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The basic elements of the Nobilia kitchen furniture are assigned by barcode to a particular customer order, and thus to an individual kitchen after leaving the so-called "anonymous production area".

Maximum data transparency in kitchen manufacturing through PC-based control technology

Nobilis: Series production with lot-size-1 flexibility demonstrates the true potential of Industry 4.0

Nobilis manufactures an enormous number of kitchens per year, with over 580,000 produced in the two manufacturing plants located in Verl in East Westphalia, Germany. That may be series production in the truest sense of the words, but the real specialty here is the customization that is implemented at the same time. PC-based control from Beckhoff offers the ideal foundation for universal transparency of the parts and production data, allowing individual kitchens to be supplied flexibly and efficiently in a lot size of 1 – entirely in keeping with the ideals of Industry 4.0.

Around 2,600 fitted kitchens leave Nobilia's two production plants every day, making the company Europe's largest manufacturer. If this figure alone is any indication of the high demands placed on the manufacturing processes, then according to Nobilia's technical director, Martin Henkenjohann, it is made even clearer by the special market requirements: "Despite series production, we manufacture fitted kitchens entirely in accordance with the customer's wishes, which means in a lot size of 1. In order to achieve this, we started way back in 1990 to keep all parts and production data transparent and universal over the entire manufacturing process – entirely in keeping with present-day Industry 4.0 concepts. That includes both the design data and the individual processing steps, so that we always know exactly where a particular piece of kitchen furniture is in the sequence of processes. This is the only way that we can meet the increasingly variable and specific customer requirements on the one hand and implement optimized and error-free freight transport with our own fleet of vehicles on the other."

Industry 4.0 requires real-time data over the entire process

Modern Industry 4.0 concepts, and the higher flexibility in production that is attainable with them, are not possible without ensuring transparency of all machine and parts data. Martin Henkenjohann explains what this means for Nobilia: "Real-time tracking capability over the entire process is the fundamental requirement. This starts by applying a barcode label that contains all necessary information about a piece of furniture, e.g. the front

of a kitchen floor cupboard, as it moves from the anonymous prefabrication to the order-related production area. The production aspects with regard to further processing steps on various machines are just as important here as logistic details, such as the loading time and truck information or the delivery address. For example, each processing machine scans the barcode and retrieves the associated machining data from the central Oracle works database or from Web services."

It is the transparency of the real-time data that makes the daily produced volume of 2,600 individually manufactured kitchens possible. 88 different front designs form the basis for this process, and there are 250 different items behind each design. Depending on the format of the front, plus such things as the fittings and handle or panel variants, this results in an extremely wide range of floor, wall, and tall cupboards. Regarding the logistic management of the virtually infinite variety of fitted kitchens, Martin Henkenjohann explains: "The barcode of a drawer front, for example, contains the configuration of the entire drawer, including its width and depth, the height of the rear wall and the type of handle. The production facility accordingly supplies all required parts, initiates the correct processing sequences, and ensures that the desired drawer is placed in a logistic train 'just in sequence'. The latter then drives to the assembly area, where the finished body of the cabinet is married to the drawer and other elements such as side-hung doors. Through real-time tracking, we know exactly where each part is in the production process at any time. That corresponds precisely to the Industry 4.0 approach."



Martin Henkenjohann, technical director at Nobilia, recalls: "Way back in 1990 we started to keep all parts and production data transparent and universal over the entire manufacturing process – entirely in keeping with present-day Industry 4.0 concepts."

Manufacturing controlled by time units and aligned with loading dates

Planning the production of Nobilia kitchen furniture is by no means traditional. In fact, production is controlled by time units; i.e. the tall, floor, and wall cupboards are tracked to determine which production sequence they are in and whether these sequences are correctly parallelized. Ultimately, all elements must enter the loading stream from a total of nine assembly lines with the right timing so that the individual fitted kitchen – complete with all cabinets, electrical appliances and accessories – can be loaded completely and on time onto the correct truck. Martin Henkenjohann comments: "The planning of an incoming customer order and thus the production control is taken care of by the dispatch department, which is actually the final link in the chain. This means that our vehicle fleet optimizes the use of its truck volumes on the one hand and the route to the customers on the other."

The dispatch department finalizes the production plan just four days before the planned kitchen delivery date, so the usage of the production capacities must be

extremely flexible. In order to properly take into account all customer requests within a short time, the construction data for the product variants are already stored to a large extent. In addition to that, each of the three assembly lines for the tall, floor, and wall cabinets can also be used to manufacture one of the two other cabinet types within certain limits. Dieter Grossekatthöfer, Sales Manager, Engineering at Beckhoff, illustrates this point: "Through the use of PC-based control technology and the units which are designed for as many different machining processes as possible, the machines cover a very wide range. For example, a drilling optimizer calculates a sequence in which, as a rule, as many holes as possible can be drilled simultaneously. When changing the product, however, it may be the case that consecutive drilling of the holes produces a better result so that, for example, it is possible to drive to intermediate gluing positions which are unavoidable for mechanical reasons. With these capabilities, the machines are optimally configured for maximum production flexibility."

PC control as an open and efficient system

The idea of data transparency at Nobilia was hatched back in 1990 in or-



Each element can be very clearly assigned to the correct kitchen furniture via unique barcodes.

der to meet the increasing demands on production. According to Martin Henkenjohann, the decision in favor of PC-based control technology was clear from the outset: "Without the openness and high performance of PC Control, universal data storage would likely not have been possible at all, due to our heterogeneous manufacturing environment. Not only that, we have benefitted over all those years from a very close and fruitful co-operation with an expert partner in Beckhoff. In addition, the entire system is extremely flexible and thus sustainable, which means it is easy to adapt to changing requirements."

With Beckhoff control technology and an Oracle works database developed in cooperation with Nobilia, a central, closely meshing link between ERP and design software has been created. In this way, the requirements of a historically grown and accordingly heterogeneous production landscape can be satisfied. At the same time, it was and continues to be possible to continuously tap efficiency potential through the increasing integration of stand-alone solutions. A technical quantum leap in this context – according to Matthias Gehle, Beckhoff expert for networks and systems – was the introduction of TwinCAT,

Innovative potential through "leading-edge cluster"

In Martin Henkenjohann's view, two research projects by the Industry 4.0 "leading-edge cluster" in Germany, "it's OWL" (Intelligent Technical Systems East Westphalia Lippe), headed by Beckhoff as the consortium leader, promise innovative potential. Dr. Ursula Frank, Project Manager R&D Cooperations at Beckhoff, explains: "The goal of the ScAut project is a Scientific Automation platform for the development and operation of intelligent, self-optimizing machines and plants. Initial test applications lead us to expect energy savings of around 20 %, productivity increases of approximately 10 %, as well as a reduction in maintenance expenditures of around 50 % as tangible, economical benefits, just through the implementation of Scientific Automation functions such as advanced Condition Monitoring and power monitoring. The innovation project "efa" (Extreme Fast Automation) deals – essentially one level lower – with the increase in performance of the control technology. At the same time, eXtreme Fast Control (XFC) is to be implemented in large and complex projects, extending up to complete production plants. Important topics include the optimization of cycle times and leveraging the full potential of multi-core processors." Through efa in particular, Martin Henkenjohann expects considerably increased computing performance so that production processes can be mapped even better in real-time, enabling further increases in manufacturing transparency.



At a glance

Solutions for the furniture industry

Universal data transparency for lot-size-1 manufacturing

Customer benefit

Maximum product variety with efficient series production

Applied PC control

- TwinCAT: open and flexible automation software for heterogeneous production environments
- PC Control: advanced control technology which enables Industry 4.0 concepts



During the entire order-related production sequence, not only machine information, but also information on the production status of the furniture parts can be retrieved via the Beckhoff Control Panels and Panel PCs.

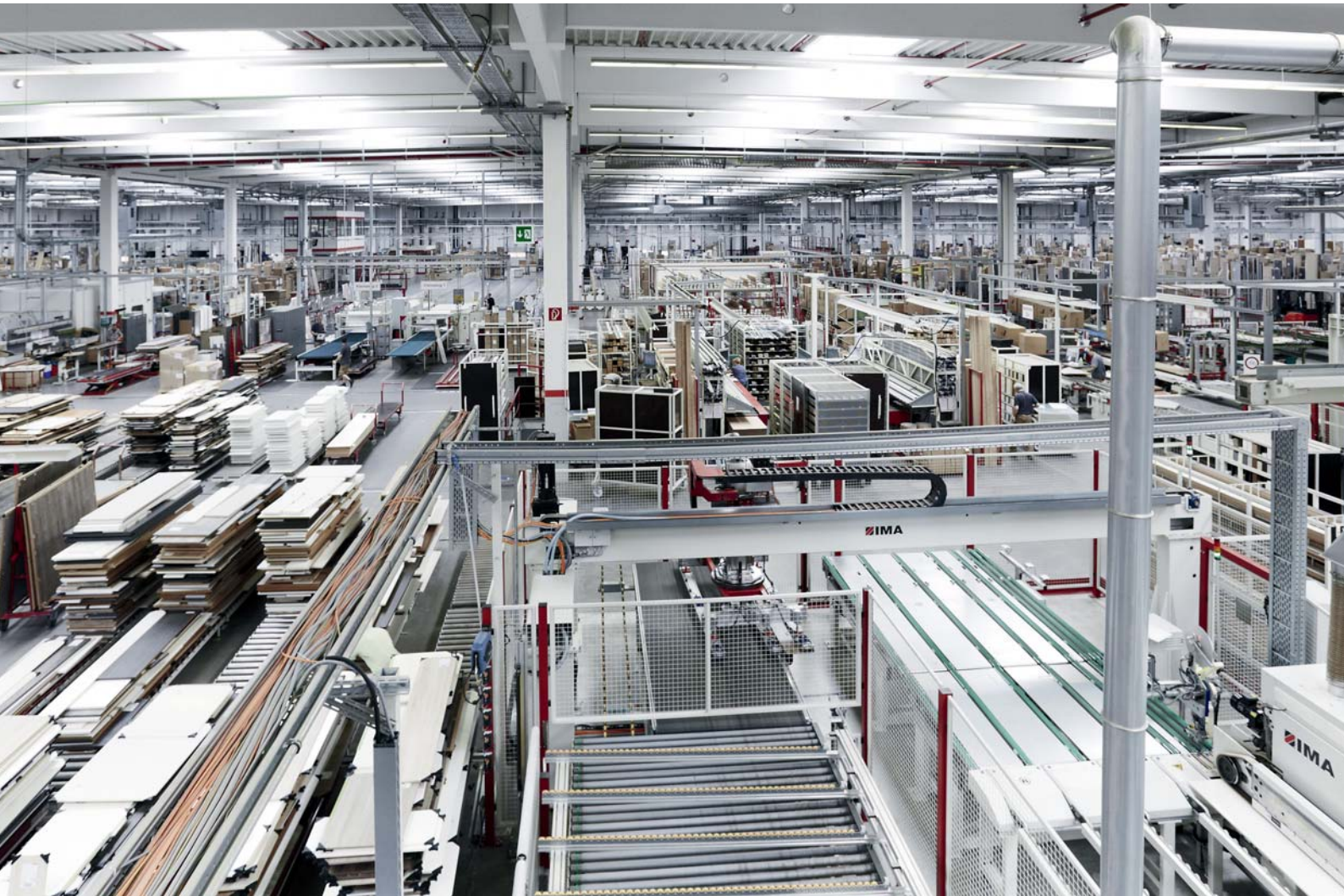
the Windows-based automation software from Beckhoff in 1996: "With TwinCAT, an entire system no longer had to be completely controlled from one control computer. Today, for instance, it is easy to connect up to seven Industrial PCs together via TwinCAT and ADS communication, for example for several drilling machines, a distribution system, and additional machining stations. Larger production units are created in this way, so that basically only a few equipment types, such as a tall cupboard assembly belt or a drawer unit, have to be regarded. For each of these plant types there is a pre-defined, customized TwinCAT application available, which only needs simple parameterization to be adapted. On the one hand, this allows existing knowledge to be transferred to all plants without great effort, and on the other, software engineering can be much more efficient."

Dieter Grossekatthöfer regards the possibility to modularize the plant as a further advantage of TwinCAT: "As opposed to the earlier stand-alone solutions with no real overlapping communication, it is now possible to create individual function modules, for example, for the side or base area or a drilling unit.

This is an enormous advantage during commissioning, because these modules can be commissioned separately and then simply combined afterwards. This considerably reduces the commissioning time and facilitates the continuous modernization of Nobilia's production landscape."

Universal PC-based control technology

Nobilis uses PC control from Beckhoff universally throughout both of its manufacturing plants, from the EtherCAT I/O system and motion control through to the Control Cabinet Industrial PCs (IPCs) and Control Panels with TwinCAT PLC/NC. Even the few older machines with conventional PLC technology can be integrated with PC-based control. Matthias Gehle summarizes the results as follows: "A homogeneous data flow can be achieved despite the very heterogeneous machine pool. The data is held in the central Nobilia database. Special high-level language applications developed by Beckhoff that are implemented in the production plants communicate with this database and supply the respective plant controllers with adapted information. Over all these years that has been the key to the continuous improvement of efficiency in production."



Nobilis produces a total of 580,000 individual kitchens per year and has concentrated on implementing a universally networked manufacturing environment since 1990.

Further efficiency potential on the way to Industry 4.0

Industry 4.0 is a concept that will only be fully implemented in the coming 10 to 20 years. Nobilia has already implemented it to a great extent today, but Martin Henkenjohann sees some potential for further development in the short and mid-term: "Currently, we are using RFID and RTLS (real-time locating systems) on a test basis with the goal of making the identification of the furniture pieces more variable in comparison with the barcode system and also to provide them more clearly with all necessary information. In addition, our production control will benefit from TwinCAT 3 and the multi-core IPC technology which it optimally supports."

Further information:

www.nobilis.com

www.beckhoff.com/Industry40

www.beckhoff.com/TwinCAT