to precision. The developers made use of a magnetic encoder system from Sony that is cut to length from rolled continuous material, and only needs to be glued to the track. The advantage of this was the existence of a reference cam and the high resolution of the reader head. Bexte pointed out that "this kind of sensor can be adjusted, with a little practice, in no more than five minutes". Care is only required during handling, warns the software engineer, because magnetic tools can damage the measuring system. The Beckhoff developers are working at present on this restriction. They are working on a procedure that will be added to the linear motor making it insensitive to external influences. The measuring principle involves using the magnets of the secondary section to determine

Beckhoff Industrial PC controls 69 axes

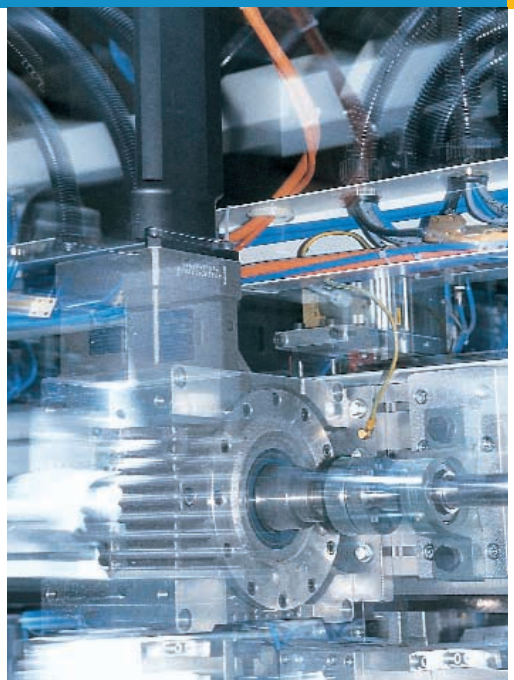
The SBFD-B-NC woodworking machine is an automatic machine for drilling and milling wooden parts from which slatted frames are manufactured. The plant is controlled by an Industrial PC with a Pentium 4 processor and with a decentralized 15 inch Control Panel. Windows 2000 Professional serves as the operating system, while the automation software is TwinCAT NC PTP with a PLC cycle time of 10 ms.

Five machining stations, with a total of 31 AL2000 linear servomotors offering maximum velocities of 1000 mm/s ensure precise positioning of the machining heads. These drives, along with another three rotary servomotors, are coupled to the system through four Lightbus rings. The chain conveyor for static positioning is linked via CANopen. The plant includes also more than 27 positioning drives with CAN Bus interfaces, along with seven fast and crawl axes. The total number of inputs and outputs is 1134.

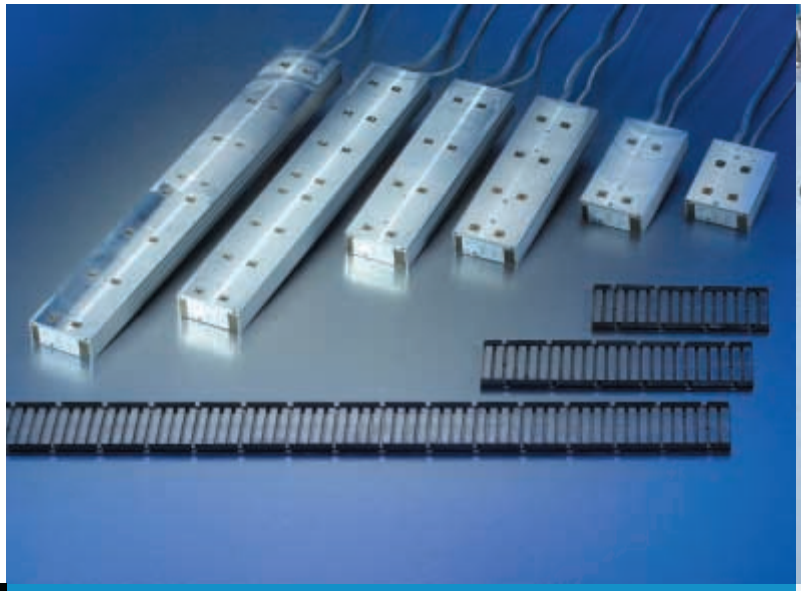
position and velocity. An incremental transducer signal having 1000 increments/24 mm is generated from their magnetic field strengths (24 mm corresponds to one logical rotation of the linear motor). Fed into the AX2000 drive amplifier, this yields a positioning accuracy of 0.1 mm.

In contrast to applications in machine tools, where high powers require water-cooled linear drives, and where a high precision also makes expensive optical measurement systems necessary, the solution described here is ideal for applications in the woodworking industry or on packaging machines. Another reason why direct drives are favored by the control engineers at Koch is that they can be integrated seamlessly into the existing automation concept with TwinCAT. The servo amplifiers are positioned via the Beckhoff Lightbus, while the drives for simple positioning tasks are operated with CANopen.

A Beckhoff Industrial PC C6150 with the PLC/NC TwinCAT software is the master of a total of 69 axes.



Practical tips: What advantages can be expected from linear drives?



→ We asked Leo Gövert and Oliver Bexte what required special attention when converting to linear drive technology.

PC-Control: Mr. Gövert, you have been positioning the drilling stations on your machines using the directly driven linear drives from Beckhoff for a good year now. Have you regretted this step?

Leo Gövert: No, quite the contrary. We did not just choose an accurate, low-maintenance technology, but in our case it was also the most economical.

So are linear drives cheaper than rotary ones?

Leo Gövert: If you compare the single drives of each technology, then not at this time. But in our machining stations, up to nine drives work on one track, and that is where the saving comes from.

How many drives must you use on one track in order to cover the costs?

Oliver Bexte: Roughly speaking, we can say that the break-even point is at four drives. With eight drives, we had a 10 per cent advantage.

And where does the increased precision come from?

Oliver Bexte: We achieve high force constants for accurate positioning through a very good force to weight ratio. On top of this, there is the direct measurement system, which yields a better resolution than the resolver technology used in conventional motors. If we then compare the freedom of wear of the linear components in comparison with toothed racks and the wear on bearings, we also expect significantly better results over the long term.

What changed conditions have to be taken into account?

Oliver Bexte: The foundations for the machines have to be made more stable if they are to accept the increased forces from the linear motors without vibration.

Was that the only difficulty?

Leo Gövert: Well we did have to shield the magnetic encoder system for displacement measurement to protect it from the electromagnetic effects emanating from power lines. Once you know that this is necessary, it's no longer a problem.

Could you summarize the advantages again?

Leo Gövert: As we said, with the 31 linear servo drives we don't just achieve accurate positioning in a smaller construction. The parameterization is also a lot easier to do. Besides, the drives could be smoothly integrated into the existing TwinCAT automation scheme.