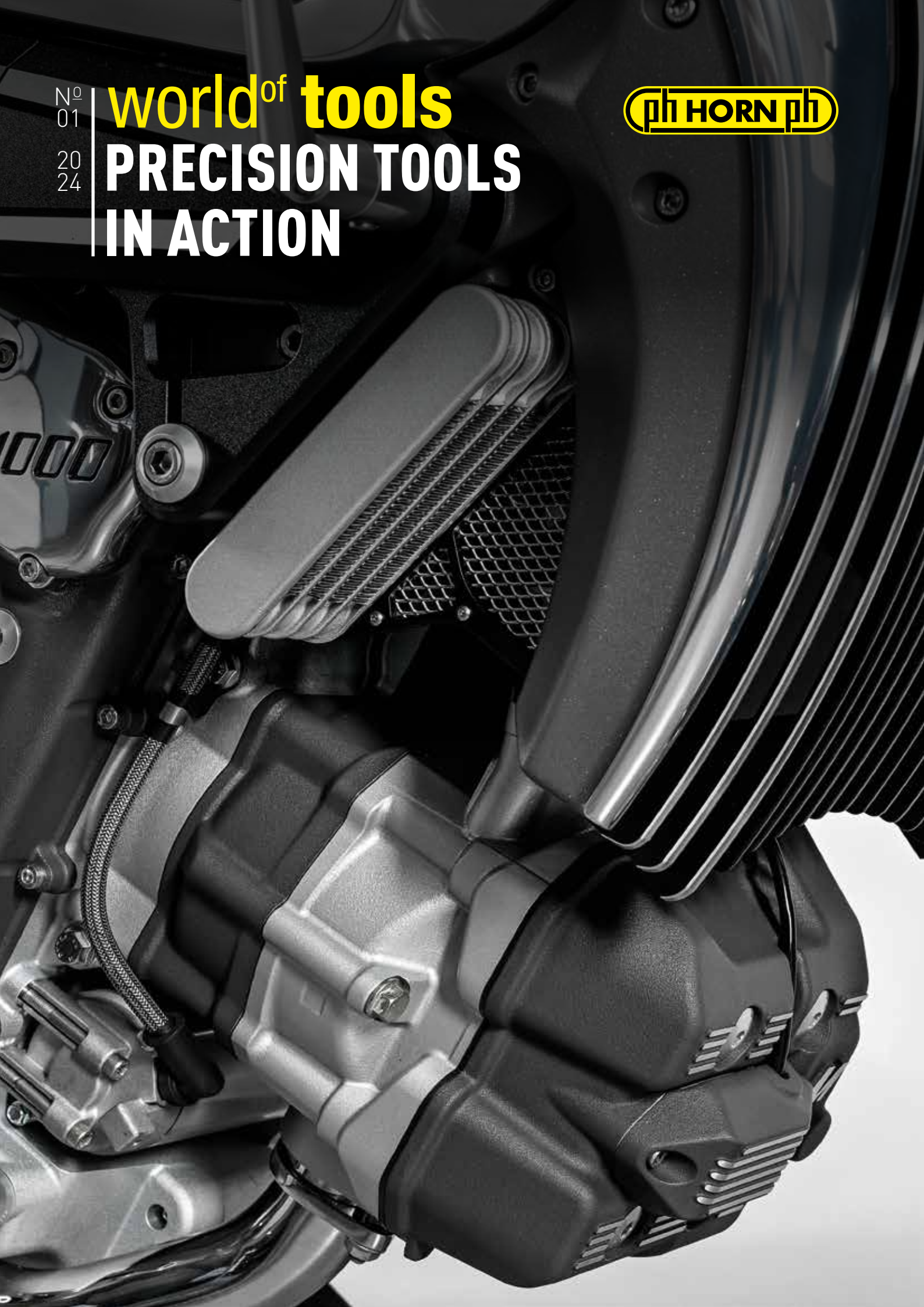


Nº 01 2024

world of tools

PRECISION TOOLS IN ACTION

HORNP

DEAR
LADIES AND GENTLEMEN,

Companies are currently facing a whole host of challenges. We are undergoing a huge process of change in Germany, Europe and around the world. This process is unprecedented in terms of the number of different issues and the speed at which it is taking place. In a global context, it is practically impossible to make predictions today. This makes it all the more important for us to be available to you as a reliable partner.

In addition to reliability, in this issue we offer you a broad insight into various solutions and practical production examples. Our user reports focus on the topics of PCD milling, micromachining, toolmaking and high-polish milling. We take a closer look at groove and cut-off milling. In addition to an overview, we provide a categorisation of which system is used when.

We also provide insights into our internal processes. HORN was honoured with the Allianz Industrie 4.0 Baden-Württemberg Award 2023. The award recognises our digital infrastructure in production as an outstanding Industry 4.0 solution. This puts HORN in a pioneering role in the field of digitalisation.

We are pleased to offer you added value in terms of information with this world of tools.

Markus Horn and Matthias Rommel, Managing Directors, Paul Horn GmbH

world of tools
№ 01 2024

Imprint: world of tools©, HORN's customer magazine, is published twice a year and is sent to customers and interested parties. Publication date: March 2024 Printed in Germany.

Published by: Hartmetall-Werkzeugfabrik Paul Horn GmbH • Horn-Straße 1 • D-72072 Tübingen • Tel.: 07071 7004-0 Fax: 07071 72893 • E-Mail: info@de.horn-group.com • Internet: www.horn-group.com

Circulation: 20,400 in German, 4,500 in English, 3,900 in French

Editors/Texts: Nico Sauermann, Claudia Stelzer, Christian Thiele

Overall production: Werbeagentur Beck GmbH & Co. KG • Alte Steige 17 • D-73732 Esslingen

PRECISION TOOLS

DOWN TO THE SMALLEST DETAIL

PRECISION TOOLS

DOWN TO THE SMALLEST DETAIL

The supplier needs around 1,700 kg (3,747.858 lbs) of sand and one week of working time to produce the 15-part sand mould of the monocoque frame. During casting, 80 kg (176.37 lbs) of aluminium flows into the mould.

"Why don't we actually build motorbikes in France?" That's what Olivier Midy thought when he started the development of his own motorbike 30 years ago. Since the start, around 300,000 hours have gone into the development of his Midual Type 1. The inventor has built numerous technical specialities into the bike, paying attention to perfection down to the smallest detail. With an eye on precisely these details, Paul Horn GmbH supports Midy and his team with precision tools that are used to build this motorbike work of art. "We rely on tools from Germany because we need solutions that can fulfil our high quality requirements," says Midy.

The hallowed halls of the Midual company are located in the western French city of Angers. This is where Midy and his small team build the first-class, high-end motorbikes. Midy already had a passion for working on motorbikes as a teenager. In 1992, the mechanical engineer began developing his own motorbike. He initially financed the project from his own company, which produced parts for the automotive industry as a contract manufacturer. When building his Midual Type 1, Midy wanted to change everything that had gone before and eclipse it with technical perfection. So he began the development of the Type 1 on a blank sheet of paper.

Sand-cast aluminium monocoque frame

One special feature is the position of the two-cylinder boxer engine. For technical reasons, well-known manufacturers only install the engine transversely. Midy, however, has managed to install the boxer engine longitudinally. In order not to lengthen the wheelbase of the motorbike, he tilted the boxer forward by 25 degrees. This tilt also made it possible to install the six-speed gearbox under the rear cylinder and the bearing for the rear swing arm. Another highlight is the frame. While most motorbike manufacturers install a tubular frame with an attached sheet metal tank, the Midual Type 1 comes with an aluminium sand-cast monocoque frame with an integrated 14-litre petrol tank. "Alongside the engine development, the development of the frame took the most time. The casting, subsequent CNC machining and finishing by hand are very time-consuming. It takes around 80 hours to finish the frame," explains Midy. The buyer should have the necessary small change ready for the complete bike. The starting price is around 165,000 euros.

"What we can do ourselves, we do ourselves," says Midy. There are two CNC milling centres in his workshop for machining. In addition to engine components and frames, the milled parts also include the brackets, footrests and other add-on parts. Most of the small parts on the Type 1 are milled from solid material. With the exception of the indicators and plugs, there are virtually no plastic parts on this motorbike. Midy has been relying on tool solutions from Tübingen for numerous milling operations for three years.

MIDY ALREADY HAD A PASSION FOR WORKING ON MOTORBIKES AS A TEENAGER.

After casting, machining takes place on a CNC machining centre.

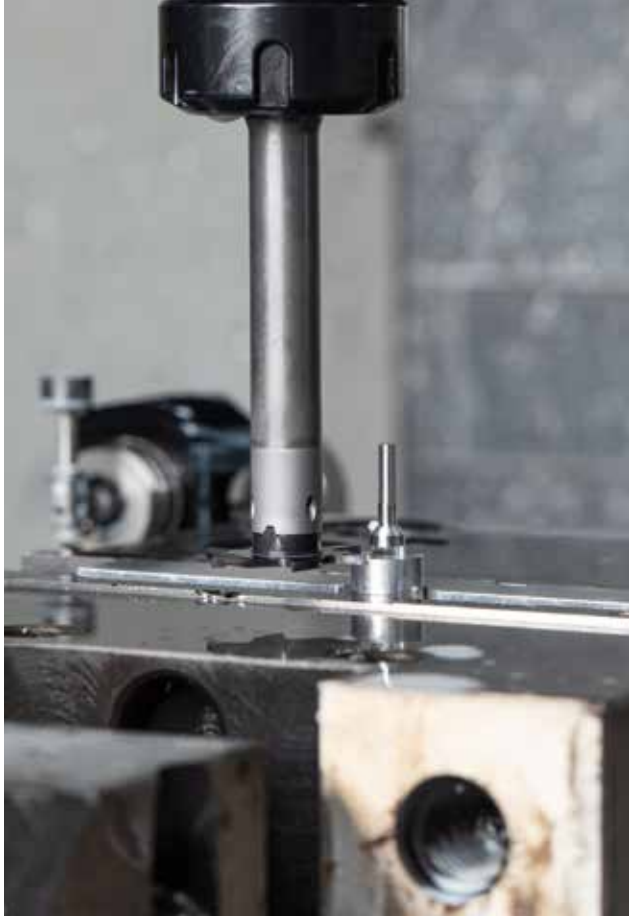
The HORN DTM milling system with PCD inserts ensures high surface quality on the aluminium components.

High surface quality

Midy was looking for an appropriate tool solution for face milling the motor housing. It is made of an aluminium alloy and consists of two halves. The demands on the milled finish are high. The surfaces must lie within a narrow tolerance range after the milling process. Furthermore, the surfaces also serve as sealing surfaces later on. "In addition to flatness, high surface quality is an important criterion," says Midy. Midy came across HORN's tool systems through one of his employees, who had used them already at his previous employer.

After the initial contact with HORN France, the first tests followed shortly afterwards. The HORN engineers used the DTM milling system with a diameter of 80 mm (3.15"). The number of teeth is z = 7. Polycrystalline diamond (PCD) is used as the grade for machining the aluminium alloy. The PCD grade consists of a mixture of different sizes of diamond grains. As the volume percentage of diamond increases, so do the effective hardness, toughness and cutting edge quality. Strict quality standards and their control are a matter of course and ensure high performance. The anti-friction properties of the diamond surface in combination with the internal coolant supply prevent the formation of built-up edges. The tool mills across the workpiece at a cutting speed of v_c = 600 m/min (23.622"/min), an infeed of a_p = 0.1 mm (0.004") and a feed per tooth of f_z = 0.01 mm (0.0004"). An almost mirror finish is

Midy relies on the Supermini tool for broaching splines.



The HORN circular milling system is used for cut-off milling.

achieved on the surface. "Monocrystalline diamond is normally used for milling high-gloss surfaces. However, with the high quality of PCD cutting edges, very good surface finishes can also be achieved. The surface is always a reflection of the cutting edge quality," explains HORN technician Roger Kasper.

THE SURFACE IS ALWAYS A REFLECTION OF THE CUTTING EDGE QUALITY.

Holder system with aluminium body

In addition to the quality of the cutting inserts, the holder system plays a decisive role. The insert seats in the tool holder are equipped with an adjustment system. The axial run-out can therefore be set with µ-precision using a presetter. The adjustment system of the inserts is designed to be user friendly. The aluminium body of the tool holders is lightweight for low energy consumption during acceleration and deceleration. The reduced mass compared to a steel milling cutter body also ensures faster acceleration and deceleration times. This enables highly dynamic milling processes. To prevent wear on the body due to chip impact, it is provided with a hardened protective coating.

"The quality of the milling result has impressed us. The better the production quality, the better the quality of our motorbikes. In addition to the sealing surfaces, we also mill decorative surfaces with the tool," says Midy. He developed the Midual Type 1 engine entirely by himself and also manufactures most of the engine parts himself. The unit has a displacement of 1,036 cm3 and an output of 107 HP at a speed of 7,800 rpm. The maximum torque of 98 Nm is available at 6,000 rpm. When developing the engine, Midy was not looking for maximum performance and brute power. He developed a comfortable and durable drive for the country road. "I ride my Midual almost every day and already have over 200,000 kilometres on the clock," says Midy. The six-speed gearbox was also designed by the Frenchman. He does not yet have the necessary machines in his factory to manufacture the gearbox. He has it manufactured by a supplier in Spain.

Small details

No matter where one looks: Every single component of the Type 1 is well thought out, of high quality and, where possible, milled from solid material. Midy even manufactures the screws for holding the leather parts himself. As he does not yet have a CNC lathe, the screws are milled and engraved with the Midual logo. For cut-off milling, he uses the circular milling system from HORN. In addition to groove and circular milling, the system also exhibits high performance during cut-off milling. Like every part of a Type 1, the screw heads receive appropriate post-treatment by hand polishing after milling.

Midy relies on HORN's Supermini N105 tool system for broaching splines. The splines are required, for example, on the foot lever for shifting gears. The precision-ground tool cutting edge matches the profile of the teeth. During the shaping process, the infeed of the individual strokes is 0.1 mm (0.004"). Once a tooth has been completed, the spindle continues to rotate to move on to the next tooth.

Looking to the future

Midy has already built around 40 of his Midual Type 1s. The motorbike virtuoso is already developing his Type 2, for which he also needs the support of his partners. "We are really looking forward to the next projects. We are happy to have strong partners like HORN at our side supporting us with their solutions and expertise," summarises Midy.

The motorbike virtuoso: Olivier Midy's passion has been channelled into the development of the "perfect motorbike" for 30 years.

Great care is taken during final assembly of a Midual Type 1.

A successful collaboration: the Midual team with the experts from HORN.

PRECISION TOOLS

MICRO SCREWS FOR THE WATCH INDUSTRY

Dominik Läng in conversation with Mattia Knecht.

To ensure that the famous "Swiss movement" of a watch runs smoothly, in addition to numerous precision components and gears, the precision mechanical masterpiece must ultimately be held together by screws. Their production requires a great deal of know-how, so it is no wonder that well-known Swiss watch manufacturers rely on micro-precision screws from their own country. One manufacturer of such screws is Aeschlimann AG Décolletages from Lüsslingen in the canton of Solothurn. For micromachining, the specialists led by trained micromechanic Mattia Knecht rely on the µ-Finish system from Paul Horn GmbH. Knecht receives technical advice on tooling issues from Dominik Läng, an engineer at Dihawag, HORN's sales agent in Switzerland.

For Swiss-type turning of watch screws, Aeschlimann relies on HORN's µ-Finish tools and Tornos Swiss Nano machines.

From micro watch components to parts for the medical industry to excavator hydraulic components, Aeschlimann AG Décolletages is considered a specialist in the manufacture of precise, rotationally symmetrical workpieces. Founded as a screwmaker's workshop in 1937, the company has evolved into a manufacturer of complex CNC components and offers its customers special finishing processes such as honing, cylindrical and centreless grinding, and options for super-finishing. With 165 employees, the Swiss company primarily produces turned parts up to a diameter of 120 mm. However, Aeschlimann also demonstrates expertise in milling parts up to 300 mm long. Its customers include companies from the watchmaking, automotive, hydraulics, machinery and electronics industries. In addition, Aeschlimann supplies precision Swiss components to the medical, metrology and bicycle industries.

Delicate components

Depending on its quality, a Swiss movement consists of many individual components, for example the gear train, the winding mechanism, the drive, the balance and the hand movement. In a complicated, high-quality watch, many components are assembled into a movement within a very small space. Screws are used to assemble the individual components. To produce these screws, an average machinist would probably find it very difficult.With the naked eye, the workpieces can hardly be distinguished from a piece of fine swarf. "Handling and measuring the screws is a considerable challenge that requires a lot of practice. The dimensions are not checked with a micrometer, but under a microscope with 50-fold magnification," Knecht explains. The dexterity required to handle the screws is also evident when checking the threads with a thread ring gauge. "You need a lot of experience to turn screws with diameters far below one millimetre into a thread gauge by hand," says Knecht.

Aeschlimann relies on the HORN µ-Finish tool system and Tornos Swiss Nano machines for sliding-head turning of watch screws. Micromachinists are the main target market for this range of tools, which is based on the S274 system. The inserts are ground with great care. Each tool undergoes a 100 percent inspection during production to ensure high cutting edge quality. The insert seat of the tool carrier, in conjunction with the central clamping screw and the precision-ground periphery of the indexable insert, enables a changeover accuracy within microns. This allows the insert to be rotated in the machine without having to remeasure the centre height and other dimensions. "HORN offers high-end tools for many applications. From watch screws to medical industry components and hydraulic parts, there are solutions. We use HORN tools on a range of our machines," says Knecht. In addition to numerous standard profiles, inserts with special shapes are also available to meet customer requirements.

DEPENDING ON ITS QUALITY, A SWISS MOVEMENT CONSISTS OF MANY INDIVIDUAL COMPONENTS.

Feed rates in the µ range

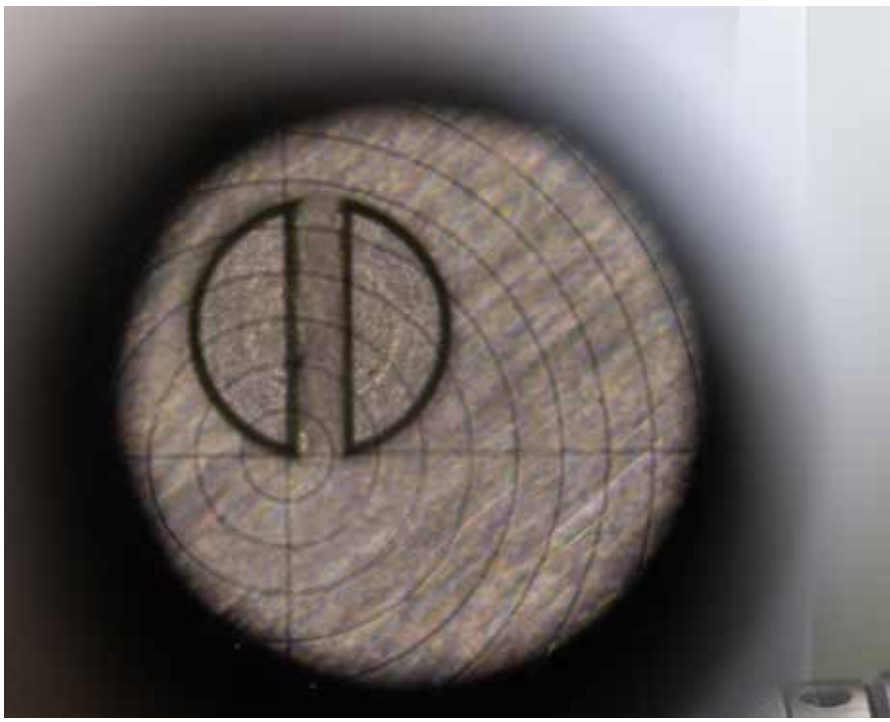
"The quality of the cutting edge plays an important role in micromachining. You can only run feeds in the micrometre range if the insert is similarly sharp," says Dominik Läng. Three different tools are used

for turning a screw. First, the face of the screw head is axially turned. "We turn the head first because we cannot pick up and clamp the screw on the fine thread," says Knecht. The smallest screw variant produced at Aeschlimann has a thread diameter of 0.2 mm. After machining the flat surface, the screw head is slotted. Then the thread diameter is turned by reversing the direction of spindle rotation, after which the thread is milled up to the screw head without an undercut. Tapping of the screw is again done by a HORN tool from the µ-Finish programme.

THE QUALITY OF THE CUTTING EDGE PLAYS A DECISIVE ROLE IN MICROMACHINING.

The service life of an insert during reverse turning is around 17,000 screws. When parting off, the cutting edge achieves a tool life of 40,000 screws. "With the new HORN coating ES15, we are able to increase productivity even more," says Knecht. The new coating is a HiPIMS layer (high-performance impulse coating magnetron sputtering). HiPIMS produces an even more homogeneous and significantly more durable coating whose hardness and toughness are especially suitable for steel machining and for machining small and very small parts. HORN also uses PVD (physical vapour deposition) technology for its tool coatings. PVD is a process in which the coating material is vapourised by electrons, laser beams or arc discharges. The vapourised material is deposited as a coating on the workpieces, forming a layer. By varying the supply of reactive process

Manipulating a thread ring gauge requires considerable dexterity.



The watch screws are inspected under a microscope using an in-process measuring system.

gases, the coating composition can be influenced. In this way, nitrides or carbides or mixtures of the two layers are formed during the coating process. PVD coatings increase the service life of cutting tools many times over.

Partnership

In Switzerland, the company Dihawag represents the German tool manufacturer, HORN. The partnership between Aeschlimann, HORN and Dihawag has existed for over 20 years. During this time, HORN has been able to successfully solve a number of machining applications with its tools. "The cooperation is paramount. The technical advisors from Dihawag and HORN take care of our machining applications quickly and reliably. There is a real partnership and delivery of the tools is very quick," says Knecht.

Through visual inspection, the experienced micromachinist is able to detect problems during the turning process.

PRODUCTS

GEOMETRY FOR HIGH FEED RATES

Geometry for high feed rates

Full radius ahead – with the new KR cutting edge geometry, HORN presents an indexable insert for high feed rates. The geometry is highly capable for groove, longitudinal and copy turning. The cutting edge demonstrates elevated performance particularly at high loads during trochoidal turning thanks to its stable design. Furthermore, the geometry's good chip control ensures short chips and thus increases process reliability. The KR geometry enables feed rates of over 0.25 mm/rev (0.01"/rev) and infeeds of a_p = 2–3 mm (0.079" – 0.118").

HORN offers the new KR geometry for the S229 indexable insert system. As standard, the user can choose between radii of 2 mm (0.079"), 2.5 mm (0.079) and 3 mm (0.118"). With its high heat resistance of over 1,000 degrees Celsius, carbide grade IG66 ensures maximum performance during the turning process. The carbide grade also contributes to an increase in tool life. Depending on the application and machine interface, the user can choose from a wide selection of tool holders. HORN offers holder systems ranging from simple square shanks to modular cassette systems.

HORN OFFERS HOLDER SYSTEMS RANGING FROM A SIMPLE SQUARE SHAFT TO THE MODULAR CASSETTE SYSTEM.

EXTREMELY HARD GRADE FOR STRONG BRAKES

Extremely hard grade for strong brakes

"With the performance of the grade, we can almost bring a lathe to its knees," says HORN product manager for ultra-hard cutting material, Aribert Schroth. We are talking about cubic boron nitride (CBN), or solid CBN to be precise. The grade has no metallic bonding phase and therefore has the highest hot hardness of all cutting materials. In addition, the abrasion resistance increases compared to CBN substrates. Solid CBN is mainly used for cast iron machining. HORN is launching a new product range for the economical machining of brake discs. This includes solid CBN ISO inserts and solid CBN-tipped full radius and shaped inserts. In addition to the inserts, stable tool carriers round off the product range.

Cutting speeds of well over 1,000 m/min (3,280.84 ft/min), depths of cut of several millimetres and feed rates of up to 0.7 mm/rev (0.028"/rev) are typical when machining brake discs made from cast materials. The tool system used must be able to keep up and, above all, last a long time. The tool life requirements are high due to the price per cutting edge of solid CBN. Depending on the operation and metal removal rate, well over 1,000 brake discs can be machined per insert corner. HORN offers two different tool solutions for machining the heat compensation groove of a brake disc. The tipped S117 profile grooving insert is ideal for large batch production in terms of speed and long tool life. During the process, the groove is produced in just under two seconds in a single operation. For greater flexibility, HORN provides S229 tipped full radius inserts. They offer the option of copy turning the heat compensation groove in around four seconds. Regrinding and re-tipping are possible with both types.

For further machining applications on a brake disc, HORN offers a solid full CBN ISO S insert with eight cutting edges. In conjunction with the tool holder, the tool system is suitable for roughing and finishing. The neutral design of the inserts fully utilises the number of cutting edges. This means that eight cutting edges per ISO insert are available for most turning operations. The tool holder combines important criteria: The frictional connection between the carbide thrust pad and the insert occurs via a defined annular surface. This prevents compressive stresses on the CBN insert. Engagement of the thrust pad in the bore of the insert pulls it into the insert seat of the tool holder with a secondary force. This prevents clamping errors and increases precision.

SOLID CBN IS MAINLY USED FOR MACHINING CAST IRON.

NEW TOOL HOLDER FOR SYSTEM 224

WITH OVER 25,000 STANDARD ITEMS, HORN HAS A LARGE TOOL PORTFOLIO COMPRISING NUMEROUS DIFFERENT TYPES.

New tool holder for System 224

With over 25,000 standard items, HORN has a large tool portfolio comprising numerous different types. This includes the 224 grooving system with various holder systems. To provide the user with a better overview, HORN has combined the features of various holders into one. The new tool holder combines two coolant connections. The connection is made either via a transfer on the contact surface or via a threaded connector on the side. The internal coolant supply is fed directly to the insert via the clamping finger or directly to the flank face via a hole.

HORN offers the tool holder in a compact design as a square shank of dimensions 16 mm (0.63") x 16 mm (0.63"), 20 mm (0.787") x 20 mm (0.787") or 25 mm (0.984") x 25 mm (0.984"). All holder sizes are available from stock for widths of cut of 2.0 mm (0.079"), 2.5 mm (0.098"), 3.0 mm (0.118"), 4.0 mm (0.157"), 5.0 mm (0.197") and 6.0 mm (0.236"). The tool shanks are made of high-strength steel, which ensures high precision of the insert seat and a long service life of the system.

PRODUCTS

FOR DIFFICULT APPLICATIONS

For difficult applications

Hard shell – soft core: HORN has developed the new SG66 grade for turning workpieces having different hardness zones. When machining turned parts with hardened surface layers or with an interrupted cut, users quickly reach the limits of CBN inserts. This is where the new grade comes in. In combination with the fine-grain carbide, the aluminium-titanium-silicon chromium nitride layer delivers high performance when machining hardened steels up to 58 HRC. The maximum allowable temperature is 1,200 degrees Celsius (2,192 degrees Fahrenheit). Due to the high flexural strength of the carbide substrate, interrupted cutting is also possible in hardened materials. In addition to hard machining, the carbide grade is also suitable for reliably processing highly temperature resistant and other difficult-to-machine steel alloys.

The carbide grade SG66 is available for all common HORN insert systems. The in-house coating also enables a short delivery time for special tools. SG66 cannot replace the CBN grade. HORN has, however, filled the gap for particularly difficult groove turning applications. In comparison, the CBN grade achieves twice the cutting speed and more when machining through-hardened materials.

IN-HOUSE COATING ENABLES SHORT DELIVERY TIMES FOR CUSTOMISED TOOLS.

PTO SHAFT MILLING

PTO shaft milling

HORN is expanding its tool portfolio for gear cutting to include types for milling PTO shafts. Manufacturers are increasingly focusing on the complete machining of drive shafts. HORN has standardised its own tool range for this purpose, which demonstrates high milling performance. The double-edged carbide insert S274 is used. The programme includes tools for PTO shaft sizes 1 3/8" and 1 3/4". The portfolio also includes special milling cutters for restricted shaft clearances. The M274 tool holders are equipped with an internal coolant supply for targeted cooling. The carriers have a diameter of 63 mm (2.48") and 10 teeth.

THE PORTFOLIO INCLUDES SPECIAL MILLING CUTTERS FOR RESTRICTED SHAFT CLEARANCES.

Tractor attachments such as a mower or loader wagon do not have their own drive. To operate them, the mechanical drive energy of the tractor must be transferred to the attachment. This is done via the power take-off or PTO shaft. This drive, which can usually be switched on and off, is available at a secondary output of the tractor transmission. The energy can be utilised directly via a PTO shaft. A profiled shaft stub, which protrudes from the gearbox, is connected to the PTO shaft of the attachment by means of splined or involute gears. For operation, the user attaches the PTO shaft to the stub shaft in an axial direction. Rotationally symmetrical locks are used to secure the connection, which can be released easily and without tools.

QUICKLY TO A CUSTOMISED SOLUTION

Quickly to a customised solution
With its tool configurator (HTC – Horn Tool Configurator), HORN offers the possibility of supplying grooving tools in a short lead time. HORN focuses here on the grooving insert system 117. Following an enquiry from the customer, the HTC system offers the option of automatically generating a tool drawing of all insert profiles. This eliminates the lengthy design phase. The system enables quotations to be generated together with the technical drawing within 48 hours. Delivery time for tool holders and inserts is 10 days from the time of order.

THE TOOL SYSTEM IS MAINLY USED FOR GROOVE AND GEAR BROACHING.

Numerous cutting edge shapes and widths are possible for the grooving system. The inserts have a blank width of 8.5 mm (0.335") to 26 mm (1.024"). The tool system is mainly used for groove and gear broaching. Thanks to the Greenline process, HORN offers a delivery time of five working days. The number of pieces is limited to a batch size of 50 and is subject to the customer's approval of the drawing.

PRECISION TOOLS FOR PRECISE TOOLS

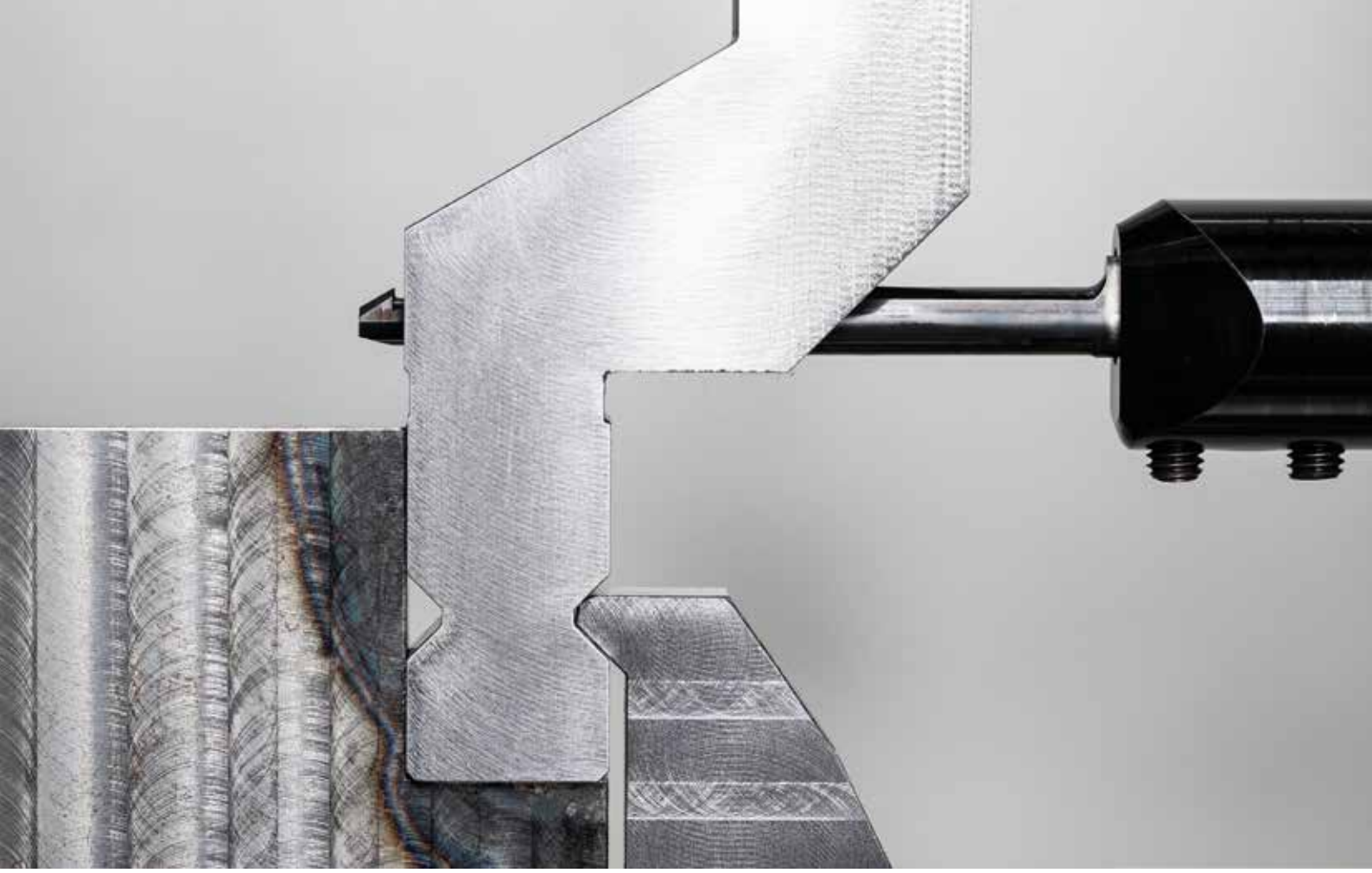
The bending tool specialists at Wila stopped searching for the famous µ a long time ago. They found it and have it reliably under control in series production. The Dutch company is recognised as one of the world market leaders for press brake tooling. The tools, with manufacturing tolerances of less than 0.003 mm (0.0001"), are used wherever high precision is required when bending and folding sheet metal. To achieve this level of accuracy, the company uses cutting tools from Paul Horn GmbH. In addition to numerous standard tools, some customised solutions from HORN are also in use. For example, Wila uses Supermini turning tools for milling.

In addition to high quality standards and fast customer service, Wila's corporate philosophy includes trusting cooperation with reliable partners. "We have always been very brand loyal and prefer to work with longstanding partners. In addition to our machinery, this applies to suppliers of precision tools," explains Frank Rouweler. The managing director is responsible for production as well as research and development at Wila.

Safety-Clicks for easy set-up

The company has been in existence for over 90 years and during this time has become one of the world market leaders in the development and production of high-precision press brake tooling. In addition to its headquarters in Lochem, the Netherlands, the company operates sites in the USA and China. As well as numerous types of press brake tools, Wila offers the appropriate tool holders in the lengths required by the user. The era of digitalisation and smart manufacturing does not stop at productive bending and folding. On request, Wila equips its top tools with a recognition system in which a robot recognises the tooling during automatic tool

The HORN supermini system can be designed for a range of machining operations.



Despite the long overhang, no vibration and chatter marks occur during machining.

change. This makes it possible, for example, to bend small batches of different products in any order. The engineers at Wila have also come up with an efficient system for changing tools manually. Conventional press brake tools have to be inserted one after another into the guide of the tool holder. With the Wila Safety-Clicks system, the user can click the tool elements into the guide rail of the tool carrier from the front. "With this system, we have greatly simplified the set-up of press brakes," says Rouweler.

The Safety-Clicks quick-change system is a locking device that is tensioned and released using a spring. For this purpose, a groove is machined on the press brake tool and a flat counterbore on the opposite side. It was precisely this flat counterbore that presented Wila's employees with a productivity problem during machining of the tools. "To mill the flat counterbore, we had to turn the components for a second operation. As we were clamping several components at once on one tower, this took an enormous amount of time," explains Wila tool planner Erik Klein Beekman.

Difficult task

Klein Beekman approached Joop Nijland, the technical advisor at HORN's Dutch representative Harry Hersbach Tools, with this problem. Wila's task was clear: complete machining including the milling of the flat counterbore on the back in a single clamping. Together with HORN application engineer Roger Kasper, Nijland looked for an appropriate tool solution for a productive milling process. "The task sounded quite simple at first, but due to the long overhangs caused by the component geometry, the machining turned out to be

WITH THIS SYSTEM, WE HAVE GREATLY SIMPLIFIED THE SET-UP OF PRESS BRAKES.

very delicate," recalls Kasper. Nijland adds: "The tool has to be positioned through a 6 mm (0.236") bore with a length of up to 70 mm (2.756") in order to mill the flat counterbore on the back. In addition, the tight tolerance and the required surface finish posed major challenges."

THE TOOL PASSES THROUGH THE HOLE IN RAPID TRAVERSE AND POSITIONS ITSELF AT THE BACK OF THE COMPONENT.

There is only one system for this task in the HORN tool portfolio. Mainly intended for boring small diameters, the Supermini tool system type 110 is also suitable for special milling operations. The tool's solid carbide blank with integrated coolant hole offers optimum conditions for grinding special shapes. "With the first version of the special tool, we presented a functioning solution to those responsible at Wila. However, the vibrations that occurred due to the long overhang led to slight chatter marks on the surface," explains Kasper. The tool designers followed up with a new version of the tool. The insert geometry, tool coating and shape of the tool shank were all improved. "In particular, the optimised and strengthened shape of the shank solved the problem with the vibrations," says Nijland.

Task fulfilled

The milling operation is as follows: The tool passes through the bore in rapid traverse and positions itself at the back of the component. At a speed of 1,200 rpm and a lateral infeed of a_e = 0.5 mm (0.02"), the Supermini mills the flat counterbore with a pulling circular motion in three successive infeeds. The machining cycle is one minute. The tool life is 180 minutes. The dimensions and surface quality are within the tolerances required by Wila. "After further trials, we have now implemented several types and lengths of the HORN tool in our produc-

A successful team for over 30 years: Wila tool setters Erik Klein Beekman, Roger Kasper, Hans van der Zaag and Joop Nijland.

Focusing on solid partnerships: Joop Nijland in conversation with Wila managing director Frank Rouweler and Roger Kasper.

tion. We are very satisfied with the changeover and have saved one operation and other unnecessary machine movements," says Hans van der Zaag.

A high degree of automation is used in Wila's production. On average, there are three machine operators for every twelve production cells. Wila develops its own automation systems for tool production with partners such as Schunk, Fastems and Kardex. The company mainly uses milling centres from Mazak for press brake tool production. "We have had a very good partnership with this machine manufacturer for several years. The machines are precise and user-friendly. We have numerous machine types, but they are all similar in terms of operation. This makes our personnel deployment planning much easier," says Rouweler.

The partnership with HORN and Harry Hersbach has existed for over 30 years. Many HORN tool systems are used at Wila. They include, for example, the circular interpolation milling system and the type 380 cutter heads. In addition to the use of the Supermini tool described above, HORN also solved other tricky tasks by supplying special solutions. "We have been very satisfied with the tools from Tübingen for years and of course with the advice and technical service from HORN and Harry Hersbach," says van der Zaag.

GROOVE AND CUT-OFF MILLING

MASTERING PROCESSES: ALL-ROUNDERS FOR MILLING

Groove milling, parting off and gear cutting: these are just three processes that the circular interpolation milling system from Paul Horn GmbH accomplishes productively. As a true all-rounder, the extensive tool portfolio of this tool system tackles several other milling tasks as well. It can be used from an inside diameter of 8 mm for precise boring, for slot milling of narrow grooves from a width of 0.2 mm or for milling splines. The system has proven to be a problem solver in its numerous standard variants, as well as in special custom shapes for other milling processes.

THE TOOL SYSTEM PROVES ITSELF TO BE A PROBLEM SOLVER.

The circular milling system from HORN offers the user a number of advantages: it is fast, reliable and achieves good surface finish. The tool, which is interpolated on a helical path, plunges into the material either at an angle or almost horizontally. This makes it possible, for example, to machine threads reproducibly to high quality. Compared to machining with indexable inserts for larger diameters or solid carbide cutters for smaller diameters, circular milling is generally more economical. Circular milling cutters have a wide range of applications. They machine steel, special steels, titanium, aluminium and special alloys. The precision tools are particularly suitable for groove milling, circular interpolation of holes, thread milling, T-slot milling, profile milling and gear cutting. However, they are also effective in special applications such as milling sealing grooves or machining connecting rods.

Milling of splines

The production of splines on a drive shaft had the potential for improvement. The shaft, which is 200 mm in diameter, almost 5,000 mm long and weighs around 600 kg, is used in the construction of large engines. The user previously had the teeth machined externally. HORN suggested that the spline teeth be machined using its 635 circular milling system in the same set-up as the turning operation. The special profile of the tool's six teeth matches the nominal profile of the tooth flanks on the workpiece. The overhang of the tool is long due to the cutting conditions but the vibration-damping solid carbide shank means there are no problems with tool vibration. All HORN tools for circular milling have an internal coolant supply. The precise interface between shank and insert allows micron-accuracy

The HORN milling system provides vibration-free cutting even with a long overhang.

A large selection of diameters and different numbers of teeth as well as of cutting widths characterise the circular milling system from HORN.

concentricity and run-out of the insert during changeover. Roughing and finishing are done with the same tool. In addition to the significantly faster production time and the elimination of subcontracting out production, the quality of the splines has also increased.

Slot milling in micromachining

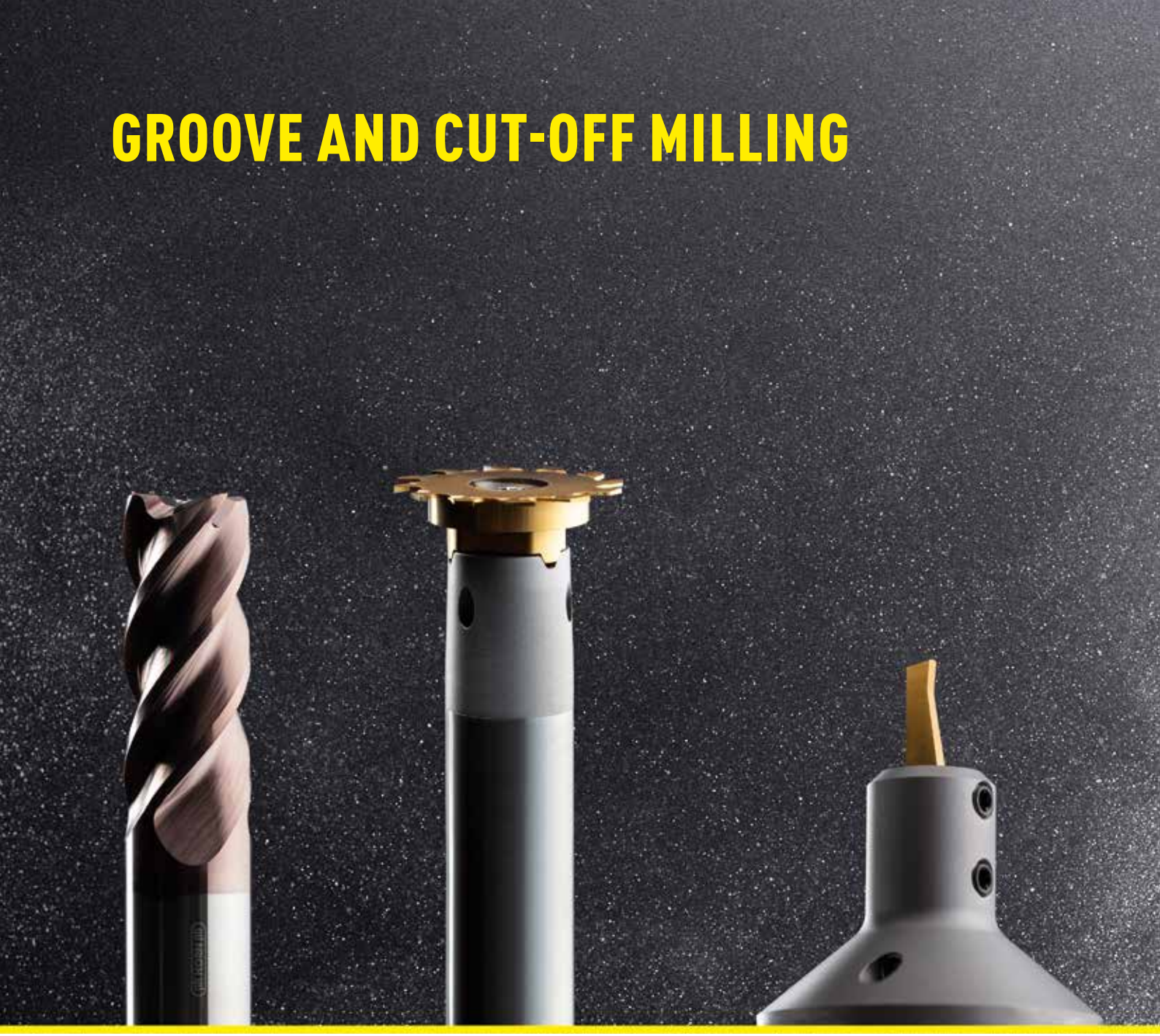
Another application example is the machining of a valve component. The workpiece has a diameter of 1.6 mm and a length of around 3 mm. To enable the valve to be adjusted, a 0.3 mm wide by 0.5 mm deep slot has to be milled on the face of the component. The user previously machined the slot with a fine HSS saw blade. However, the variable stability of the process offered the potential for improvement. HORN solved this problem with its 606 milling system. The six-edged insert with a cutting width of 0.3 mm provided the user a secure milling process.

HORN has expanded the circular milling system to include tools for producing narrow grooves. The enlargement of the tool system offers the user the possibility to produce narrow grooves less expensively. HORN supplies the tools in cutting widths from 0.25 mm to 1 mm as standard, depending on the diameter. The maximum milling depth t_{max} is between 1.3 mm and 14 mm, also depending on the tool diameter. Subject to the material to be machined, the cutting inserts are available with different coatings. The solid carbide tool shank, due to its mass, ensures vibration damping during milling. All variants of the tool are equipped with an internal coolant supply.

These are just two application examples of the many possibilities offered by the HORN circular milling system. The flexibility in the design of the cutting edges, the precise interface between the cutting insert and the shank, the numerous diameter variants as well as the different numbers of teeth that may be milled per insert characterise this tool system.

THE CIRCULAR INTERPOLATION MILLING SYSTEM IS FAST, RELIABLE AND ACHIEVES GOOD SURFACE FINISH.

GROOVE AND CUT-OFF MILLING



SOLID CARBIDE END MILL

- Versatile in use
- The appropriate tool for every material group
- Diameter from 0.1 mm (0.004") to 20 mm (0.787")

CIRCULAR GROOVE MILLING

- For internal and external grooves
- Universally applicable
- High changeover accuracy
- Cutting widths 0.2 mm (0.008") to 10 mm (0.394")
- Groove depths up to 14 mm (0.551")

SPEEDFORMING

- For narrow and deep grooves
- Can be used for profile grooving

GROOVE MILLING

- For deep grooves up to 70 mm (2.756")
- From groove width of 3 mm (0.118")
- For effective chip removal with internal coolant supply

CUT-OFF MILLING

- For cutting different materials
- From cutting width of 1.2 mm (0.047")
- Large cut-off depths

ABOUT US

EXCELLENT INDUSTRY 4.0 STRATEGY

"And the winner is HORN" – The Industry 4.0 Baden-Württemberg Alliance honoured HORN's IT architecture in production as an "outstanding individual Industry 4.0 solution". Paul Horn GmbH in Tübingen is continuously driving forward the further development and digitalisation of its entire value chain. In order to accelerate digitalisation in the production environment, HORN has developed a scalable standard solution for connecting existing and new systems. Thanks to the optimised networking of the systems, HORN customers benefit in many areas including even better delivery performance.

In 2018, HORN launched a project to digitalise and network existing systems (retrofit). The objectives include the introduction of a service-oriented architecture (SOA) in production and the standardisation of data in terms of the asset administration shell. The concept developed is also intended to form the basis for connecting future systems. In the preliminary study of the project, it quickly became clear that the entire IT architecture of production must be considered for sustainable digitalisation. The concept of so-called production capsules describes both the methodical approach for replacing the automation pyramid and a generic Industry 4.0 architecture consisting of infrastructure (hardware, networks, locations), applications, interfaces, technologies and processes.

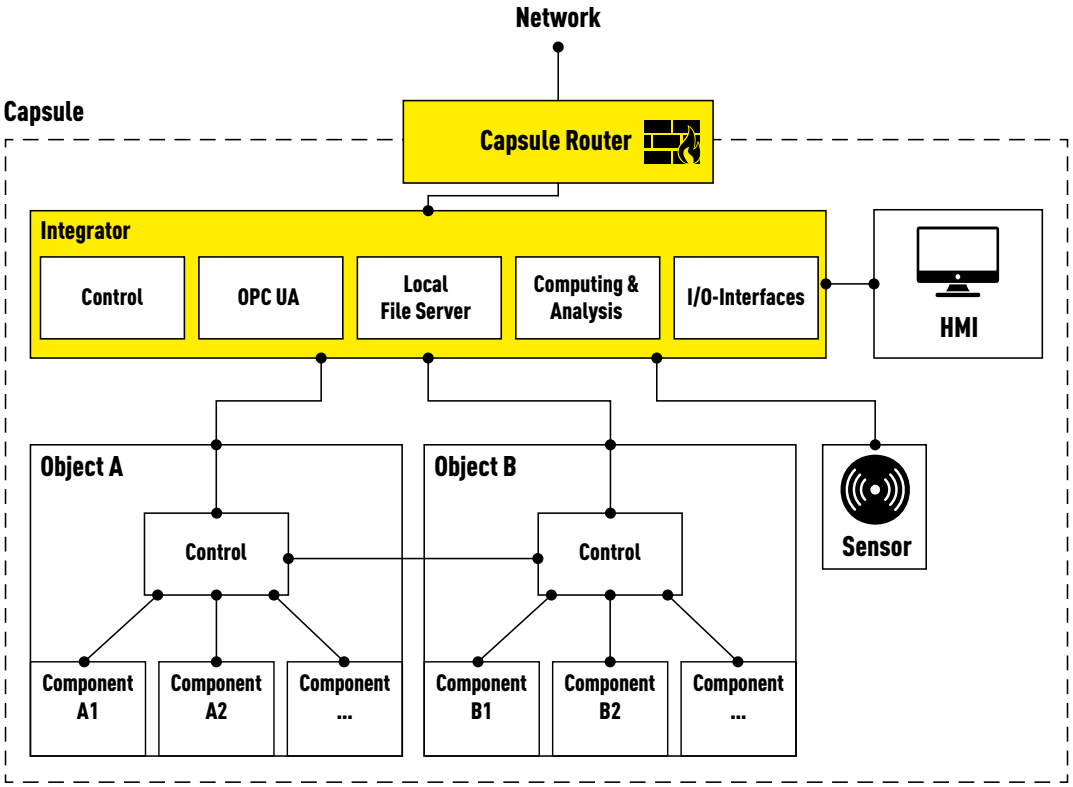
The production capsule is a functional unit of components that is required to fulfil a specific purpose. For example, a production capsule in the field of grinding consists of at least one CNC machine and is supplemented by automation, a computer for edge computing or more if required. The concept deliberately does not limit the scope of a capsule, which means it can be applied generically. This ranges from individual smart sensors to entire production areas.

In addition to logical demarcation, the Industry 4.0 concept also addresses the encapsulation of the resulting data. This primarily involves the targeted concealment of information from unauthorised access and the definition of standard interfaces (black box model). It is not possible for outsiders to communicate with individual components of a capsule. They only see the data and functions that it deliberately provides. Together with a semantic data model,

André Hoettgen, Industry 4.0 architect at HORN, received the award for the outstanding individual Industry 4.0 solution.

this creates the basis for the standardisation and service orientation of production. With the use of OPC UA, an appropriate standard is available to realise the concept while taking IT security into account.

Technically, encapsulation already takes place at network level through the use of physical or virtual routers with local firewalls. The central communication partner of a capsule that can be reached from the outside is



Schematic representation of a production capsule.

called an integrator. The task of an integrator is to support the connection of the components – for example by translating proprietary protocols into OPC UA and by harmonising and aggregating the data. The (M2M) communication of the other components within a capsule remains unaffected. The integrator also provides local services for pre-processing the collected data or for web visualisation.

HORN has already equipped the majority of its machinery with production capsules. The flexibility and scalability of the concept allow a wide variety of systems to be connected quickly. The precision tool manufacturer has around 600 machines and systems in production worldwide. There are also devices from other areas, such as building management systems. The added value is evident in the diverse challenges faced by the various business units. Administration costs are reduced for IT, as remote maintenance is automated and the system operator can activate it using a key switch. IT security is increased by isolating the systems on the network side – a single defective machine has no effect on the rest of production. In-house mechanical engineering and maintenance benefit from manageable warehousing and the long-term availability of the installed and standardised hardware. The recorded data can be automatically recorded and evaluated thanks to the standardisation and semantic description. The power and machine data, such as spindle speed or temperatures, are recorded centrally via the integrator and made available in a standardised manner via OPC UA. The solution enables visualisation based on the data models. This enables, for example, an overview of the status of all machines on a production line. André Hoettgen, Industry 4.0

The excellent Industry 4.0 strategy at HORN is applied, among other things, in the ultra-modern grinding shop.

architect at HORN: "Networking the systems makes it possible to optimise existing processes and rethink future production technologies. Collective intelligence improves delivery performance and paves the way for even more versatile tools."

PRECISION TOOLS

HIGH-POLISH MILLING INSTEAD OF POLISHING

An application from Germering in Bavaria shows that special machines are not required for milling high-polish plastic surfaces. The Enggruber company, in collaboration with Paul Horn GmbH, is crystal clear that this even works with conventional machines. The tools are monocrystalline diamond, which ensure surface quality to within nanometres during ultra-precision machining. "The quality of the tool cutting edge is the decisive factor for the surface finish that can be achieved," says HORN tool specialist and product manager for high-hardness cutting materials, Aribert Schroth.

In Germering, to the west of Munich, in an industrial building that looks inconspicuous from the outside, you would never guess that high-quality acrylic glass displays are produced here for the elite in various industry sectors. In the display industry, Thomas Enggruber is known as the "Red Adair" – the famous firefighter. With his many years of expertise, he puts out fires and solves problems before they become a problem. Enggruber's portfolio includes cosmetics displays, awards and trophies, furniture and other products made of acrylic and Plexiglass. He also manufactures his own products in his workshop. For example, he produces picture frames with a 3D effect and elegant chopping boards made from crystal-clear plastic.

Fire and flame

"We look closely at the processes in our factory and are constantly looking for potential to further optimise them," says Enggruber. One major goal was to process the edges of acrylic glass blocks or panels. "We receive the raw material in the form of sawn pieces. In the production process for large panels, the two sides are already crystal clear and are covered with protective film. However, when the panels are cut to size, the four edges are rough when they are delivered," explains Enggruber. There are various ways of making these rough edges crystal clear. On the one hand, acrylic glass can be flame polished. This involves carefully passing a flame from an acetylene torch over the edges. This creates a clear surface, but it is not perfectly flat. In addition, hairline cracks may also appear on the edges. On the other hand, the edges can be polished by hand using a polishing machine,

The inserts can be easily clamped by a screw, without having to remove the milling cutter.

Monocrystalline diamonds are used for high-polish milling.

also known as a buffing machine. Buffing provides a shiny finish, but requires a lot of time, especially for large quantities.

Another process for machining the edges is milling with monocrystalline diamond (MCD) tipped tools. Enggruber had been using this process for some time, but the surface results were not completely satisfactory for him. He was also bothered by the time-consuming handling and adjustment of the previously used tool systems. "To change the inserts, we had to remove the entire tool and then readjust it again. This was always time consuming," says Enggruber. In order to optimise this effort and the result, Enggruber set out to find a new tool solution.

Supermini in action

A high-polish machining video uploaded by HORN to a well-known online video platform aroused Enggruber's curiosity, who then contacted the HORN sales representative Helmut Hoffmann. Together with Aribert Schroth, Hoffmann analysed Enggruber's problems and developed a new and more user-friendly solution. "With our expertise in interchangeable inserts, the solution was quickly obvious," says Hoffmann. The existing milling cutter body is equipped with Posalux interfaces to accommodate the inserts. HORN technicians therefore designed a Posalux cassette in which the seat for the HORN insert is milled. The insert chosen was a special shape from the HORN Supermini tool system , which can be easily and precisely clamped from the front using a clamping screw in the cassette. This eliminated the need to completely remove the milling cutter body.

The milling tools have multiple cutting edges with up to five teeth and a diameter of 120 mm (4.724"). However, only one MCD insert is fitted per tool. The other inserts serve as pre-cutters and are set back by around 0.1 mm (0.004"). "Only one MCD insert is used to produce the high-polish surface so that it is not damaged by recutting," explains Schroth.

ONE MAJOR GOAL WAS TO PROCESS THE EDGES OF ACRYLIC GLASS BLOCKS OR PANELS.

Enggruber uses two different machines for high-polish milling the edges, which originally came from the woodworking industry. "In our industry, this machine concept of polishing milling machines has been used for a long time," says Enggruber. The machines only have one axis that carries out the milling operation. The acrylic glass blocks or panels are clamped by a foam-padded hold-down device. The other machine concept is similar to a planing machine. Here, the workpiece is clamped between two wide belts and guided over the milling cutter.

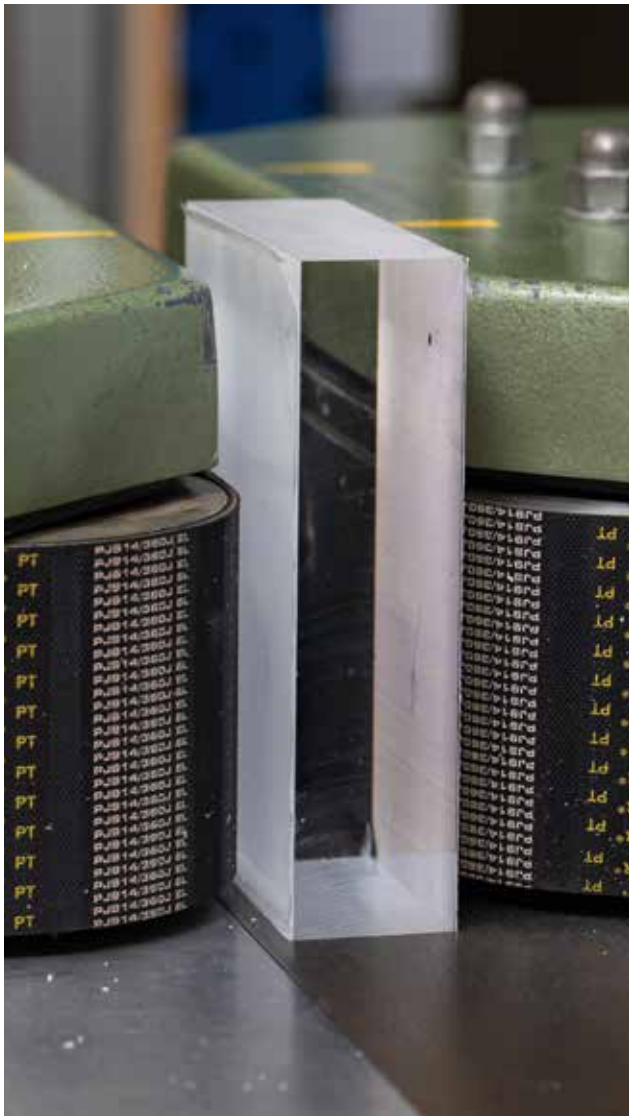
Craftsmanship

The quality of the tool cutting edge plays an important role in producing surfaces with a mirror finish. The quality of the cutting edge is reflected in the surface to be machined. The final grinding or polishing of the MCD inserts is akin to craftsmanship. Similar to the cutting of diamond jewellery, the finishing of a tool cutting edge for high-polish machining is done by hand using grinding pliers. Air-bearing grinding tables with a solid granite top provide optimum conditions for grinding the inserts. A microscope with 200x magnification is used for visual inspection. Under this magnification, the cutting edge must be absolutely free of nicks. The resulting insert has a maximum radius of 0.0002 mm (0.000008").

Synthetic diamonds are mainly used for high-polish machining. Two different processes are used to produce the synthetic stones. In the HPHT process (High Pressure, High Temperature), the diamonds are created under high pressure and heat. In other words in an almost natural way, not over millions of years but within a few hours or days, depending on the desired size. In this process, pure graphite powder is transformed into a diamond at a pressure of 60,000 bar and a temperature of 1,500 degrees Celsius (2,732 degrees Fahrenheit). Diamonds from this process are characterised by a light yellowish colour, which is caused by the refraction of light from embedded nitrogen atoms. The maximum edge length of synthetic stones is 10 mm (0.394"). Dimensions beyond this are theoretically possible, but would not be economical.

THE QUALITY OF THE CUTTING EDGE IS REFLECTED IN THE SURFACE TO BE MACHINED.

A successful collaboration: Thomas Enggruber in conversation with Helmut Hoffmann and Aribert Schroth.



Time-consuming buffing by hand can be saved by high-polish milling.

HORN relies on the even purer MCC diamonds for equipping MCD tools. These monocrystalline stones are created using the CVD process. Various gases, mainly methane, are used as a source of carbon, which is deposited during the process to allow the diamond to grow. The diamonds are characterised by their crystal clear to light brownish colour, depending on their thickness. A major advantage of this process is the edge length of the stones that is possible. This means even long tools with cutting edge lengths of 30 mm (1.181"), for example, can be realised. Previously, natural diamonds had to be used for such tools, which are impractical due to their high price, scarcity and natural inclusions.

Satisfied customer

Schroth and Hoffmann achieved Enggruber's task with the tools provided. "We are very satisfied with the solution to our problem. HORN's advice, service and technical expertise impressed us," says Enggruber.

Grinding and polishing of MCD inserts is akin to craftsmanship.


HORN
MASTERING PROCESSES
DOWN TO THE SMALLEST DETAIL
EXPLORE HORN
Top quality comes from pairing the optimal machining process
with the perfect tool. HORN combines cutting-edge technology
with outstanding performance and reliability.
horn-group.com