Milling machines for the high art of mould making

What do precision milling centres have to do with mascara applicators?

Company Zahoransky Automation & Molds

Perfect aesthetics requires the highest quality - also for the moulds used to produce mascara applicators (Photo: Zahoransky)

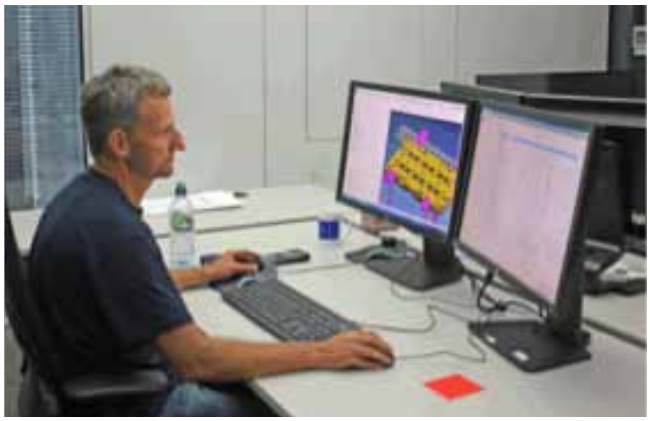
It is hard to find product categories with aesthetic requirements that exceed those of the healthcare & beauty sector. The requirements that such products have to meet encompass all relevant aspects, such as design, colour, surface quality or look and feel. It goes without saying that items produced by plastic injection moulding need moulds that fulfil comparatively stringent quality requirements. Furthermore, high expectations for the productivity and the reliability of the production process play an important role. For manufacturing such moulds, a leading German manufacturer relies on the precision and performance capabilities of milling centres from Röders.

"When producing injection moulds, we are regularly pushed to the limits of feasibility" Volker Waizmann (Photo: Klaus Vollrath)

"We produce injection moulding tools, plants for the production of brushes, blister packaging machines and related automation systems, up to the provision of complete production solutions for healthcare & beauty items as well as medical technology products," explains Volker Waizmann, Production Manager of Zahoransky Automation & Molds GmbH in Freiburg, Germany. With its workforce of 190 employees, the company belonging to the medium-sized Zahoransky Group supplies tools for the injection moulding of, e.g., toothbrushes, mascara applicators or the overmoulding of medical cannulas. These tools are extremely challenging. For example, toothbrushes are mostly produced by sequentially injecting several plastic components. The moulds are often very large and encompass dozens of identical cavity inserts. The challenges result not only from the accuracy requirements for the given cavity itself but also from the position tolerances of the individual inserts. In addition, the various individual cavities into which the plastic

This toothbrush was produced by sequentially injecting three different plastic components (Photo: Klaus Vollrath)

The Z.TIM stack injection moulding tool consists of two tool sides with a central rotating cube. This makes it possible to produce two different parts on one tool (Photo: Klaus Vollrath)



Cutting-edge software is used to design and calculate the moulds (Photo: Klaus Vollrath)

The two automated Röders production cells. In the foreground an RXP 500 DS with RC 2 carrousel magazine, partly concealing an RXP 601 DSH with expandable RCM linear magazine for workpieces and tools (Photo: Klaus Vollrath)

components are sequentially injected must exactly match not only the desired contours of the components but also in respect to the three-dimensionally curved parting surface between cavities. The latter is mandatory in order to avoid the formation of ridges if individual inserts have to be replaced.

ZERO TOLERANCE FOR DEFECTS

"Our tools are mostly one-offs, and we are regularly pushed to the limits of feasibility," says Waizmann. "Simple" tasks are a thing of the past, and there is no room for failures or experiments. Advanced tools have up to 48 cavities, and the customers expect that they can be used without any restrictions and with the highest possible productivity. Furthermore, in the event of a failure, the replacement of individual inserts should be easily possible without any need for modifications. This requires extensive experience, not only with respect to the manufacturing of the mould itself but also regarding the whole production process. Thus, for example, in the case of multi-component products, the material behaviour of the different plastic components must be precisely known. Otherwise, the component injected in the first round could become distorted when it is transferred to the next production step. The demands on productivity are so high that handling systems sometimes have to extract the finished products in less than a second. At the same time, the manufacturing process has to be reliably mastered, and the products must fulfil the highest aesthetic and haptic requirements. This requires experienced employees as well as the use of cutting-edge computer programs, e.g., for simulating the injection moulding process. Thanks to the expertise of its staff, the company is able to compete successfully against rivals from countries with lower wage levels.

HEAVY-DUTY HIGH-SPEED MACHINING

"Given the high number of moulds we produce, the individual departments are relatively sharply delineated," explains Waizmann. His department is supplied with pre-machined mould insert blanks whose outer contour is machined in the soft state, then hardened, and finally ground exactly to fit into the mould frame. His team then takes over, carving out contour-defining areas such as the parting plane and the cavities from the massive hot-work steel chunk already hardened to 48-52 HRC. This is carried out partly by penetration EDM and partly using a five-axis Röders milling centre RXP 601 DSH. "Nowadays, we opt for hard milling wherever technically feasible, as it helps us to reduce manufacturing costs on the one hand and throughput times on the other," adds Waizmann. The machining is carried out using solid carbide cutters in the diameter range of 0.2 to 10 mm, which, like the palletized workpieces, are supplied by a fully automatic linear Röders RCM handling system. The advantage of this configuration is that everything – hardware as well as software – comes from a single source. The CAM department can also access the Röders RCM job manager database, work with the tool types available there, and even create new types directly from the CAM workplace. This also simplifies work for the operator by automatically

The workspace of the RXP 601 DSH. In the middle is the robust tilting rotary table, supported on both sides. The counter bearing on the right side has a loading capacity of 7,000 kg (Photo: Klaus Vollrath)

creating workflows, for example, that only require the operator to link workpieces to the corresponding job. Another advantage of the RCM solution is its modular expandability. It can be expanded through the integration of a measuring machine or a washing plant, for example, thus growing quasi-organically with the needs of the department. The manufacturing cell has already been designed for a second milling plant. The department thus sees itself well-prepared for the future, confirms Waizmann.
A second, older Röders system – an RXP 500 DS with an RC2 carrousel magazine for the palletized workpieces – is mainly tasked with producing the required sinking EDM electrodes, mostly using graphite but sometimes also copper.

OUTSTANDING PRECISION

"In the case of large-sized tools with numerous inserts for multi-component injection moulding, the precision requirements are almost extreme," says Waizmann. With such tools, virtually everything from the position in the mould frame to the three-dimensional course of the parting plane must be exactly correct, since even the slightest deviations in the product shape would be disadvantageous. The customers nowadays only allow deviations of max. 0.02 mm on the individual plastic part, and this notwithstanding overall tool sizes of e.g. 750 x 1,000 mm. Due to the high injection pressures, tolerances of less than 10 µm are required for the mould parting plane in the mounted state, which translates to a maximum individual deviation of ± 5 µm. In addition, the removal of material during polishing must also be accounted for. The machining process thus constantly teeters "along the µm edge". It is thus no wonder that the workshop is fully air-conditioned and the reference points of the components are determined directly in the machine by means of an automatic measuring sensor, in order to compensate for deviations stemming from the zero-point clamping system. The shape accuracies achieved on the milling machine are measured and documented by the job manager. A periodic recalibration is performed by means of a reference part, which has also been measured externally on a measuring machine. The Röders machines are designed to reliably achieve such accuracies even after years of heavy-duty utilization and when operated in five-axis mode. A major factor for this is the direct drives in all axes, which – due to their frictionless operation – provide the highest machining accuracies and a virtually unlimited service life. In addition, the machines have a sophisticated internal temperature control system for all critical components, including the drives, as well as options for a further increase in accuracy.

UPGRADABLE CONTROL SYSTEM

"One of the outstanding features of the Röders systems is their control, which combines the highest performance with ease of use," says Waizmann, adding that "in our daily routine, we benefit from the fact that our plants have exactly the same version of the control system despite their great difference in age". Upon delivery of the new RXP 601 DSH, the control software of the older RXP 500 DS was simply updated to the same level. Due to the continued further development of the control and regulation systems, such updates open up new rationalization options resulting in shorter machining times or higher surface quality or producing easier handling and extended functionalities. Thanks to the well-designed, Windows-based control concept, familiarization and training of the machine operators are no big deal. Likewise, learning to master the Röders job manager RMS Main, including its connection to the CAM system and the tool management, went easily and smoothly.

RELIABILITY ALSO WITH RESPECT TO SERVICING

"For us, punctuality in the delivery of tools and production equipment is a must," says Waizmann. Since the basic production time for a large injection tool amounts to 8-12 weeks and the company has only very limited reserve capacities with respect to HSC hard machining, the availability of the machines and therefore their reliability as well as the reaction time and efficiency of their service are very important factors. The company has had very good experience with this during the eleven years since the delivery of the first Röders system. Röders endeavours to keep service costs as reasonable as possible in the interest of the customer. Where remote support in direct contact with Zahoransky maintenance specialists is sufficient, this mode of operation is preferred. If it involves the installation of a new subsystem, the required parameterization is simply transmitted online. Furthermore, using the remote maintenance service is free of charge. On the other hand, whenever the presence of Röders service specialists is required, they are quickly on the spot. This is a strategic point for him, in view of the time pressure to which he is subject himself. "The fastest and most accurate machine does not help me if I cannot get a binding date for the arrival of a service technician in the case of a standstill. Manufacturers who cannot assure this will no longer be addressed when we discuss new investments," confirms Waizmann.
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The storage area of the RCM automation system contains milling tools (left), workpiece pallets (centre and bottom) and a gripper station (top) (Photo: Klaus Vollrath)

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THE RÖDERS RXP 601 DSH

The Röders HSC five-axis milling machine RXP 601 DSH has been designed to meet even the most stringent requirements with respect to precision and high chipping performance, even when machining hard materials. It has friction-free linear direct drives which, together with 32 kHz control systems, provide for both high dynamism and high precision. The essential prerequisites for this performance include high-precision optical measuring rods in all axes – an aspect where the manufacturer simply will not compromise. Due to its accuracy and dynamics, this plant can also be used for coordinate grinding, as is the case with other types of Röders machining centres as well. In addition, the Z axis has a patented friction-free vacuum counterbalance to avoid any reversal marks in the Z direction.
To ensure maximum thermal stability, the systems have a sophisticated temperature management. The temperature of the medium, which circulates through all essential system components, is controlled with an accuracy of ± 0.1 K. A further special feature is a proprietary PC-based control system, whose functions are precisely tailored to the specific tasks of HSC high-precision milling or coordinate grinding. As a special feature, Röders offers control updates to prevent machines from becoming obsolete because their control system is too old. The current version of the control system, the RACECUT, significantly reduces processing times even further. <<

RÖDERS AUTOMATION

Röders offers automation solutions for various stages, from handling small components weighing just a few kilograms to workpieces with a mass of 1,500 kg. These solutions from Röders are not only able to interface with plants from the same manufacturer but can also integrate systems from other manufacturers. In addition, a modern, high-performance job manager is available, which can also be fitted with interfaces to higher-level systems. <<