

BJM: PC-based control ensures flexibility in profile machining systems

→ Design and construction of window production machines requires flexibility down to the last detail. Due to the wide variety of different window profiles and individual customer requirements, machine adaptation to modified and optimized processes should be as straightforward as possible. The company BJM uses TwinCAT NC Interpolation, the software-based motion control solution from Beckhoff for its complex profile machining systems in order to offer its customers maximum flexibility.

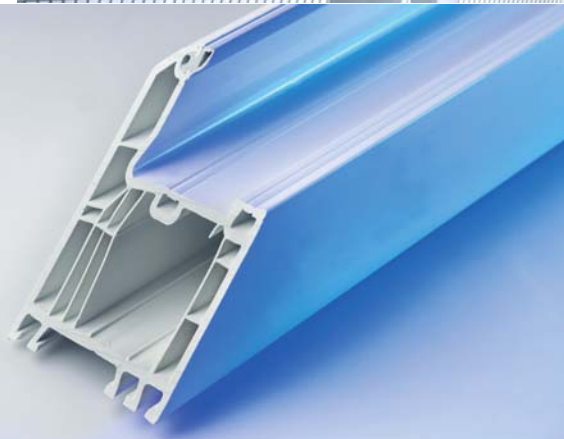
Machine construction that is made-to-measure

BJM Ingenieurbüro & Maschinenbau GmbH is based in Verl, Germany. The company develops and builds made-to-measure window production machines. "Our machines are used for processing plastic and aluminum profiles for windows and doors", said Dietmar Kay, who is responsible for distribution and marketing at BJM. Due to the variety of different window profiles that have to be processed, almost all BJM machines are custom-built. "We can't take a standard machine catalog

to our customers", said Dietmar Kay, "instead we have to determine their exact requirements and then design and build a tailor-made machine for the respective application."

This not only requires flexibility on the part of the machine manufacturer, but also on the part of the control equipment supplier. BJM has been cooperating with Beckhoff right from the start. "Beckhoff is BJM's main supplier of control components. To date, we have equipped

The transport axis in this aluminum processing center is moved via a synchronous servomotor at velocities of up to 3500 mm/s.



Frame profile for plastic windows with numerous cavities resulting in high thermal insulation.

around 250 individual machines and around 200 production facilities of different sizes, including fully automatic profile processing systems with PC controllers from Beckhoff", said Wolfgang Brunnert, one of BJM's managing directors. "Meanwhile Beckhoff specialists are familiar with the requirements for our custom machines and can respond accordingly", said Dietmar Kay.

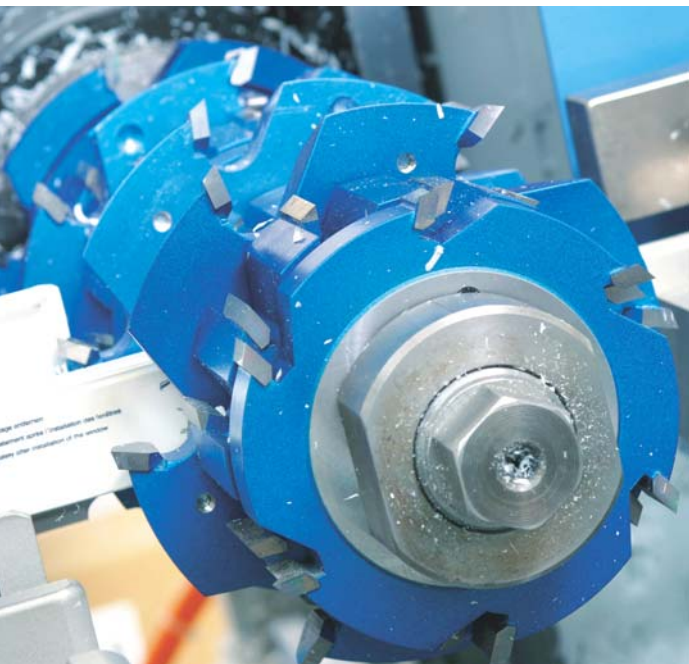
Almost all machines are different

When designing a fully automatic profile processing center, a wide range of factors must be taken into account: Profiles and processing steps have to be specified. Traditional processing steps include sawing and drilling or milling of oblong holes and recesses. Steel reinforcement, including cutting, is either introduced manually or automatically.

Locking pieces may have to be supplied and attached fully automatically based on customer specifications.

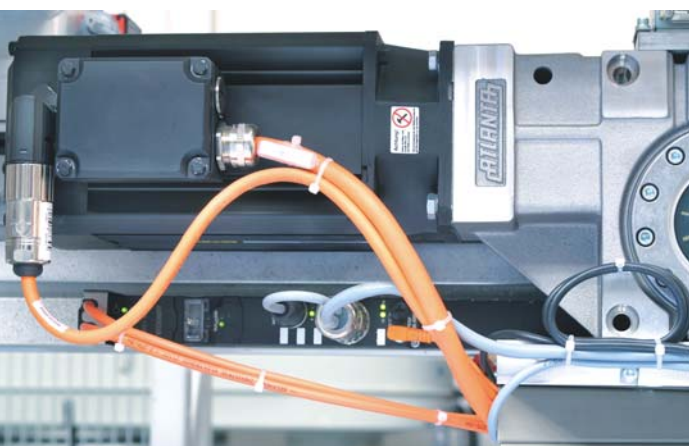
The wide variety of profiles that have to be machined represents a further challenge. For example, a well-known profile manufacturer from Germany alone offers around 12,000 different aluminum profiles. Occasionally, special architect-designed profiles are used for individual projects. The processing machine must be able to handle the whole range of parts.

All these factors, including profile variety, functional requirements, productivity, and customer-specific spatial conditions are taken into account in customized machine concepts and implemented by BJM. BJM deals with all machine construction tasks in-house. Beckhoff is a partner for machine control technology that not only supplies hardware and software components, but also offers engineering services.



Contour miller for mullion or transom profiles

Servo motor with interference-proof IP 67 Fieldbus Box



BJM Managing director Dirk Jacobebbinghaus (left) and Wolfgang Brunnert. "Beckhoff is BJM's main supplier of control components. To date we have equipped around 250 individual machines and around 200 production facilities of different size, including fully automatic profile processing systems, with PC controllers from Beckhoff", said Wolfgang Brunnert.



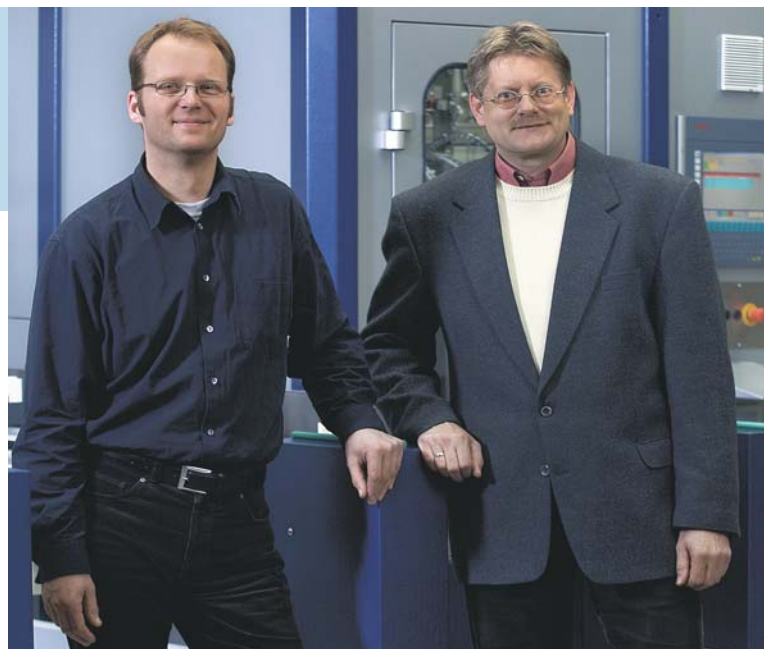
Technology briefing as the starting point

"The project phase follows well-rehearsed steps based on years of cooperation, i.e. BJM specifies the functionality and Beckhoff offers matching system solutions", said Dietmar Kay. "We also discuss innovative control strategies and scope for integration in the current project", said Frank Maasmeier, window industry expert at Beckhoff.

The control concept is entirely based on Beckhoff components. At the field level, the inputs and outputs are connected in local terminal boxes in the machine via Bus Terminals and Couplers. Exchange with the IPC takes place via the interference-proof Lightbus. The intelligent, compact positioning drives for profile format adjustments are controlled via CANopen. The drive components, including servo drives and servo motors, are connected via the high-speed EtherCAT fieldbus. "Systems with many servo axes requiring fast signal acquisition and processing need a very fast fieldbus system. We therefore use EtherCAT in our profile processing systems", said Frank Maasmeier.

The BJM machines are controlled by Industrial PCs from Beckhoff, equipped with Ethernet ports for data interfacing with the process planning EDP system of the customer.

TwinCAT PLC and NC I are used as software PLC and NC. "For achieving the sometimes very complex processing cycles, we use subroutines written in DIN code, which are developed and optimized in cooperation with our customers. The speed of the software NC combined with anticipatory, optimizing sorting logics for handling tasks ensures maximum processing speed with consistently high machining accuracy", said Thorsten Knapp, systems engineering project manager at Beckhoff. "A further advantage is the integrated approach of our system solution that covers hardware and software", said the systems specialist. "Beckhoff offers fully integrated, advanced control solutions with adaptable software modules for production data acquisition and analysis." "In addition, Beckhoff offers a wide and scalable range of Industrial PCs and Embedded PCs", said Dietmar Kay. "On the one hand we are able to guarantee optimum functionality and on the other, we can use a cost- and performance-optimized system solution."



The window manufacturing industry also has special requirements in terms of IT interfacing: IT-Basis is design software that offers enterprise resource planning and production modules covering all sector-specific EDP aspects, including CAM modules. An automatic profile machining system has very different IT interfacing requirements than other production systems. Frank Maasmeier points out another special characteristic: "The design programs used in the window manufacturing industry generate production datasets in Beckhoff XML production data format that are transferred to the machine computer via the corporate network. In this way, all specific and relevant production data are imported directly into the Beckhoff IPC for processing by the control system."

"In view of the high technical demands for our machines, only capable control systems and cooperation with knowledgeable partners can lead to success", said managing director Wolfgang Brunnert, reflecting on 12 years of fruitful cooperation with Beckhoff.

Precision and flexibility down to the last detail

All processing options are reflected in the programming – the associated machine program is already stored in the control system for each profile to be processed. Only the production data have to be updated and allocated specifically for each order. In this way programming errors can be avoided and the machine can be commissioned and put into use very quickly.

"The flexibility of our control software offers tremendous benefits", said Frank Maasmeier. After all, parts with lengths between 300 and 7,000 mm have to be transported, cut and machined fully automatically based on specified production data. All profiles are different. The various national requirements for window, doors and façade construction not only determine the profile contours, but also the machining process. This implies continuous variation of the requirements for the control task. Considerable diversity and versatility is also required when taking into account profile and tool positioning – including tool and profile data management."

A high degree of flexibility is also needed for assembly of steel reinforcement components, which are required to provide the necessary rigidity for PVC profiles. In order to prevent inserted steel bars from moving inside the PVC profile during transport, the system reduces tongs acceleration and speed, screws in the first screw, and checks the result. The tongs speed is then increased again, so that the remaining screws can be processed more quickly.

Profile length registration is also a detailed task and involves two steps: The length is initially determined roughly via light barriers installed at certain intervals. Tongs then move the profile to a light spot where the length is measured exactly via a linear incremental measuring system. This measuring technique is fast and precise and enables high-performance residue processing, leading to significant cost optimization of the profile machining process.



The company BJM Ingenieurbüro & Maschinenbau GmbH, based in Verl, Germany, has been designing and building machines and fully automatic profile processing centers for the window manufacturing industry for 12 years. It was established in 1995 by engineers Wolfgang Brunnert, Dirk Jacobebinghaus and Jürgen Messow, who still lead the company today. Over the years, BJM has become an established manufacturer of window production machines with distribution throughout Europe. In 2006, the company generated sales of 12 million euros.

Dietmar Kay said: "Our profile machining systems are fully configured and tested at our plant, sometimes including pre-acceptance by the customer. The profiles are "run in" on the machines, and compliance with the contractually agreed specification is verified, e.g. productivity or absence of scratching on aluminum profiles.

After these tests, the machine is dismantled again into transportable units, delivered to the customer, re-assembled and commissioned."



A 19-inch Panel PC C3330 with alphanumeric PC keyboard is used as PC platform for the aluminum processing center.





Milling from below. All aluminum profile processing steps (with the exception of sawing) are carried out in this drilling and milling module. The TwinCAT NC I automation software enables all required holes and contours such as recesses, circular shapes and profile cylinder cuts to be processed in this station.



The cut components are placed on a trolley with special compartments for subsequent processing in the welding machine.

Maximum quality through precise profile measurement

Certain plastic production machines – and in particular aluminum applications – require profile height measurements due to fluctuating profile dimensions. The measured value is compared with the specified value and a tool positioning correction is applied. This algorithm is integrated into the Beckhoff control system. The procedure for width measurements is similar. This is required for counterbore holes, for example, to prevent countersunk bolt heads from protruding and to ensure that the counterbore holes do not exceed the specified depth.

The different profiles must be fixed in an optimum position for processing. In the past, this involved time-consuming machine changeover procedures. BJM developed a patented, profile-independent and fully automatic adaptive clamping system for their machines based on motor-driven adjustment functionality.

Since BJM sells its profile machining systems throughout Europe, the machines and their automation components must be suitable for all operating conditions found across Europe, including different menu languages, different temperature and humidity requirements and different voltage and supply conditions. "We haven't had a single failure so far", said Dietmar Kay. "Just in case, PC-based control technology offers simple and fast access to individual machines via Internet or remote service for troubleshooting purposes", said Thorsten Knapp and continued: "The focus is on reliability, which is why the measures required for integrating the control computers into the corporate network and the Internet are fully coordinated with the end customer."

→ BJM www.bjm-gmbh.com