

Fully automatic HSC hard machining

Automation in mould making: milling machine manufacturer as development partner

Company Hella



Current status of the fully automated production cell with two RXU 1200 DSH milling centres, one RXP 950 DSH system and a robot with a gross carrying capacity of 790 kg and a large store for cutting tools and pallets (photo: Klaus Vollrath)

Although complex injection moulding tools are often one-off pieces, systematic standardization of processes and automation of the machining steps in conjunction with the use of suitable



"Our expectations have been met, and even surpassed with respect to cost-effectiveness", Karl-Heinz Uhle (photo: Uhle)

machines enables benefits to be achieved relating to both quality and costs. However, suitable solutions often require individual adaptations of both hardware and software. Users are therefore well advised, when choosing their supplier, to consider flexibility and efficiency with respect to the development of the necessary adaptation. **A case story.**

"Hella is a world-leading supplier of automotive lighting technology, but also of vehicle electronics", explains Karl-Heinz Uhle, Head of Production at Hella Werkzeug Technologiezentrum GmbH (Hella Tool Technology Centre)

in Lippstadt. Such modern lighting systems for the automotive industry are made of plastic in an injection moulding process, which requires numerous and occasionally very large-format tools. The plastic components for such LED lighting systems must be made with maximum precision so that the light produced complies with the requirements imposed both by the customer and the legislator. Quality criteria include, for example, a homogeneous light distribution and defined limits between bright and dark, even at distances in excess of 100 m. Consequently, the corresponding injection moulding tools have to meet stringent requirements in terms of accuracy and surface quality, particularly in connection with the beam-

guiding elements. With some 200 employees, the Hella Tool Technology Centre is responsible for supplying the global production plants of the internationally operating automobile supplier with the appropriate moulds, which weigh up to 36 t. Alongside the production of new moulds, another focus of activities is the maintenance of moulds within the Group, which frequently calls for the production of new components to replace those which have worn down. The moulds exhibit a high degree of complexity such as multiple component injection capability and numerous slides and require production times of up to 7,000 hours. Although the toolmaker is a subsidiary of Hella, it has to hold its own against bids from the free market on an order-by-order basis. As a



Noticeable features in the working space are the robust z-axis, which is particularly rigid due to the guides on all four corners, and the stable rotating/swivelling table, which is supported by bearings on two sides (photo: Klaus Vollrath)



"During the course of the development, it has been seen that we made just the right decision by selecting Röders as the supplier", Carsten Berhorst (photo: Berhorst)

matter of principle part of the demand is acquired externally. Alongside quality and due dates, therefore, costs are also of prime concern. Consequently, it was back in the year 2009 that first thoughts were directed towards how the benefits of automating the processes might be exploited. An initial small cell for automated, unmanned production went into operation as early as 2011.

MACHINE TOOL MANUFACTURER AS STRATEGIC PARTNER

"In order to exploit the benefits of such a concept to the optimum, we needed a solution that could be adapted

to our special requirements with maximum flexibility over the entire scheduled period of use", explains Carsten Berhorst, Project Manager for the introduction of Röders Automation at the Hella Tool Technology Centre. The appropriate planning steps began back in 2009 and have even been the subject of various academic theses. In addition to the efficiency of the milling machine in terms of dynamics and accuracy, the prerequisites for the project also include the use of uniform software standards for all processes. At the Hella Tool Technology Centre these are Catia for the CAD engineering design and Tebis for the CAM programming. A further prerequisite is a zero-point clamping system with modular scalability, with the aid of which a wide range of workpieces from small parts to moulding plates weighing half a tonne can be clamped using the same scheme with standardized accessories. The original idea was to combine two milling centres from different manufacturers as well as a robot from a third manufacturer in order to supply the cell with workpieces and tools. However, after careful consideration, a



The spindles with cutter heads of up to 35 mm in diameter machine the material with a hardness of up to 50 HRC (photo: Klaus Vollrath)

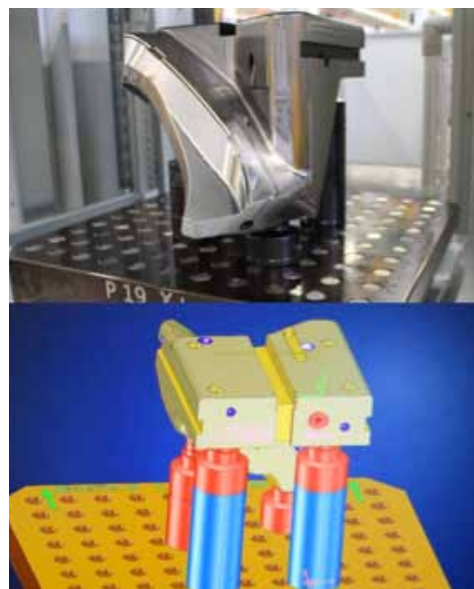
decision was taken to seek one single partner as the main contractor instead. This main contractor therefore had to ensure overall supervision of all the constituent parts of the system – both hardware and software. A prime focus of the cell was to take over the finishing of die sections in a hardened state, but in some cases also providing them for rough machining in the "soft" condition before hardening. Usual materials are hot-forming steels such as 1.2343, which exhibit hardness values of approximately 50 HRC, or prehardened steels such as 1.2738.

ORIGINAL CONFIGURATION

"The first cell delivered at Easter 2015 ultimately consisted of two RXU 1200 DSH 5-axis milling centres supplied by Röders automated with a robot having a net carrying capacity of 495 kg from the same supplier", recalls Karl-Heinz Uhle. The decision



Irrespective of their robustness, the plants are even sufficiently precise to be able to machine very fine details with milling cutters down to diameters of 0.4 mm (photo: Klaus Vollrath)



During automation, the very flexible zero-point clamping system with modular scalability manufactured by FCS proves to be of particular benefit (photo: Klaus Vollrath)



Since being extended, the cell has had a total of 543 internal and external tool positions as well as 21 pallet spaces for workpieces (photo: Klaus Vollrath)

was taken in favour of this type of system as it optimally met the requirements both for precision of machining as well as for efficiency in rough milling and drilling. In addition, these machines are equipped with highly dynamic and precise linear drives as well as an especially stiff z-axis with no less than four guiding rails. With their working space of 1,000 x 1,050 x 600 mm and a loading capacity for the rotating/swivelling table of 1,500 kg, they are capable of machining all relevant workpieces. They are even robust enough to machine large workpieces made of hardened tool steel with cutter heads of up to 35 mm in diameter. During the process, 3 mm of material are machined down in some cases, with the thickness of the chips reaching 0.2 mm. Holes with diameters of up to 12 mm and depths of up to 250 mm are also drilled into the same workpieces. For this rough application, the machines have been equipped with powerful spindles using the HSK A63 interface, which achieve a maximum rotational speed of 24,000 rpm. Irrespective of their robustness, the plants are so precise they can machine very fine details such as radii of 0.25 mm using milling cutters with diameters down to just 0.4 mm. Concluding high-gloss finishing processes, where necessary, are carried out by polishing operations either manually or in separate plants. Due to the surface quality and also the accuracy that can be achieved, it was possible to significantly reduce the expenditures for these additional processing steps. At the same time, accuracy was also improved because it was possible to reduce geometrical distortions during polishing to a minimum.

OPERATIONAL EXPERIENCE

"Through training measures and with the assistance of simulation software, we were able to prepare ourselves thoroughly before delivery", Carsten Berhorst reveals. The fact that Röders has developed a separate control unit for its machines and can therefore take a very flexible approach to individual customer wishes proved to be particularly advantageous. Just how important this was could be experienced, for example, when using

smaller tungsten carbide tools with NC programs that had previously been written for other machines that were considerably "softer" and slower in their path guidance. The new Röders systems not only have a very rigid machine frame but additionally control the tool path extremely precisely thanks to their 32-KHz control frequency and additionally achieve exceptional dynamics thanks to the linear motors. It was possible to experience this immediately after the commissioning of the machine e.g. because small tools with an extended arc of contact with the workpiece tended to break off as they were being pushed against the workpiece flanks with substantially higher forces than were customary from previous practice. After the adaptation of these existing NC programs, it was then pleasing

to see that the machining operations proceeded significantly faster. Close contact with the support experts of Röders proved to be extremely helpful in this connection. Thanks to the good preparation, production of parts was able to start up only four weeks after delivery, and the subsequent ramping-up process also proceeded in a pleasingly fast and trouble-free manner. The post-processor handbook supplied by Röders, which enabled optimum tuning of the post-processor to the requirements of the Hella Tool Technology Centre, also proved to be very helpful. Familiarization with the RMS6 machine control unit and with the RMSMain Job Manager by Röders also took place quickly and smoothly as the producer of these two software packages not only paid attention to high operational efficiency but also focused on their user friendliness.

PLANT EXTENSION

"The selected solution has proven to be so effective to date that we undertook an initial extension in the summer of 2018", Karl-Heinz Uhle reports. To this end, the robot was placed on a rail of 5,500 mm in length and the cell extended by adding a smaller Röders system of the type RXP 950 DSH. This unit has a smaller working space of 600 x 905 x 500 mm but has been equipped with the same spindle as for the other machines so that all milling tools can be freely exchanged within the cell. The same clamping system as present on the other machines was of course selected in order to ensure a large degree of consistency. The Job Manager is used to clear assignments for one or both machine types and thus allocate them automatically to the correct machine. In total, the cell now has 543 [external + internal] tool positions instead of the previous 198, and the number of pallet spaces for workpieces has risen from 11 to 21. Discussions concerning the addition of a fourth Röders unit for the future are currently in progress. All workpieces are set up on the previously mentioned modular pallet system with zero-point clamping by operations scheduling so that loading and unloading of the machines can be carried out at any time without personnel.

PARTNERSHIP WITH WIN-WIN OUTCOME

"During the course of the development, it has been seen that we made just the right decision by selecting Röders as the supplier", says Carsten Berhorst. As expected, he continues, there was a need for adaptation during the implementation of the cell and in the alteration of existing hardware and software. During the course of project planning, installation and the production start-up, Röders has proven, in his opinion, to be both a competent and efficient partner, with whose assistance it has been possible to cope with all the desired conversions. The cell is supervised on a two-shift system by two employees and continues in unmanned operation both through the night and at weekends. Today the three plants each achieve an average overall running time of roughly 6,000 hours per annum. Depending on the mix of jobs, some of the machines reportedly even attain 700 milling hours in a given month in some cases. "Our expectations have been met, and even surpassed with respect to cost-effectiveness", says Karl-Heinz Uhle summing up.
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THE RÖDERS RXU 1200 DSH

The Röders RXU 1200 DSH milling centre has been specially developed with a view to high levels of strain in tool and mould construction. One important feature is the Quadroguide design of the z-axis with four instead of the usual two guiding rails at the four corners of the especially rigidly designed z-axis. This makes it possible to achieve high roughing capacities while maintaining high dynamics and precision, and in addition the machine can be equipped with spindles having a maximum torque (S1) of 100 Nm. All axes have powerful, wear-free linear direct drives or torque drives as well as high-precision optical path-measuring systems. The c-axis is supported by bearings on both sides to ensure high stability and machining accuracy, and the counter bearing can take a weight of up to 20 t. The swivelling direction of the c-axis at right angles to the x-axis ensures dynamic decoupling of the directions of motion. The special 5-axis geometric compensation of the Röders control unit guarantees maximum accuracy for any positions and also for simultaneous machining operations. With the Röders Racecut, the 32-kHz control system for the axes allows a particularly high dynamic level to be achieved while maintaining very good surface quality. Running through all essential components are cooling channels, in which a medium stabilized to a temperature of ± 0.1 K circulates. The dimensions of the working space are 1,000 x 1,050 x 600 mm and the maximum weight of workpiece is 1,500 kg. The swivelling range of the table with a diameter of 895mm and swing circle diameter of 1,200 mm is $\pm 115^\circ$. Chucks for different pallet systems can be integrated into the table. The system can be equipped with various spindles and table geometries. <<