From sixteen machining steps to just four

Sophisticated automation of a challenging milling task

Custom-made: Top right, the RXP 601 DSH Z2 milling center with double spindle; in the middle, the robot; and left, the magazine with workpieces and tools
(photo: Klaus Vollrath)

Top-quality products must stand out from their competitors by their distinctive design. This brings about correspondingly high stakes for the associated manufacturing tasks. Lamy, an SME writing instrument manufacturer, is proud of its quality and, even today, still occasionally repairs fountain pens sold up to 60 years ago. The production of the molds for the casing of the current series recognizable by their distinctive Lamy logo involved sixteen processing steps involving different technologies. In close cooperation with the milling machine manufacturer Röders in Soltau, a process was developed that masters this task fully automatically in just four steps in 24/7 operation, resulting in a significant increase in efficiency.

"The market for writing instruments is huge and extremely competitive," explains Jörg Weber, head of toolmaking at C. Josef Lamy GmbH in Heidelberg. As a medium-sized manufacturer of high-quality writing instruments, the company has to hold its own against low-cost mass producers on the one hand and luxury brands on the other. In addition to quality, the design of the products thus plays a decisive role. It must be easily recognizable and distinctive while conveying the impression of high quality at first glance. Therefore, the demands placed on the injection molding tools used to manufacture the plastic parts of the writing instruments, such as fountain pens, are correspondingly high.

The area of the "Lamy" logo on the upper part of the casing, known as the barrel, is particularly challenging. Additionally, the perfect fit of the mold halves to each other as well as the high-gloss finish of the molded containers without any shading also posed major challenges for the toolmakers. Until recently, the production of these molds required numerous machining steps using different technologies such as milling, die-sinking EDM, polishing and measuring. Furthermore, the EDM as well as manual grinding and polishing processes were not safely controllable with respect to geometrical accuracy.

CHALLENGES POSED BY THE LAMY LOGO

"In the past, creating this logo on the container in line with design specifications implied considerable efforts in toolmaking," adds Viktor Schellenberg, team leader in Lamy's toolmaking shop. Embedded in a high-gloss environment, the logo has to protrude sharply from a velvety matte recess in the base material. Formerly, the sharp edges required could only be achieved by die-sinking EDM. However, this had the disadvantage that the wear and tear on the electrodes did not allow for sufficient repeat accuracy. In addition, the surface damage caused by the EDM process required considerable polishing efforts, which in turn impaired the sharp edges of the lettering.

Clearly satisfied: Jörg Weber, Head of Toolmaking, and Team Leader Viktor Schellenberg in the workspace of "their" milling cell
(photo: Klaus Vollrath)

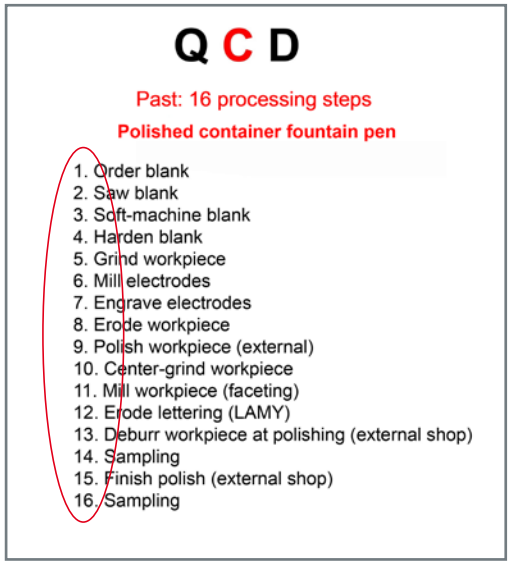
Striking and unmistakable: the Lamy logo on the barrel of a fountain pen and the milled, uncoated mold inserts
(photo: Röders)

Today, the mold halves are milled from the already hardened blank (above) and briefly polished. After structuring the background by a short EDM machining pass and applying a TiN coating, they are ready for sampling
(photo: Klaus Vollrath)

Deeper surface damages (burn marks) which occurred occasionally were another problem, only becoming visible after polishing. Since most of the additional machining of the blank was done by milling in different hardness conditions, the components had to be re-clamped, re-measured and re-aligned several times between different production installations. This resulted in considerable additional expenditure. The entire process sequence for manufacturing the mold insert in question previously comprised a total of 16 sub-steps, complemented by the necessary intermediate measuring processes. Another handicap was that the services provided by the external polishing shop resulted in throughput times of a total of 6-8 months, which is unbelievable today. To make things even worse, some faults only became apparent during sampling of the tools, sometimes prohibiting the use of one or even two cavities of a four-cavity tool. This forced the company to constantly keep an additional stock of replacement cavities.

NEW CONCEPT: MILLING INSTEAD OF ERODING

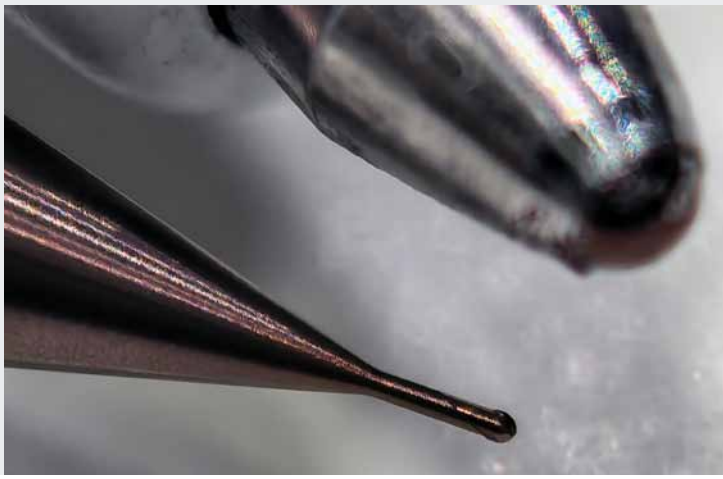
"In August 2021, we therefore asked the milling machine manufacturer Röders based in Soltau to team up with us in order to develop an adequate solution to this problem," recalls J. Weber. The core idea here was to replace the EDM eroding of the logo section by micro milling. At the same time, the entire outer surface was to be machined to high surface quality so that polishing could be largely reduced. The aim here was to carry out a broad bandwidth of milling operations – from roughing of the outer contours to near-gloss micro-machining finishing – in one machine and thus in a single clamping. For such applications, Röders has developed a twin spindle solution for its proven precision machining centers. The Z-axis of these machines features two spindles mounted next to each other. In addition to the robust and precise roller-bearing standard spindle (HSK 40, 42,000 rpm), it is also equipped with an air-bearing high speed high precision spindle (HSK 25, 60,000 rpm). This spindle is



The Lamy logo on the partial tool used to be machined using EDM erosion. This process chain required a total of 16 machining steps
(graphic: C. Josef Lamy GmbH)

The air-bearing spindle can be seen to the right of the standard HSC spindle (here holding a 3D probe and with open sliding cover). Below it is the second exchanging set with its own probe ball and measuring laser
(photo: Klaus Vollrath)

The hardened blanks, which are ground flat only on one side and provided with threaded fixture holes, are fixed to the self-developed workpiece carrier with four screws, thus enabling effective, collision-free five-sided machining (photo: Klaus Vollrath)



Shown next to the tip of a ballpoint pen, this micro milling cutter from Moldino with a CBN ball head has a diameter of only 0.1 mm and lasts for 8-10 hours of use (photo: Klaus Vollrath)

particularly smooth-running and optimally dampened. This arrangement allows additional machining operations to be carried out in the same clamping, making it possible to use micro milling cutters with diameters down to 0.1 mm. The high spindle rpm performance enables sufficient cutting speeds and, thanks to the excellent smoothness of operation, also optimum surface qualities below Ra 10 nm. The additional spindle also includes its own double-set of automatic exchanging, testing and cleaning devices for the tools. The software takes care of all the additional management tasks for the operator. Based on the tool data, it automatically selects the spindle to be equipped, while the other one is closed with a blind cover to prevent dirt contamination. During machining, the control system takes into account the highly accurately known distance between the two spindles.

SUCCESSFUL PROCESS DEVELOPMENT

"Of course, Röders first carried out a proof of concept with a corresponding system in the technical center on its premises," reports V. Schellenberg. Extensive milling tests were carried out on already hardened blanks using Moldino milling cutters. These proved convincing in terms of quality and accuracy as well as machining performance and tool life. Today, the Lamy toolmaking shop manufactures these mold inserts on its new five-axis RXP 601 DSH Z2 milling center in just four production steps instead of 16 as in the past. The required CAM programs are created from the CAD data using Hexagon's VISI software. Machining is completely performed on already hardened blanks. These are first rough machined on five sides in a single pass, followed by pre-finishing and measuring for acceptance. Only the gloss areas are later lightly "wiped" externally with polishing paste. This is more cost-effective than final high-gloss milling, as polishing costs are significantly lower than the corresponding milling costs. The related cost savings compared to the past are now 70 %. Finally, the low-lying background area of the logo is structured using a short EDM erosion treatment. After a TiN coating, the parts are then ready for sampling.

FULL AUTOMATION

"The Röders system also measures the mold inserts in the same clamping," says J. Weber. A tactile 3D probe and the RMS Inspect measurement software are used for comparing the high-precision measuring results to the CAD surface data of the workpiece. The machining accuracy can thus be determined on the machine itself with an accuracy of 5 µm across the entire workpiece. Once the milling system had proven its capabilities, a profitability calculation was performed. It showed that the productivity of the plant could not be fully utilized in single-shift operation, while automating the machining process would pay off within a year. Consequentially, a complete automation solution with robot feed and magazines for palletized workpieces, tools and grippers was implemented in 2023. The RMS Main job manager, also developed by Röders, handles the allocation of CAM programs, tools,

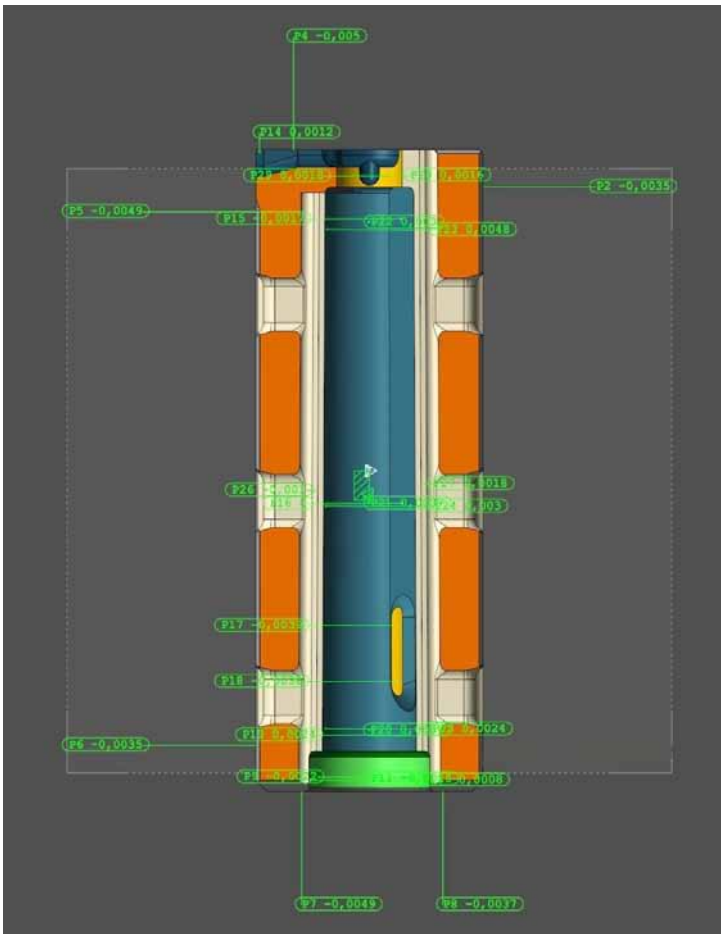
The robot supplies the system with loaded workpiece carriers, standard HSC tools or micro milling cutters (photo: Klaus Vollrath)

workpieces and grippers. During the design phase of this cell, attention was already paid to enable future expansions by mounting the robot on a linear rail in preparation for the future enlargement by additional plants.

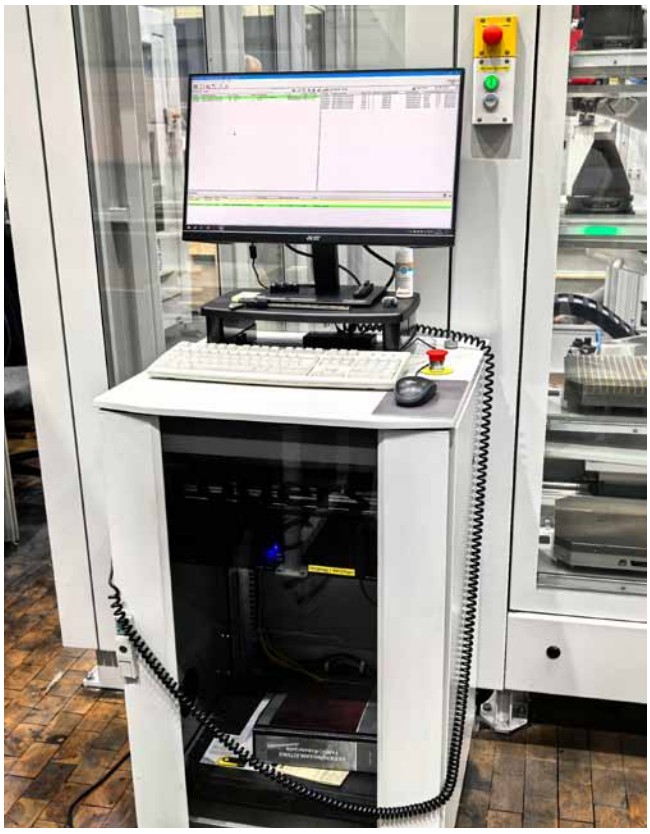
FULLY SATISFIED WITH SYSTEM PERFORMANCE, TRAINING AND SERVICE

"Since then, production on this manufacturing cell has been running 24 hours a day, 365 days a year – except for maintenance and cleaning work," says V. Schellenberg happily. Since then, more than 1,400 mold units have been manufactured. The scrap rate is close to zero. There have been no significant failures to date. Spare parts are delivered just-in-time as needed, and the service representative, who has already been notified, shows up the very next day.

Initially, there were some concerns about workforce acceptance, as the control system was developed by Röders. However, these quickly dissipated, as the first two employees trained by Röders returned very impressed by its simple, intuitive handling. Since then, they have internally trained three to four additional colleagues, so that a sufficient number of operators is now available for rotating shifts. In principle, the job management system can also be operated by anyone familiar with Windows. "Thanks to this Röders development, we now have a fast, cost-saving and reliable process instead of the previous 'job piecemeal' approach," summarizes J. Weber, who is already considering further expansion of the production cell.
Klaus Vollrath, b2dcomm.ch



Measurement report for a workpiece measured "green" against CAD data with a resolution of four digits (graphic: C. Josef Lamy GmbH)



Key prerequisite for operating the RMS Main job manager is "sufficient familiarity with Windows" (photo: Klaus Vollrath)

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