Highly precise multi-purpose machine for the tool shop

Machining center for heavy-duty service in milling and jig grinding

Company Feintool

The Röders machining center RHP 500 installed in the Feintool shop proves itself for HSC milling as well as for jig grinding jobs involving ultra-hard materials with up to 66 HRC (Photo: Klaus Vollrath)

Feintool is a specialist for fine stamping and forming of precision sheet metal parts for various industrial applications with a world-wide reputation. The top performances its customers require can only be achieved if the entire process chain from the press through to the tool, the consumables and the periphery is carefully designed and optimized from one source. Key elements for success are the very precisely manufactured stamping and forming tools, which are developed and manufactured by a team of experienced professionals in the technology center in Lyss. They are manufactured using high-performance HSC machining centers made by Röders which are equally suitable for HSC milling as well as for jig grinding – even when the materials reach hardness levels of up to 66 HRC.

"The experience we made with Röders was so positive that we already commissioned another machine for delivery in March 2016" Christof Wüthrich (Photo: Klaus Vollrath)

"Our specialty is the fine stamping and forming of sheet metal", says Christof Wüthrich, Head of control station/ element production at the department for tool development at Feintool Technologies AG in Lyss (Switzerland). Fine stamping is a world apart from conventional stamping operations. The key difference comes to light when one examines the accuracy and quality of the produced components. During normal stamping operations, the punch forces the metal through the opening of a die whose clearance is noticeably larger than the punch and further increases with depth. Hence the sheet is only partially cut through, while the rest of its cross-section will be merely torn apart. The edges are therefore rough, uneven and their angle deviates from the ideal 90 °. The difference between sheared and torn areas can often already be discerned with the naked eye. In addition to wide dimensional tolerances, the planarity of the parts is often impaired. Such stampings are therefore unsuited for manufacturing many of the highly complex, ready-to-install multifunctional parts that are nowadays required by many high tech customers from the automotive sector through

A selection of typical fine stamping/ forming parts highlights the bandwidth and complexity of the requirements that the Feintool machines have to meet (Photo: Klaus Vollrath)

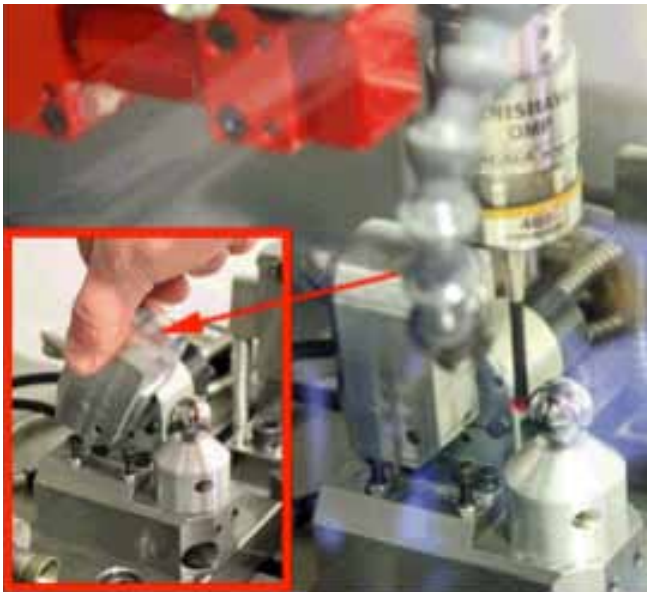
"In view of our job composition, it is very convenient that we now can process by hard milling as well as by jig grinding in the same machine and within the same fixture" Christian Iseli (Photo: Klaus Vollrath)

to the mechanical engineering or precision mechanics industries. In contrast to this, fine stamping achieves clean cuts at right angles due to extremely tight tolerances of the cutting gap and a special clamping technology of the material performed using a v-shaped protrusion of the locking plate closely following the contours of the part.
The process is characterized by outstanding accuracies und uniform edges of the stampings. The high dimensional precision and flatness of the parts prevents the necessity for costly finishing treatments. The parts can usually be directly processed in downstream operations such as embossing or cold forming. The elimination of intermediate processing steps allows for significant cost savings when compared to conventional production methods.

PRECISION MACHINES AND TOOLS

"This requires presses and tools that are specifically designed for the high requirements of the process", adds Christian Iseli, expert for machining of hardened materials in the Feintool Technology Center. This is true for all essential aspects of the complete system from the accuracy of the press movement when actuating the punching tool to the extremely narrow clearances of the cutting and forming tools that are often down to just 5 µm. Another aspect is achieving the highest possible productivity in order to offset the augmented investment costs. This in turn calls for a single-source holistic approach to the design and optimization of the process chain from machine, tooling system, materials technology through to component design.

Massive fine stamping matrix made from ultrahard tool steel. Typical features include the fine-ground vertical inner and outer contours as well as the v-shaped protrusion closely following the contours of the part (Photo: Klaus Vollrath)



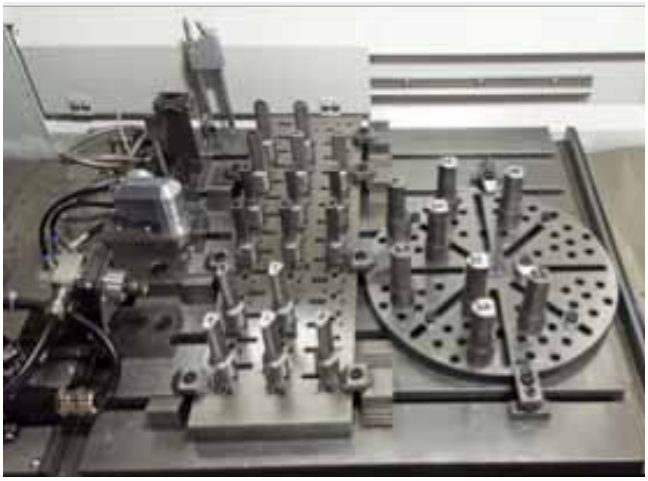
Prior to starting the measuring run, the automatic probe that has been clamped into the spindle is calibrated using the sphere whose protective cover has been automatically lifted for the operation (Photo: Klaus Vollrath)

Therefore Feintool constrains its activities to exclusively developing customized solutions, whose components are realized completely on their own responsibility, to the inclusion of the necessary peripheral systems, and also provides for comprehensive consulting, engineering and training. To ensure the required efficiency, the presses run at high speed, reaching between a few dozen and up to 200 strokes per minute depending on the size of the parts and the complexity of the task. Such high productivity levels can only be achieved with tools ensuring the required accuracy of the parts under high stress and over long operation periods. These key components are thus designed and produced in-house by a special department with a workforce of 40-50 employees.

ULTRA-HARD STEELS ARE EXTREMELY CHALLENGING

"The smooth functioning of such highly stressed tools depends on countless factors", explains C. Wüthrich. This applies even for seemingly marginal details such as the type of punching oil put to use. While for standard stamping tools with their wide clearances, this indeed is of low criticality, the related know-how becomes a match-winning aspect when it comes to cutting clearances of just 5 µm. Similar diligence is required for all processing steps when making the tools, from soft machining through heat treatment and hard machining to the coating operations. A particular challenge is posed when it comes to machining some ultra-hard components reaching hardness levels of up to 66 HRC.

This in turn defines the requirements that have to be met by the machining centers used for the various stages of tool production. The techniques used include the usual turning and milling in the soft state. After the hardening treatment, wire EDM machining may be put to use depending on application and geometry. Finally, the parts are treated by grinding or jig grinding. Processing accuracies between ± 2.5 and ± 5 µm have to be reliably achieved.



Mix of numerous, partially differing stamps. Position and dimensions of each part are determined prior to starting the machining process. This allows long unmanned production runs and thus high profitability even without a handling system (Photo: Feintool)

TURNING AND GRINDING HARD MATERIALS WITH THE SAME MACHINE

"Given the complexity of many geometries and the high accuracy requirements we have to meet, we often have applications where it makes sense to use both hard milling and jig grinding in order to achieve optimum efficiency", says. C. Iseli. For such tasks, it is desirable to perform both jobs on the same machine and in the same set-up. Decisive advantages are on the one side gains in accuracy because misalignments due to re-clamping inaccuracies cannot occur, and on the other side the elimination of time expenditures for the re-calibration after re-clamping.

Therefore, after thoroughly reviewing adequate systems available on the market, the company opted for a three-axis machining center Röders RHP with hydrostatic guideways, the reason for this choice being that the system was able to excel at both types of operation. With the grinding machines of a Swiss manufacturer currently used in the shop, additional milling operations could also be performed, but performance and rigidity of the spindle did not meet the expectations. The same applied to the dynamics of the axis movements. In clear contrast, the Röders machining center fulfilled all expectations both in terms of material removal rates as well as with respect to the achievable machining accuracy and surface quality. Further advantage was reduced workspace requirements since only one machine had to be installed. A further important aspect was the freedom of choice between milling and grinding operations. For certain tasks, this offered the opportunity to freely opt for the significantly more economic milling instead of the time-consuming grinding operations.

APPLICATION STRATEGY

"The experiences we since were able to collect with the system were so positive that, already in March 2016, a further Roeders machine will be commissioned", says C. Wüthrich. The learning curve with the first machine was pleasantly short and lasted just 2-3 months. The new machine is the model RXU 1001, which differentiates itself from the first machine mainly by the enhanced stiffness of its axes. In addition, this machine is equipped with roller guides instead of hydrostatic guides. Sample machining tests performed at the Röders application lab prior to placing the order ensured that notwithstanding these differences, the expected and required precision can be achieved safely.

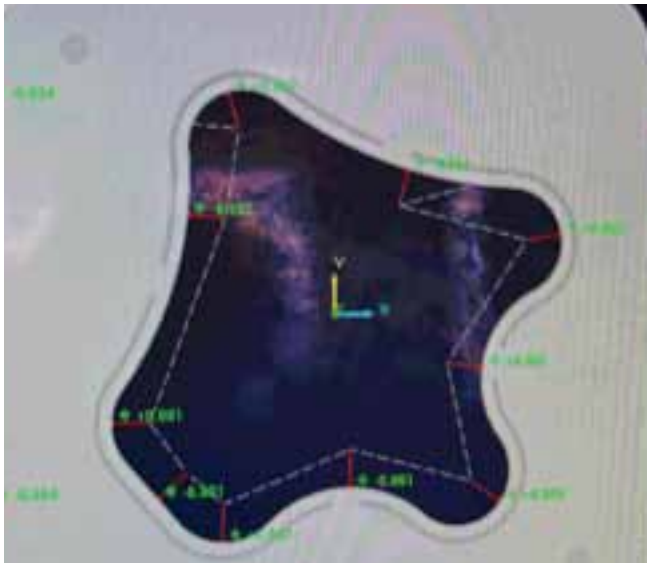
Up to now, the usual machining sequence after hardening included rough grinding in order to remove the machining allowance that had been respected during soft milling, leaving a residual finishing allowance. Subsequently, a finishing pass using fine grinding was performed. Depending on workpiece height and requirements on surface quality, restrictions with respect to limited tool lengths occasionally required resorting to several grinding passes.

The current mode of operation of the Röders machine after the hardening treatment mostly starts with hard milling to remove the allowance left before the heat treatment. In the case of very tall workpieces, another pass involving rough grinding might be necessary in order to remove the slant resulting from the yield of the milling tool. After that, the final contour is achieved by fine grinding. In the case of matrices, a further hard milling operation is performed to provide for chamfers and the v-shaped protrusion of the locking plate closely following the contours of the punch opening.

The measuring probe available for Röders machines is used for checking the workpiece and its position in space before starting any machining processes, as well as afterwards in order to verify the outcome. Meanwhile, the Feintool crew has gained so much experience with the machine that they omit resorting to an intermediary measuring run before changing from milling to grinding operations, starting with the grinding process immediately right away as soon as the tool has been exchanged.

GOOD SUPPORT

"A key factor contributing to keeping the ramp-up phase pleasantly short was the very good support we experienced from Röders", recalls C. Iseli. Of particular importance had been the assistance in programming, since this had until now been uncharted territory for the Feintool crew. Training as well as development and implementation of special post processors for the production planning department were performed by a Röders specialist dispatched to the Feintool shop. This direct cooperation was a major success factor. While the production planning team is able



The protocol of the measuring run performed by the machine using its built-in software routines is displayed on the screen. It highlights the precision achievable with the Röders machine (Photo: Klaus Vollrath)

The application lab where completed Feintool die sets are thoroughly tested before delivery (Photo: Klaus Vollrath)

to handle the bulk of the NC programming tasks helped by the integration of the already mentioned post processors into the TopSolid CAM-software, the operators have been enabled to program minor jobs or adjustments directly on the spot using built-in control software cycles. Ultimately, according to C. Wüthrich, it was this overall package of machine performance and support by the manufacturer which tipped the scale in favor of Röders when the decision was taken to commission another machining center after a comparatively short time.
Klaus Vollrath

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THE SPECIFIC ADVANTAGES OF THE RÖDERS TECHNOLOGY

Röders HSC machining centers are designed for the highest accuracy requirements combined with high metal removal rates even when having to machine hard materials. They feature extremely dynamic frictionless linear direct drives and high-precision measurement and control systems equipped with high-precision scales enabling for positioning steps of less than 50 nm. In combination with a fast control system featuring a frequency of 32 kHz in all control loops, they show no hysteresis effect (stick-slip) at changes of direction: by interpolation of axes, this results in perfect circular movements. This applies to both hydrostatic and recirculating roller guidance systems, albeit the former are characterized by superior dampening characteristics. In addition, the Z-axis is equipped with a frictionless counterbalance system in order to avoid any reversal marks in the Z direction.

In order to offer the highest thermal stability, the machines feature a sophisticated temperature management system. The cooling/heating agent circulating through all vital machine components is maintained within a temperature range of just ± 0.1 K. Another thing that sets Röders apart is a proprietary control system based on standard PC technology whose functionalities have been carefully tailored to meet the specific requirements of HSC- resp. high precision milling and jig grinding. Furthermore, Röders offers its customers control system updates that eliminate the risk of the system becoming outdated. The control software supports both helical and the fast hub grinding strategies. Further specialties include conical as well as 5-axis-grinding. Thanks to specific routines for special grinding strategies using pre-defined tool types and grinding parameters, the programming using a CAM system can be complemented by efficient and fast programming directly at the machine. <<