Issue 2/15

world of tools

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THE CUSTOMER MAGAZINE FROM HORN

TOPICS:

- Special feature on gear teeth
- All aboard the Greenline tool express
- New administrative building
- Turning

EDITORIAL

Dear Readers,

This issue of world of tools is focusing on gear teeth, a subject we can find meaning in from lots of angles. Most people's minds will turn to gear mechanisms and wheels when they think of gear teeth – and from a technical perspective that's something which often springs to mind for us too. But there is more to gear teeth than that. They are also a metaphor for the way in which we work with our customers: like gears intermeshing, we complement one another, exchange information, work in tandem to bring machining solutions to life, and drive forward developments. In other words, we keep things moving.

Our Greenline production system is proof of our ability to win over customers not just through the quality we provide, but also through the speed at which we work. This is a system that enables us to deliver special tools within five days of the customer approving design drawings.

This year's HORN Technology Days marked a fantastic event for our customers and us alike. The mixture of technical presentations, background knowledge, practical demonstrations, partner companies and the opportunity to talk to visitors one to one made them a complete success for the fifth time in a row. We also have more ahead of us, as we are set to present new products and enhancements to our range at world-leading trade fair EMO 2015.

I hope you find this issue an informative and entertaining read.

Lothar Horn
Managing Director
Hartmetall-Werkzeugfabrik Paul Horn GmbH
Tübingen

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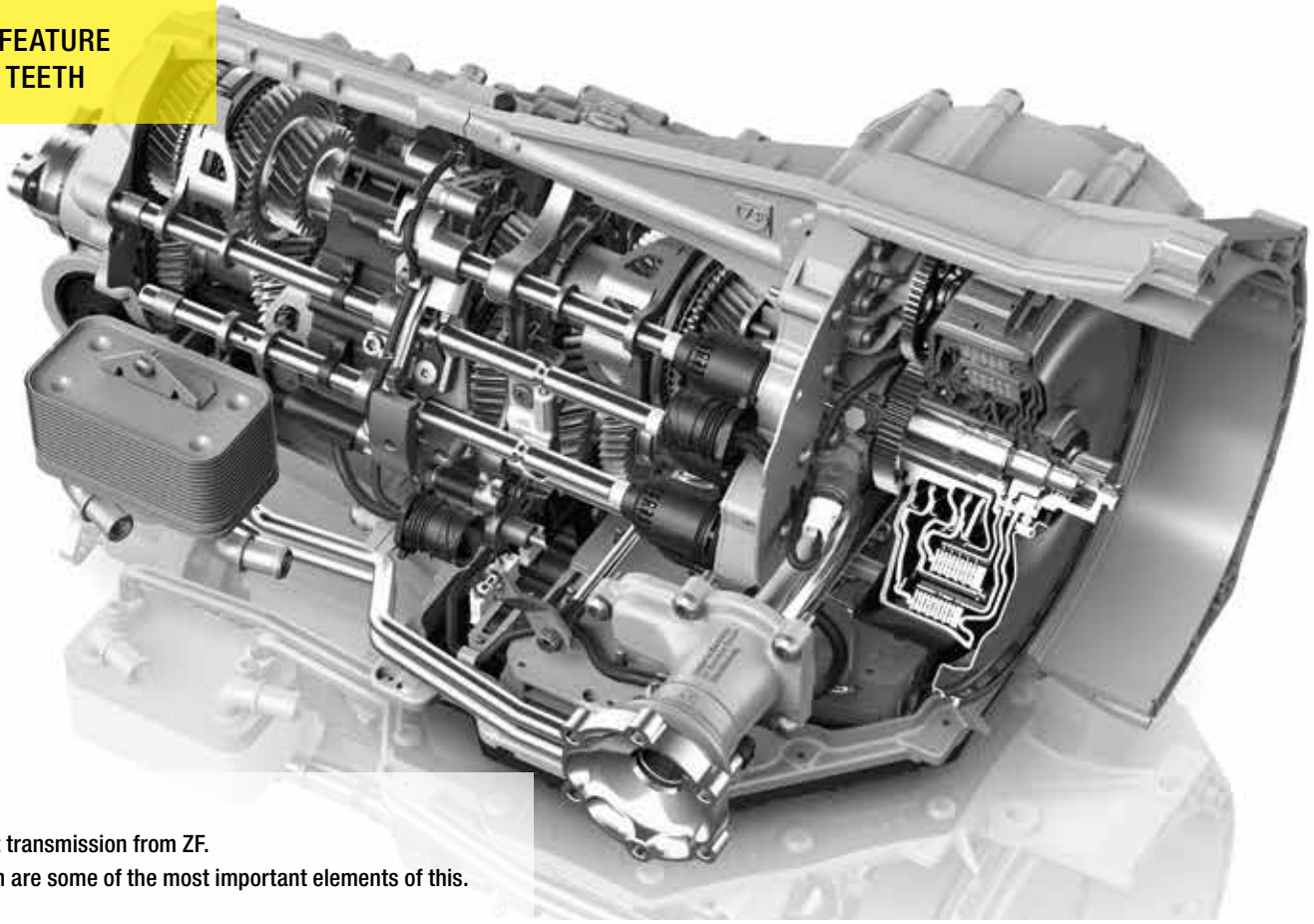


The 7DT sport transmission from ZF.
The gear teeth are some of the most important elements of this.

TEETH MAKE THE WORLD GO ROUND

Manufacturing is the key

Where would modern technology be without gear wheels? Working in tandem, they transfer torque from one shaft to another, change speeds and directions of rotation, and convert linear motion into rotating motion – and vice versa. But that's not all. They also connect rotary axes at different angles to one another and provide a positive-fit, non-slip method of transferring torque. They increase speed and torque several times over in gear mechanisms. And in the precision movements of mechanical wristwatches, bringing together multiple gear wheels engineered with micro-unit precision, they move the hands with the utmost accuracy. By contrast powerful gear mechanisms are able to transfer several thousand kW.

Gear wheels and spline shafts come in versions with internal and external gear teeth. Gear wheels, for their part, are available as cylindrical gears; with spur toothing, helical gearing or double helical gearing; in the form of spur or spiral-toothed bevel gears; or as helical gear wheels, featuring two axes that do not need a point of intersection – much like their close relative, the hypoid gear. However, a gear wheel can also adopt the role of the worm in a worm gear pair: a toothed rack (a gear of infinite diameter) is one particular example of this. Gear wheel mechanisms are classified as rolling-contact or helical varieties according to the alignment of their axes.

The gear teeth most commonly in use are of the involute variety, providing an appropriate means of handling slow-to-fast transmission ratios and vice versa, as well as both clockwise and anticlockwise rotations – not only that, but they also demonstrate reasonably low backlash and are both simple and inexpensive to manufacture. Second in the rankings behind them are cycloid gear teeth, whose advantages lie in the exceptionally low friction they produce during slow-to-fast transmission and the higher transmission ratios they are able to cope with. On the other hand, this variety's design and the production technology it requires are more demanding. While another type known as lantern pinion gear teeth exists alongside these, it no longer figures prominently in the world of technology – the exception

The compact and stable M279 milling system in action.

Always broach in a 12 o'clock position and program a lifting and feeding radius that will not harm the machinery.

being the special chain drive variant found in applications such as bicycles and motorcycle propulsion mechanisms.

The module is the unit that is used to measure the size of teeth in gear wheels, and is defined as the quotient of the gear wheel pitch p (the distance between two adjacent teeth) and the mathematical constant pi. Besides the module, the teeth have fundamental quantities, specified as products, including the addendum and dedendum, the fillet radius, and the tip chamfer. The German standard DIN 780 specifies certain preferred series that provide reference points for selecting standard tools: series I covers modules of 0.05 to 60, while series II ranges from modules of 0.055 to 70. Rather than the module, the American system of measurement uses a dimension known as the diametral pitch.

A multitude of machining methods

Hobbing, profile milling, generation of gears by planing, gear shaping, broaching, hob peeling, profile broaching, five-axis free-form milling, and scraping are all types of machining that involve a geometrically defined cutting edge. Hob and profile grinding, honing, lapping, eroding, and etching, meanwhile, represent methods in which the cutting edge is not defined. Large-batch gear wheel production in mechanical engineering and the automotive industry primarily relies on machine tools that offer special kinematics, as well as elaborate tools such as hobbing cutters – all expensive investments that will usually only pay off if they are being used for production on a large scale. By choosing a standard CNC turning centre or machining centre, plus tools that are appropriate for the application in question, and you will still find equipment that is perfectly capable of machining tooth profiles accurately and in line with strict cost-efficiency requirements.

Milling and broaching up to module 6

HORN now offers integrated tool systems for all module sizes from m 0.5 to m 6 (19.685" to 236.2205"). The HORN gear teeth range offers a solution for everything from milling spur gears, milling shaft/hub connections, broaching internal and external gear teeth, and milling worm shafts to milling custom gear teeth profiles.

HORN's variety of milling systems is designed to accommodate any application, with the right one for the job selected on the basis of the module (DIN 3972, reference profile 1):

Up to module 3: cutting inserts of type 606 to 636 (also available as three cutting edges). The 613 design, intended for modules 1 and 1.5 (DIN 3972, reference profile 1), offers advantages including a diameter of just 21.7 mm (0.8543"), with six teeth that ensure short machining times for machining gear teeth on shafts even where there is limited space available. The carbide grade AS45 opens up a wide range of applications, as well as enabling exceptional tool lives.

Up to module 4: the M274 and M279 milling systems, available in single-row and two-row versions for wide profiles.

Up to module 6: the M121 milling system. This can be used both as a milling tool for gear teeth up to module 6 (reference profile 1 according to DIN 3972) and for shaft/hub connections as well as many other profiles. A main body that is adapted to suit the cutting edge shape in question ensures that the cutting inserts are provided with secure support. The cutting inserts are screwed directly into place, without the need for additional clamping elements. An integrated coolant supply provides an effective means of cooling the cutting inserts with a direct blast of cooling lubricant, and enables longer tool lives. The large dimensions available for the S121 cutting insert accommodate design depths of up to 15.5 mm (0.6102")and design widths of up to 19 mm (0.7480"). In this case too, the AS45 carbide grade is able to handle a wide range of applications involving different materials. Available as an arbor milling cutter, side milling cutter or end mill designs, the tools are equipped with four teeth in the case of 63 mm (2.4803") diameters and six teeth where the diameter measures 80 mm (3.1496").

Supermini tool systems of type 105 and 110, plus types S117 and 315, are designed for the highly efficient processes developed specifically by HORN: gear teeth broaching on standard turning and milling centres, involving internal and external gear teeth with a range of tooth sizes. The preliminary and final broaching stages, which use just one cutting insert, cut down cycle times significantly.

GEAR TOOTHING WITH THE PERFECT MILLING TECHNIQUE

HORN's 713 milling tool pushes the Mori Seiki to its dynamic limits.

The pedal shaft of an electric motor-driven mountain bike, featuring serration and involute gear teeth.

The force measuring shaft of the electric drive. 30 teeth, falling into the module 1 category, are milled with speed and exceptional precision.

Hailing from the German municipality of Berngau, family-run company König Engineering has a long-standing focus on gear mechanism production. In recent years, it has turned its attention to splines for the gears in mountain bikes driven by electric motors. To produce them, it relies exclusively on HORN gear milling cutters – resulting in this success story.

Operating out of its Berngau site near Neumarkt in der Oberpfalz, the 12 employee-strong König Engineering has fitted the classic contract manufacturer profile since its founding in 2007. Keen to avoid being tied down to specific sectors, it has cultivated customer relationships that cover a wide base and, as a result, produces parts for mechanical engineering and plant construction, as well as automotive and electric motor applications. When it comes to the specific type of electric motor technology used in all-terrain e-bikes, König Engineering's focus is on producing toothed drive parts including force measuring shafts and pedal shafts. Its customer in this case is an electric drive supplier for one of Europe's highest-profile bike manufacturers.

The force measuring shaft converts pedal force into electronic pulses in order to regulate the motor gain. Measuring 50 mm (1.9685") in length and 31 mm (1.2205") in diameter, the component is equipped with module 1 involute gear teeth, featuring 30 teeth, on one side: despite the application involving simply splines, the involute variety was selected for its ability to transfer higher torques than straightforward serration. As splines make mounting and removal processes simpler, they are easy to service as well as being completely rotationally symmetrical. Using a special type of tool steel, the shaft is machined entirely from the short bar in a Mori Seiki NLX 2500 Y machine. The toothing process takes place following external machining, but before internal machining for stability and concentricity reasons.

Three steps to optimisation: a 713 insert with three, six and nine cutting edges.

80 percent less time required

König started out by attempting to broach the gear teeth, but its purchase of a machine featuring a Y axis then opened up the possibility of introducing milling. Managing Director Patrick König embarked on a hunt for the right tool to do the job: “Back then, the Tübingen company HORN was the only supplier able to provide special-purpose exchangeable head systems at short notice. That marked the beginning of a long-standing partnership with HORN.” Peter Rümpelein, one of HORN's sales representatives with extensive experience in gear teeth technology, helped König get the process off the ground and optimise it. To start with, a 313 insert with three cutting edges was introduced – but as part quantities rose, the machining process became a time-sensitive operation and began to need a 613 insert with six cutting edges. It was the 713 milling insert with nine cutting edges that brought about the next giant leap in productivity: normally featuring 12 teeth, the grinding conditions and cutting edge diameter of just 21.7 mm (0.8543") allowed for only nine teeth with an involute profile. This step achieved a total time reduction of 80 percent.

Part quantities: From three figures to six

With the number of cutting edges, the cutting data and the travel distances now set to ideal levels, the time that had once been spent on machining was effectively freed up. The run-in, milling process, run-out, retraction, return pass and infeed were all optimised at the dynamic limits of the machinery, taking it to a speed beyond fast. Now, milling is carried out at the same time as the coolant is introduced and demonstrates excellent process reliability thanks to the short M313 milling cutter shank featuring HORN's tried-and-tested screwed-on interface. The gear teeth length of 9 mm (0.3543") plus run-out adds up to approximately 300 mm (11.811") per part – equating to a milling length of 400 m (15,748.0315") assuming a reliable tool life of 1400 parts. A gauge is responsible for checking whether the milling cutter is reaching the end of its tool life. A precision-ground tool, the 713 milling cutter with a grade of TA45 mills the profile to the entire cutting depth in a full cut. The mere 700 shafts produced during the first year were thus catapulted to a six-figure part quantity in the space of 12 months.

Keeping König satisfied

The case-hardened steel pedal shaft is equipped with three sets of gear teeth: one serration at each end and a set of involute gear teeth at the centre. The two end serrations help to hold the pedals and use a special geometry that offsets them by 180 degrees, while the involute gear teeth, with a module of 0.8 and taking the form of a spline, create the link to the electric drive. The process of optimising the two milling cutters required in this case was performed at the same time as the gear teeth were optimised, as explained previously – certainly an easier task from a materials perspective, but by no means a walk in the park given the diameter/length ratio and the less stable shaft clamping method. The longer tool throat depth in this case required the use of a more deflection-resistant, damping carbide shaft. Thoroughly pleased with how successful the optimisation process had been, König went on to establish a long-term partnership with HORN in more of its in-house machining tasks – and HORN tools can now be found at work in König's processes for grooving, parting off, profiling and slot grooving in steel. Its CFRP machining uses PCD-tipped tools, while its internal machining processes primarily rely on Minis and Superminis, especially where titanium and stainless-steel components are involved. Internal and external broaching operations are both carried out using tools from the 117 system.

Peter Rümpelein from HORN, plus Patrick König and his production manager Stefan Zeberl (from left): “We're very satisfied with what we have already achieved and have high hopes for the future.”



CNH Industrial Belgium N.V. in Zedelgem produces combine harvesters for the global market. These machines boast a cutting width of up to 12.5 m (492.126") as well as 652 HP. To date, it has created 210,000 of these machines in total.

BROACHING INTERNAL GEAR TEETH

High-tech agriculture

210.000 is a number that New Holland in Zedelgem, an hour's drive west of Brussels, can be proud of – as this is how many combine harvesters the company has produced since its founding in 1952. None of this would be possible without upholding excellent part flow and component quality standards – and when it comes to machining internal gear teeth, the company knows it can turn to its long-established partnership with Tübingen tool specialist HORN. Special HORN tools designed specifically for broaching internal gear teeth have improved part quality, created more reliable processes and proven more cost-effective than other methods.

Of all the machines used for harvesting crops, combine harvesters are both the most expensive and the most complex. The CR 10.90, New Holland's largest type of combine harvester among the performance classes and cutting widths available, features a 12.5 m (492.126") cutting width, is driven by a 652 HP engine and can fill its 14,500-litre grain tank in just 15 minutes. New Holland is part of CNH Industrial, a group that has roots stretching all the way back to 1895 and is now the world's second-largest agricultural machinery manufacturer. Employing 2700 people, its Zedelgem plant produces not only combine harvesters, but chaff cutters and presses too. Since the company built its first self-propelled combine harvester in 1952, Zedelgem has been home to the production of 210,000 combines. Depending on their size, these complex pieces of machinery can rack up costs of several hundred thousand euros – which then have to be recouped as quickly as possible from grain harvesting. Taking geographical conditions into consideration, the time required for grain threshing ranges between 190 and 250 hours per year as a maximum, with combine harvesters achieving hectare capacities between 300 and 600 hectares depending on the width of their cutting bars.

Concealed beneath a combine harvester's unmistakable silhouette is a large number of different functions working in perfect harmony with one another. Literally at their heart, positioned at the top behind the grain tank, is an engine that drives more than 20 different units plus the running gear using hydraulic motors and V-belt gear mechanisms. When the machinery requires servicing – whether in the field or as part of routine maintenance during the brief overnight period when it is not in operation – it must be possible to remove and reattach the V-belt pulleys quickly, easily and safely: they provide access to units including the threshing cylinder, shaker and fan. Since the V-belt pulley-to-shaft connection designs began featuring external and internal gear teeth, removing a V-belt pulley has been a matter of loosening a single central screw – with no force required. The same principle has also been applied to the drive shaft and the wheel hub for the travel drive. This easy-to-service solution creates a positive, secure connection with exact concentricity and high torque transfer levels.

Standard cutting insert from the S117 system, with three cutting edges for pre-cutting and finish-cutting. A total of 55 strokes, each with an infeed of 0.1 mm (0.0039").

Efficient production a must

Designing and producing a machine that is as complex and as subject to extreme stress as a combine harvester is a real story of opposites. They are machines that have to be robust and, in spite of their weight, still able to tackle all kinds of terrain. Although only in use for a short spell during the year, they have to deliver the utmost reliability and performance. And despite the long list of demands facing them – not to mention low grain prices driven by market conditions – they have just a few hundred hours in the year to redeem all the costs associated with the price of the system itself, as well as fuel consumption, servicing and driver expenses. With that in mind, the design and the production technology are expected to yield excellent quality at the right price, even if global competition is tough. And that goes for every single component.

A different kind of broaching

Peter Lannoye, a tool engineer responsible for cutting at New Holland, uses two examples to explain the balancing act of achieving both production efficiency and high quality: a drive shaft and a V-belt pulley. After attending HORN's Technology Days, he returned to his company with some bright new ideas for making the drive shaft production process much simpler – and much better. Previously, shafts that had been pre-turned were given internal gear teeth in a type of broaching machine, before going on to be hardened and hard-turned. The clamping in the second machine created both hard-turning and concentricity issues. Together with Kees van Bers, HORN's tool engineer with responsibility for Belgium, Peter Lannoye explained how the drive shafts could be produced in a different way, and set about revamping the process. Now, the pre-machining cutting work is followed by a different method of broaching the internal gear teeth, which takes place on the same machine but does not involve reclamping.

The involute internal gear teeth, measuring 60 mm (2.3622") wide and featuring 31 teeth plus a 16/32 diametrical pitch, are subject to narrow tolerances in the case of the pitch (0.04 mm/0.0016") and the flank parallelism (0.013 mm/0.0005"). The data specified for the dedendum circle (51.46 mm/2.026"), the addendum circle (47.69 mm/1.8776") and the reference circle (49.21 mm/1.9374") determined the tool design. What was chosen for the broaching process was a standard cutting insert from the S117 system, featuring three cutting edges for pre-cutting, finish-cutting as well as re-cutting, and ensuring an excellent cutting division. The proven H117 tool holder, with a cutting insert screwed onto the face side, provides the necessary rigidity even at an insertion depth of 65 mm (2.5591"). An infeed of 0.1 mm (0.0039") and 55 infeeds in total resulted in a set of gear teeth being produced in under 12 minutes – and the 8 m/min (314.9606"/min) feed rate achieved in the process exactly matched the fast speed of the Victor Taichung Vturn 46. While the maintenance staff had initially insisted that stress at specific points on the feed screw and bearings was a risk, the process has so far progressed without inflicting damage on the machine and avoiding any further warnings from maintenance engineers.

Broaching the only solution

Buoyed by his positive experiences with the gearshaft, Peter Lannoye prepared to introduce the broaching technique for internal gear teeth to a large belt pulley. This kind of broaching was the only solution available for the component, as the method that had been used before had caused the internal diameter to diminish too significantly. The task was to broach an internal set of gear teeth of 30 mm (1.1811") in length with a 125 mm (4.9213") retracted length – and Kees van Bers, together with the HORN team in Tübingen, had just three months to get the solution in place. Peter Lannoye had already made the arrangements for switching the production process and machine configuration over to HORN tools, so there was no going back now and the deadline for the switchover was set. The team knew that the tools had to work right from the first broach or the goal of producing more than 10 combine harvesters a day would be thrown into jeopardy.

Chosen for the job were an H117 tool holder with a throat depth of 125 mm (4.9213"), plus a special S117 cutting insert featuring two teeth for pre-cutting and finish-cutting. And thanks to HORN and New Holland working like a well-oiled machine, the tool was even delivered before the deadline. Now, gear teeth are broached in just seven minutes at a feed rate of 8 m/min (314.9606"/min).

Peter Lannoye (li.) and Kees van Bers have worked as partners on finding sophisticated production solutions for some 11 years now. Together, they have successfully deployed more than 50 different HORN tools.

On their trip to Milan, HORN and Febametal will be showcasing product innovations and tool solutions in Hall 10, Stand B10.

EMO MILANO

The high point of 2015's trade fair calendar

This year's EMO – the world's foremost trade fair for the metalworking industry – is heading for Milan, Italy, and adopting the motto "Costruiamo il futuro" ("Building the future"). More than 1300 companies will showcase the very latest developments in the field between 5th and 10th October.

The trade fair focuses on machine tools for cutting and reshaping, as well as production systems, precision tools, automated material flows, computer technology, industrial electronics, and accessories. It draws specialists from every key sector of industry, including mechanical engineering and plant construction, the automotive industry and its suppliers, aerospace technology, precision engineering and optics, medical technology, tool-making and mould-making, plus steel and lightweight construction – and the organisers are expecting 150,000 visitors to come through its doors this year.

Tapping into the potential for synergies

EMO MILANO 2015 is overlapping with the latter part of EXPO 2015, the aim being to provide an opportunity for visitors from every part of the world to congregate in Milan. This will help place it among the top flight of cities that are seen as cultivating an active, lively presence on the international stage. As a result, Milan hopes to continue reigning as the business capital of Italy – a country with a strong industrial tradition – for many years to come.

HORN and Febametal

HORN's Italian representative Febametal will be there to showcase the company's latest product developments and solutions. Febametal's collaboration with HORN dates back to the very year in which it was founded, 1995. Paul Horn GmbH Managing Director Lothar Horn puts it in a nutshell: "This long-standing partnership in the spirit of mutual trust is underpinned by technical expertise, communication with customers, our presence on the market and our striving to create innovations and move forward." He adds: "At EMO in Milan, Febametal and HORN will make clear the positive effect that technology can have on costs per part produced."

To find out more about some of the new products and product enhancements, read pages 14 to 17.

Hall 10, Stand B10

5TH AMB CHINA, 19TH–22ND OCTOBER 2015, NANJING

AMB China in Nanjing is providing trade fair organiser Messe Stuttgart with the perfect platform for illustrating the position of metalworking in the Southeast China market. Jiangsu, located one and a half hours by train from Shanghai, represents the front-runner in business performance among China's 22 provinces. The Yangtze River Delta's industrial structure resembles that of Baden-Württemberg – the state where Stuttgart is located – in many respects, and this is one of the main reasons behind the activities of Messe Stuttgart and its Chinese subsidiary in Nanjing. When this autumn's event opens its doors between 19th and 22nd October for the fifth time, manufacturers will be there to present their innovations from the worlds of machining, reshaping, precision tools, quality assurance and automation technology.

This year will mark HORN's fourth outing at AMB China. On 1st January 2013, the company founded a Shanghai subsidiary that has a focus on sales. The organisational concept of the office and the sales activities – with a wide range of standard tools kept in stock – is geared towards Chinese business models. Special tools are sent by HORN in Germany all the way to China – a country that remains one of the fastest-growing national economies even despite its slight tapering to a steadier growth level in recent years.

Hall 1, Stand D1

NORTEC 2016, 26TH–29TH JANUARY 2016, HAMBURG

From 26th to 29th January 2016, Nortec 2016 in Hamburg will be providing a network for northern German production industry players to explore where technology is going, find ways to combine production steps, and bring together expertise and decision-makers in a single venue. Taking place every two years, Nortec is Germany's premier trade fair for industrial production technology and metalworking. It welcomes representatives from every single stage of the industrial production process chain – from prototype creation to tested final products – and provides an ideal sales platform for dealers, manufacturers and service providers working in production technology, specifically those based in northern Germany. Never the same kind of event twice, Nortec opened its doors to no fewer than 12,000 visitors in 2014. “It is precisely the regional nature of this trade fair that makes it so special, and the key industries within the region, i.e. aerospace, medical technology, shipyards and gear manufacturing, really come to the fore,” says Lothar Horn, Managing Director of Paul Horn GmbH. HORN will be presenting machining solutions, product enhancements and new products.

Hall A4, Stand 426

DS micro endmill system

There is a significant number of new additions to the DS micro endmill system for machining unhardened steels.

The new micro endmills are aimed at a whole range of target groups working in everything from tool-making and mould-making to mechanical engineering and the jewellery industry. With the expanded range, HORN is responding to the growing customer demand for micro endmills. The updated series of endmills features an optimised geometry plus an extra-fine finish. The TS3K coating has been tailored to the relevant carbide grade. Ball-nose endmills are available with a diameter of diameter diameter 0.2 mm to diameter 3 mm (0.0079" to 0.1181"); endmills with a sharp corner are available from diameter 0.1 mm to diameter 3 mm (0.0039" to 0.1181"); and torus endmills are available from diameter 0.5 mm to diameter 3 mm (0.0197" to 0.1181").

The latest additions are four-fluted micro endmills with sharp corners or with corner radii, and are the perfect choice for finishing and profile milling. These are available with a sharp corner of diameter 0.2 mm up to diameter 3 mm (0.0079" to 0.1181"), whilst torus endmills are available from diameter 0.5 mm to diameter 3 mm (0.0197" to 0.1181"). All tools are available with a machining depth of three, five or seven times the nominal diameter.

Diverse range: HORN micro endmills.

Expanded 406 tangential milling system

Side milling cutters and screw-in milling cutters are new additions to the 406 system.

The patented 406 tangential milling system has been expanded twice over, now offering side milling cutters and screw-in milling cutters.

Available with diameters of 100 mm (3.9370") and 125 mm (4.9213") as well as cutting widths of 10 mm (0.3937") or 12 mm (0.4724"), the side milling cutters achieve slot depths of 26 mm (1.0236") or 34.5 mm (1.3583"). The bore and driver slot are compliant with DIN 138. Featuring cutting edge diameters of 16, 20, 25, 32 and 40 mm (0.6299"; 0.7874"; 0.9843"; 1.2598" and 1.5748") the screw-in milling cutters are equipped with a metric thread that has cylindrical level support, plus internal cooling. Like the previous version, which included a DIN 1835-B holder, these milling cutters come with two to six AS4B-grade rhombic indexable inserts of type 406, which are precision-ground and achieve a high level of precision with very good surface quality. Positive cutting and axial angles enable a soft cut. The secondary cutting edge with integrated trailing chamfer produces outstanding surfaces. An additional free-formed surface chamfer provides a stable wedge angle and a smooth milling process.

The cutting inserts with a corner radius of 0.4 mm or 0.8 mm (0.0157" or 0.0315") achieve cutting depths of up to 6.3 mm (0.2480") and are suitable for milling exact 90° shoulders. The entire cutting length can be used during this process. The side milling cutter is equipped with identical R406 inserts, but also requires the left version (L406).

Gear milling

Module 0.5 to 3 gear milling cutters, screwed into place on the face side.

HORN is expanding its range of standardised gear milling cutters for DIN 3972 gear teeth that fall into the reference profile 1 category, now offering products that cover modules 0.5 to 4 entirely.

Between modules 0.5 and 3, HORN provides AS45-grade carbide circular milling cutters from the 613 to 636 ranges, screwed into place on the face side and available with a variety of diameters. Six teeth around the circumference ensure outstanding productivity, even when faced with high-strength materials.

Between modules 3.25 and 4, HORN offers single-row and two-row cutter heads with standardised two-edged S279 indexable inserts. The axial screw connection for the indexable inserts enables high numbers of teeth and a narrow pitch. The indexable inserts are ground with the utmost precision around the circumference and on the face. In cases where fewer teeth are present on the gear wheel, a two-row cutting division is used; this also applies to wider tooth profiles. Thanks to this cutting division, the two-row version of the indexable inserts exerts less cutting pressure on the tool, the workpiece and the machine – resulting in a better-quality product.

Slimmest indexable insert slotting cutters available on the market

Designed specifically for groove and slot cutting, the M101 milling cutter range has now been extended to include cutting widths of 1.2 mm and 1.4 mm (0.0472" and 0.0551").

These new additions are available with diameters of 63 mm (2.4803") and 80 mm (3.1496"), for slot depths of 19.5 mm or 20 mm (0.7677" or 0.7874"). The milling cutters with a 63 mm (2.4803") diameter feature a cylindrical shank with a 25 mm (0.9843") diameter and a DIN 1835-B Weldon holder. They are also designed for internal cooling. The milling cutters measuring 80 mm (3.1496") in diameter are available as arbor milling cutters or as a version with milling arbor rings. Like their predecessors with cutting widths of 1.6 to 4 mm (0.0630" to 0.1575"), the new slotting cutters are also equipped with carbide indexable inserts. Replacing the cutting inserts is a simple, highly precise process. The precision-milled insert seat ensures a secure connection with a high level of indexability thanks to a stop in the main body. The new milling cutters come with 5 cutting inserts in the version with a diameter of 63 mm, and 7 cutting inserts in the 80 mm (3.1496") version. The cutting edges for the milling cutters measuring 1.2 and 1.4 mm (0.0472" and 0.0551") in width are available with a .3 geometry, which is particularly suitable for standard steels, stainless steels and titanium materials.

New cutting widths for the M101 system.

HORN 968 system

968 modular base carrier system.

Working with Index MS multi-spindle lathes in mind and partnering with Ernst Graf GmbH, HORN has developed the modular 968 base carrier system with interfaces of type 842 (845 in the case of MS52).

It is designed for existing cartridges used with S100 cutting inserts, in both left-hand and right-hand versions to accommodate different parting-off positions. Cartridges for cutting widths of 2/2.5 and 3 mm (0.0787"/0.0984" and 0.1181") therefore fit in both left-hand and right-hand base carriers. Both the cartridges and the base carriers feature internal cooling, with the option of feeding in the coolant via the machine-side interface or from an external location. All the base carriers are height-adjustable, while a stop plate makes it possible to change the workpiece length. The stop plate is secured to prevent it twisting. The base carriers are secured on the machine using a prism and clamping claws. Left-hand Graf cartridges are also available for VC11 and DC07 ISO cutting inserts with an 842/845 interface.

940/842 modular grooving system

This modular grooving system has been developed for smaller machines with shallower groove depths for which 845 cartridges are too large – such as Index machines with W gear teeth for VDI25 or Index machines with dovetail holders.

The 940 modular grooving system for S100 inserts is height-adjustable and provides an integrated coolant supply through its clamping finger and support.

For smaller machines with shallower groove depths: the 940/842 grooving system.

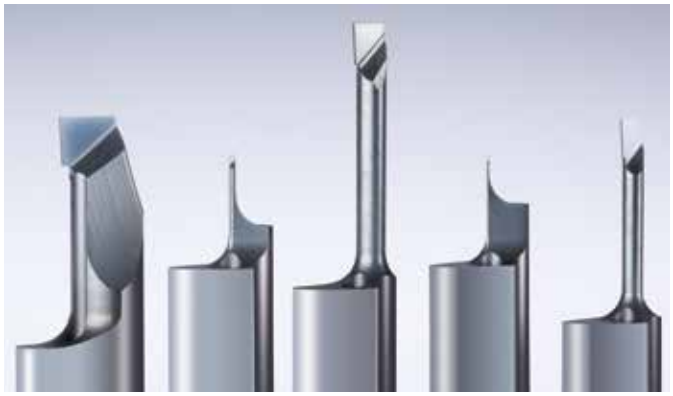
960 system for side turrets

960 parting-off system for VDI side turrets.

Provided for VDI star turrets up to now, the 960 parting-off system has been extended to include a version for VDI side turrets. The system includes basic holders for VDI 30, VDI 40 and VDI 50 side turrets.

The grooving tool holder, designed for system 845 cartridges for S100 inserts, is height-adjustable and features an integrated coolant supply. Both a normal position and an overhead position can be set, and a left-hand or right-hand version is available, as is a tool holder. There is also the option of connecting an external coolant supply.

Supermini type 105 for extremely small parts



Small tools, big performance.

The Supermini type 105 tool system from HORN successfully gets to grips with demanding tasks involving hole diameters between 0.2 mm and 6 mm (0.0079" and 0.2362"), with well over 1500 cutting insert versions.

Where it shines is its ability to be used in a whole range of applications for boring out, grooving, chamfering, threading, axial grooving, finish-boring, face turning, and broaching down to the very smallest diameters. Now, its existing scope for machining steel, cast iron, non-ferrous metals, exotic materials and hard materials up to 66HRc is being extended to include boring-out and grooving operations for extremely small parts.

A special cutting edge design for low feed rates at low cutting speeds, intended for micro-machining parts on this scale, has been added to the Supermini range, making it possible to create glossy surfaces with internal diameters from 0.2 mm (0.0079"). Versions for boring out can be obtained either without a corner radius or with one measuring 0.03 mm (0.0012"), while cutting edges with a corner radius of 0.05 mm (0.0020") are available for free-turning. Internal grooves from w = 0.5 mm (0.0020") can be achieved. The cutting edges also feature a matching coating with a hard rim zone.

Following in the footsteps of all HORN's Superminis, clamping the tools is a breeze – only one standard tool holder is required for clamping all inserts of a model series. These holders are available with or without internal cooling and with various left and right machine interfaces.

S100 range of cutting inserts expanded

The current range of internally cooled S100 cutting inserts is being expanded to include a new cutting edge of 2.5 mm (0.0984") and an EN geometry for grades AS45 and HP65. Other new additions are the 16 x 16 mm (0.6299" x 0.6299") and 20 x 20 mm (0.7874" x 0.7874") square shank holders for the S100 range with an internal coolant supply, a screw clamp and direct coolant transfer via the VDI holder, plus cartridges with internal cooling and a screw clamp with an 842 interface. A left-hand and right-hand design is available in each case.

As with the existing S100 cutting inserts with internal cooling, the coolant jet acts directly on the cutting zone, ensuring the best possible machining conditions there. The funnel-shaped nozzle creates a coolant jet, which supports chip forming and thus reduces the chance of chip build-up. Furthermore, this type of internal cooling largely prevents the formation of build-up edges and break-outs on the cutting edge. Unlike conventional cooling methods, this system therefore achieves higher cutting parameters, which allow the tool to be used more economically and effectively. Where hard-to-cut materials in particular are concerned, the AS45 carbide grade and the EN geometry shape with chip former also permit good chip flow with long tool lives and reliability, even with long engagement times and at high temperatures. The screw clamp or self-clamping device for the cutting inserts, with a stop, allow the cutting inserts to be replaced easily with a high level of repeat accuracy.

The S100 cutting insert with internal coolant supply.

Day 1 | Drawing approval | Production | Coating | Inspection | Delivery | Day 5

ALL ABOARD THE GREENLINE TOOL EXPRESS

Speeding ahead of the competition

One of the keys to business success is the ability to respond quickly to market changes even in the face of intensifying competition. Keen to establish a stable set of conditions for its priority orders, HORN has now implemented an even faster system of processing orders and created a production environment that is fit for the future, setting a shining example for the industry. A major part of this is the production capacity that the company has significantly expanded – but so too is the Greenline production strategy, which regulates production according to priority.

On average, around 96,000 production orders in 80,000 tool variants – standard tools accounting for half and special tools for the other half – pass through HORN's production area in Tübingen every year. The average part quantities that orders require amount to 90 in the case of cutting inserts and seven in the case of tool carriers. An analysis of the production orders revealed that approximately 40 percent of those orders involving smaller quantities were tying up around 20 percent of the machine capacity – in other words, small orders (particularly special inserts and tool carriers in batches between five and 50) were slowing production down.

A self-regulating production and deadline system

This evidence led HORN to eliminate bottlenecks by adding production capacity in the form of additional, multifunctional machines offering an exceptionally high degree of automation – 97 percent. Multi-machine operation, extensive standardisation of the technology used at all the HORN production sites, and significant developments in employee qualification levels also made it possible to increase the extent to which this capacity was in use.

Over the past four years, HORN has made investments to the tune of around 70 million euros. In addition to buildings, this sum has gone into doubling production capacity. More than 150 new five-axis grinding machines and 15 machining centres, fully automated processes are backed by a new organisational structure for production, flexible working time regulations, and HORN's self-regulating production and deadline system, Greenline.

Modular and automated

Given the current need to produce around nine million cutting inserts annually in batches of 90 on average, investment in state-of-the-art, efficient machinery with a high degree of automation was essential to boosting production capacity. To get the right machinery in place to suit HORN's own grinding technology, basic manufacturer-supplied grinding machines, for use in every department of the grinding shop, were set up and retooled for each specific department product range, and were automated. This step allowed a variety of products to be processed on a single machine. As this concept is based on a standard machine configuration and a homogeneous method of operation, it has made it possible to relocate orders both within grinding departments and from one department to another. This paves the way for ultra-quick responses to customers' deadline requests.

Greenline: Turbocharged lead times

HORN developed the Greenline system as a means of ensuring that the new concept could be applied as effectively as possible to small cutting insert and tool carrier part quantities too. A production and deadline regulation system, its job is to ensure that all production orders for cutting inserts in batches of up to 50 take no more than three days to produce, and that – following other processes such as coating – the products are delivered to the customer within five days of drawing approval. In the case of tool carrier production order sizes of up to five parts, the aim is to complete each order process within ten working days.

Orders started within one shift

Greenline orders must be started within one half of a shift, on the next machine that becomes available. This timeframe of brief intervals helps to maintain an hourly rhythm for entering orders into the system and for the internal provision of raw materials. The sales division decides which orders are to be processed on the basis of the Greenline concept, and sets the deadlines using a software system. During the process of entering order information, order-specific data items such as part quantities, tool type and coating are automatically compared with the Greenline requirement criteria stored in the system. The program then decides whether the order gets the green light for Greenline. Immediately following this decision, the system also defines the route that the orders are to take through the production process, including the schedule they must follow. The work preparation department processes this order data within an hour and then goes on to create the production sequence and the production orders. The CNC program is generated and stored automatically once the parameters have been entered. As the production machinery is networked, the data for the product in question immediately becomes available on all the machines for any subsequent orders.

Green means go

The Greenline order process also stands out visually from others. Some examples are the highlighted screen display that is used when the operating data is being entered and on the machine control system, plus the fact that all order-related papers are green – as are the production storage areas for the blanks and finished parts. From scheduling and resource planning to setting up and programming the machine, and all the way through to part approval, the team members working with the system require excellent technical, organisational and coordination skills. The knowledge that they possess – enhanced through training sessions and qualification processes – puts them in a position to solve any problems on site. And with certain responsibilities delegated to the machinery, employees are fully equipped to ensure products are manufactured on time to a high standard of quality. This production philosophy has met the expectations HORN had of it, making it possible to achieve short lead times and boosting delivery capability to 97 percent. Today, HORN processes around 43 percent of all orders using the Greenline system – making the company a standout within the industry.

Greenline in Fakten:

- Production order printing ≤ 1 hour
- Provision of blanks ≤ 1 hour
- Greenline orders started within one half of a shift, on the next machine that becomes available
- No idle time between the individual work steps
- Internal hourly transport system
- No interruption in production orders that are under way
- No changes to the priority or deadline status
- No bundling of Greenline orders
- Ground parts transported for coating on an hourly basis

- Began working at his father's company in Tübingen in 1991
- Initially involved in domestic sales until 1993
- Took on the additional roles of Technical Manager and Production Manager from 1993 to 1999
- Rose to Managing Director on 1st January, 1995
- Has also been Chairman of the VDMA Association of Precision Tools since September 2009

PRECISION, QUALITY AND SPEED

An interview with HORN's Managing Director

HORN is known as a specialist in machining between two flanks. Has this changed in recent years?

Working between two flanks is the ultimate discipline in machining, and has been a standout feature of our company since we were founded in 1969. That's why it's also one of our core areas of business. What's challenging about it is that the flanks usually have to remain completely unscathed, which means that it's important to pay attention to things like chip breaking and chip guidance, in addition to the machining work itself. Our product range has expanded over time, and this has helped shape the ability we now have to deal with machining tasks that are a technical challenge.

What kind of machining tasks do you consider to be a technical challenge?

Machining between two flanks is one example. Others are processes like high-feed rate milling, tangential milling, brilliant-finish machining and micro-machining. It's not possible to give a concise definition of what makes these tasks challenging – it comes down to lots of factors, including application, precision, materials and repeat accuracy, to name just a few. Today, HORN offers in excess of 20,000 standard tools and has brought more than 120,000 special solutions to life.

What keeps HORN ahead of the competition?

When it comes to products, processes and service, it's all about precision, quality and speed. And our employees are the biggest asset we have.

HORN's range includes precision tools, but also wear parts. What is the link between them?

For over 20 years now, Horn Hartstoffe GmbH has been producing the blanks for HORN cutting inserts using injection moulding and extrusion techniques. When we opened our new building and carried out extension work in 2012, we combined all four carbide shaping processes under one roof – injection moulding, extrusion, axial pressing and dry-bag pressing. We also increased our capacity in the process. Given our years of experience in carbide manufacturing and our in-house infrastructure, providing carbide wear parts was the logical next step.

You are adding more space and new premises to the Tübingen site. What are your plans for the future?

Growth, in a word. Not only do we intend to expand, as you've mentioned, we have also recently increased our field sales

force from 40 to 64 members of staff. Our aim is to ensure that customers receive in-depth support during their quest to find solutions, and to step up our efforts to launch new products on the market.

Given your vision of worldwide growth, are expansions taking place outside Germany too?

In recent years, HORN's international locations have seen expansion on a regular basis. We have also established new branches in places like the Czech Republic and China, and are planning to found HORN Mexico at the start of 2016. We already have a presence in more than 70 countries worldwide through both our own company and our sales agencies, but there's still huge potential for us to go further with this.

What are you expecting from the EMO trade fair in Milan?

EMO in Milan is one of the world's leading trade fairs, so HORN is making sure to be there – we're presenting our company in collaboration with Febametal. We will be showcasing product innovations as well as several enhancements to products. I have huge expectations of the event, but at the same time I have absolutely no doubt that it will meet them.

What was your impression of HORN's Technology Days?

This year's HORN Technology Days were the most successful ever. We attracted around 2750 participants from 35 countries, and it was the presentations, practical demonstrations and discussions involving our technical staff that held the keys to the event's success. We received fantastic feedback – even our demonstration of a production process, from carbide metal powder to a coated precision tool, provided something of a unique opportunity – and we created a great platform for discussion.

What does the future hold for HORN?

I am in no doubt that the world will keep changing and the machining market will keep developing. Technology determines costs – but having the speed to bring that technology to the customer is becoming increasingly important too. The growing concepts of digitisation and networking are providing a helping hand in this respect, although they do also raise issues such as data protection and safeguarding business secrets. I'm looking forward to finding out what's around the corner – whether that's to do with our own development, the challenges our customers set for us, or the progress that the technology of the future will bring.

Lothar Horn, Managing Director of Paul Horn GmbH: “Technology determines costs.”

Some examples from the S274 tool system.

MICRO-TURNING

Tool solutions from HORN

Turning components with diameters starting from 0.2 mm (0.0079"), using cutting depths that often measure 0.01 mm (0.0004"), poses a significant challenge to tools, tool systems and, primarily, cutting edge designs. Tool cutting edges must be highly sharp and free from break-outs, with exceptionally fine surface qualities, in order to ensure precision chip removal even at these very shortest depths of 0.01 mm (0.0004").

Given this need for high-precision and micro-turning to be so accurate, and the fact that the chip formation characteristics are strongly influenced by the workpiece material characteristics, there is only a limited range of workpiece materials that are up to the task of micro-machining. Any finely structured amorphous or polycrystalline material may be used in principle, but general micro-machining processes normally turn to materials that are easy to work with, such as copper alloys, brass, graphite and aluminium. In the watchmaking industry, the materials of choice include steel varieties like 20AP or the stainless-steel grade 4C27A, as well as brass. Some steel materials can be machined up to a hardness of 65 HRC.

One of the biggest challenges presented by high-precision turning is producing exceptionally small shafts with tolerances in the nanometre range. In many cases, the permitted absolute production tolerance drops proportionately as the component size gets smaller – so if the diameter tolerance is 0.04 mm (0.0016") in the case of a workpiece where D = 20 mm (0.7874"), then a tolerance of 0.04 µm (0.00000157") will apply proportionately in the case of a workpiece diameter of D = 0.02 mm (0.0008").

Appropriate machine concepts

Working with the production tolerances associated with components on such a small scale requires special lathe concepts. In the case of micro-turning or high-precision turning, passive force has a significant impact on the geometric quality of the component. While macro-machining allows workpieces with a large length-to-diameter ratio to be held, using the tailstock and lathe centre, small workpiece diameters mean this is not always possible in micro-turning. In series production, using special machine concepts keeps bending to a minimum – one example of this is a long automatic lathe, which uses a guide sleeve to prevent component bending by moving the component as close to the machining point as possible. Where longitudinal turning is

concerned, the feeder movement is executed by the workpiece and the tool is consistently kept at the same distance from the guide sleeve. Long automatic lathes come in two varieties, one of which uses the Swiss principle and the other the Offenbacher principle. The Swiss principle features a fixed guiding device, whereas the Offenbacher principle has a tool slide that moves the guiding device. The rod material is guided through this device. As well as this, the types of machinery employed in micro-machining usually offer significantly less space for tool holders, thus requiring the use of holders designed specifically for them. In this case, tool holders featuring an internal coolant supply ensure that tool cutting edges deliver peak performance and enable exceptional tool lives.

Special tool solutions

Paul Horn GmbH has designed precision tools specifically to cope with the special conditions found in micro-turning applications. The S274 system with the high-precision “µ-Finish” design, for instance, includes inserts for turning, grooving, backboring and parting off, and is designed for machining materials for the watchmaking industry, such as 20AP, stainless steels like 4C27A, and brass. What “µ-Finish” denotes is that the cutting edges show no signs of break-outs under 200x magnification, making them exceptionally precise.

AC25, a stable, ultra-thin grade coated with a nanocomposite, and MG12, a non-coated fine grain grade, have what it takes to meet micro-machining requirements. Practical applications show that tool lives are increased by a factor of up to 15 in comparison with other tools. A consistent centre height of ±0.0025 mm (0.0001") is ensured. This means that no further corrections are required once the tool has been set up for the first time and the customer does not need to prepare the cutting edges.

Screws, shafts and other components with exceptionally small diameters require special machine concepts and tool solutions.

A delicate, precise hand is what watchmakers working in clean-room environments need to ensure the utmost accuracy when placing hundreds of micro-engineered components on the bottom plate of a mechanical precision watch.

THE ART OF GERMAN WATCHMAKING

Precision tools for precision timepieces

Items of jewellery have always been highly desirable – and alongside necklaces, earrings and bracelets, wristwatches occupy a place as some of the most popular pieces to wear today. Mechanical watches in particular require real expertise, but it is the watchmaker's innate feel for this art, as well as precision cutting tools, that are the keys to achieving the micro-level of precision required to create them.

Whether they are hand-wound or self-winding, mechanical wristwatches have experienced an astonishing renaissance over the last 25 years. The advent of quartz and digital watches in the 1970s and 1980s may have triggered a crisis that plunged many well-known traditional watchmakers into bankruptcy, but the industry has since been in recovery – and mechanical watches have captured their market once again. This time around, however, they are more than just a way of telling time. Instead they occupy the higher plane of status symbol, showing that traditional precision engineering holds far more emotional value than the quartz technology that allows watches to be churned out in their billions.

Switzerland prides itself on being a heartland of top-quality precision watchmaking – but it is not alone. Germany's tradition in this art stretches all the way back to the 16th century and to Peter Henlein, considered to be the inventor of the watch. Glashütte in the state of Saxony is home to A. Lange & Söhne, the world-renowned company that has been producing watches at the pinnacle of precision for more than 100 years now.

Fun on a microscopic scale

Today, there is once again a whole host of German precision watchmakers doing their part to ensure that their sector is also one in which “Made in Germany” is recognised as a mark of quality the world over. Family-owned company Damasko GmbH, located in Barbing within the district of Regensburg, is one of the latest to join the ranks of precision watchmakers, but is already well on its way to becoming a household-name brand. Formerly

Christoph Damasko and company head Konrad Damasko, with Martin Weiß from HORN in the centre. The HORN range has the right solution for any challenging production task.

a metalworking firm, Damasko is now a burgeoning manufacturer of mechanical precision watches with chronometer-level accuracy. As Konrad Damasko explains: "During the 1990s, I had a desire to demonstrate to my customers that I could produce their parts with exceptional accuracy – more accurately than anyone else, in fact. I couldn't see any better way to do this than begin producing high-precision watch parts for various watchmakers. And I had fun reproducing this microscopic-scale precision in series. We spent ten years gathering experience through making parts for well-known precision watchmakers, and developed experimental prototypes. In 2004, we began supplying our very own products under our own name."

Silicon: The heart of a watch

"Since 2010, we have been building a self-developed movement that incorporates many special features, unique characteristics and patents, and is a much more enhanced type of movement as a result. Over time we have developed more than 100 of our own patented inventions. Durability, precision and robustness are what matter to us. All our watch parts are fully hardened, overdimensioned and low-wear, and we only use the very highest-quality steel and materials. One feature of our precision chronographs and self-developed movements is a patented silicon central mechanism: this contains an escapement wheel and a hairspring made from a magnetic, temperature-compensated and impact-resistant silicon. The lower weight also makes the products less sensitive to impact, and we provide a patented crown mechanism that is entirely resistant to damage. We supply watches that meet chronometer standards of quality, operating at 28,000 half-vibrations per hour – with five layers controlling their action and an accuracy of ±2-3 seconds per day. Every Damasko watch comes magnetically shielded against 1,000 gauss (0.1 tesla) – but we also have the ability to create movements and casings with a resistance to magnetic fields up to 1.5 tesla (15,000 gauss)." Small on scale but big on details, the factory and its 26 members of staff have built up a portfolio of more than 50 different watch types at a variety of price ranges, targeted at a discerning group of customers. The vast majority of the pieces produced are destined for abroad, specifically Japan, Singapore, China, the United Kingdom and the USA. Damasko watches are triple-sealed and watertight to 100 m (3,937.0079"), with a corrosion-resistant casing that can withstand even sweat at its most aggressive.

Some exotic materials

Konrad Damasko has been au fait with HORN tools since 1980, and from the point at which he took up watch production, the company has been his main supplier of cutting tools – primarily for small parts such as crowns and crown tubes with narrow tolerances and small internal dimensions. The tools are designed for grooving and parting off shafts with diameters of 0.08 to 7 mm (0.0032" to 0.2756"), and for machining casings with diameters of up to 65 mm (2.5591") as well as axles and pinions. HORN tools chase threads of M0.35 to M4x0.5, and are able to machine hardened and tempered stainless steels, tungsten copper alloys (which provide heavy metal for the winding rotor), Hastelloy, Inconel, austenitic anti-magnetic submarine steel, martensitic Cronidur, as well as other materials that are difficult to work with.

The universal Supermini 105 tool

The Supermini 105, 108, 114, 224, 229, 312, R368 and S274 µ-Finish are the HORN tools most often in use – but it is the versatility of the 105 type that pushes it to the top of the factory's favourites. Spanning the entire spectrum of materials, these tools are able to bore out small holes, create internal and external threads, perform grooving both inside and out, back-turn internal grooves for cases such as thread run-outs, and do much more besides. Damasko calls on scores of other tools besides the 1500 standard versions of the 105 available from HORN. Like the other HORN tools it uses, the Superminis are ground specifically to meet the special requirements of the geometries the factory is working with: this allows them to plunge into the very smallest diameters and part off small, thin-walled tubes. The chip breaker and flank on the main cutting edge remain permanently unaffected during the process.

Another of the main tools in use is what Damasko terms “The Jack of All Trades”: the 312 system, for grooving and parting off in cases involving cutting edge widths of 0.5 mm, 0.7 mm and 0.9 mm (0.0197"; 0.0276" and 0.0354") for diameters between 0.6 mm and 7 mm (0.0236" to 0.2756" this range being restricted by the machine power).

Coating: A weighty issue

The material grades that the company uses, such as TI25, TH35, TF45 and TF46, have been chosen specifically in order to deliver the best possible machining results while meeting the wide range of requirements that apply. The sharp, light-cutting, vibration-preventing TI25 cutting edges, which exert a low level of cutting pressure, are suitable for universal use. However they are most at home when boring out small holes, even in cases involving interrupted cutting and delicate machining conditions with internal diameters of up to 0.4 mm (0.0157"). A low-friction material with a low tendency towards built-up edge formation, the TH35 grade really stands out when it comes to machining stainless steels. The TF45 grade, meanwhile, is primarily suited to grooving and parting off, not least because of an exceptionally sharp cutting edge created thanks to its thin coating. The same is also true of the TF46, which is more resistant to heat.

Belief in the tools fosters a 35-year partnership

When asked why HORN tools are such a dominant feature of Damasko's processes, Konrad Damasko says: “I've known HORN as a partner for 35 years now. No other supplier is able to offer me such a wide range of tools that are suitable for the kind of micro-machining work I do, especially when it comes to boring. HORN can't be beaten on either geometry or coatings. I only use tools from its extensive standard range – and I really value the fact that they are available so quickly. If I place an order today, it'll come tomorrow – and I've never found anything to rival that. What makes HORN's cutting tools so special is their exceptional tool lives, their ability to be applied universally to a range of materials, their high level of indexability, and their process reliability. In the tool we use most often, the Supermini 105, I'm particularly taken by the excellent stability and low level of vibrations it has thanks to the special droplet shape and the positive fit which results from that. With the level of precision that HORN tools deliver, we can comply with even the very smallest tolerances in our movement components – 0 to ±2 µm (0.000079"). The weight balance tolerance is less than 5 µm (0.000197"), and the distances between the bore holes in the bottom plate cannot exceed ±5 µm (0.000197"). Even the holes themselves are produced with a tolerance of less than 4 µm (0.000157"). All our other movement components are subject to tolerances that are restricted to hundredth values. So the only way I can achieve the level of precision they need is by using high-precision watchmaking machines like the Tornos Micro 7, the Deco 13 and the Traub TNL 12K, as well as high-precision tools from HORN.”

Accurately micro-machining shafts, tiny screws, sleeves and gear wheels on a micro-unit scale, while maintaining the very highest standards of surface quality, requires precision cutting tools.

The multifaceted precision tool that Damasko uses to machine many of its watch components: the Supermini 105.

There was significant interest in the fifth HORN Technology Days.

HORN TECHNOLOGY DAYS 2015

From 17th to 19th June 2015, HORN opened its doors for the 5th time

Paul Horn GmbH has been holding HORN Technology Days since 2009. Right from the beginning, the customers have been the focus of this event. Over the years, it has grown both in terms of the available programme and the number of participants. In 2015, HORN achieved a record result by welcoming 2750 visitors from 35 countries over the three days – compared with around 2250 during the 2013 Technology Days.

Lothar Horn, Managing Director of Paul Horn GmbH, explained the principle behind the Technology Days: "We don't see our Technology Days as a promotional event. We want to engage in dialogue with our customers in order to advance technology and innovations, and pool our knowledge. This is also why the presentations are application-specific rather than product-specific."

A wide range of presentations were available to attend.

Participants were given an insight into production.

Attendees received an event information pack on arrival.

What visitors said:

"Another fantastic event."

"I had some excellent discussions."

"Before now, I only knew about HORN's products. I loved the look behind the scenes into production."

"The HORN Technology Days event was both informative and interactive. It exceeded my expectations."

"Brilliantly organised and executed. I didn't just feel like an attendee – I was part of the event."

"Practical and personal."

"I'll be back again."

Most of the presentations – which numbered eight in total – were coupled with corresponding practical demonstrations. The participants made good use of the opportunities to discuss the machine in question at close hand with the relevant speaker after each presentation. For the first time, the presentations were available in up to five languages: German, English, French, Italian and Turkish. The presentations covered the following topics: "Grooving and parting off stainless materials", "Longitudinal turning – flexible production of complex components", "Precision tools in the added-value chain", "Trochoidal milling", "Moulding tools and special tools", "Wear parts", "Tangential milling" and "Milling and slotting cutters".

The last day of the event saw the first HORN Careers Day take place, where the company provided information about the opportunities for training and studying, and the possibility of specialising in cutting tool technology.

Watch the video here!

phorn.de/technologietage2015

Mexico – a strategic market for HORN.

HORN GOES TO MEXICO

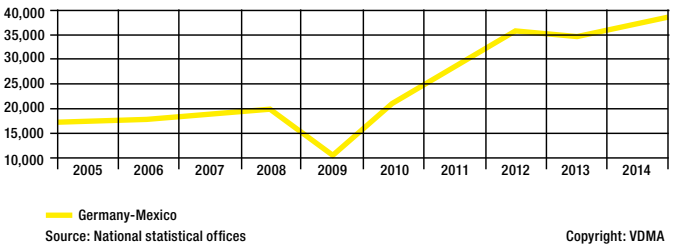
Dedicated subsidiary to open in 2016

Achieving a gross domestic product of 1276 billion US dollars, Mexico was responsible for Latin America's second-strongest economic performance of 2014. The country has the region's second-biggest population and third-largest territory, and accounts for around 2.1% of the world's GDP. Exports remain the driving force behind the country's growth, with the automotive industry and its suppliers particularly well placed to build on the achievements of 2012, a record year. The aerospace sector, pharmaceuticals, medical technology, mining, the electrical industry and the transport sector are also experiencing an upsurge.

Developments in the southern United States and a positive work ethic among the population are what has made Mexico so strategically important to HORN's position on the global market. Now, HORN is set to open a Mexican subsidiary at the start of 2016, the aim being to provide the machining market with support in the form of highly qualified, local staff who know both their subject and the market.

Think globally, act locally

At the heart of HORN's corporate philosophy is the principle of thinking globally but acting locally. HORN ensures its various subsidiaries and representatives receive support from expert individuals and teams who have a comprehensive understanding of the industry. In return, the subsidiaries and representatives support customers through local staff who know the ins and outs of the local economy and are able to respond to customers' needs. HORN Mexico will also have the opportunity to draw on the experience and proximity of HORN USA, Inc., founded in 1998. After starting life as a sales office in Franklin, Tennessee, HORN USA set up a warehouse and installed a small number of grinding machines shortly thereafter. Hot on the heels of this came production machines for producing cutting tools with the right dimensions to serve the North American production industry. HORN USA's experience gained from adapting to market requirements, combined with Paul Horn GmbH's expertise, are sure to create the ideal conditions for the Mexican subsidiary to make a successful start.



Germany's exports of cutting tools to Mexico, in millions of euros

ON A COURSE TOWARDS THE FUTURE

New administrative building in Tübingen

Paul Horn GmbH is extending its Tübingen site. Not only is Factory III being erected on Dußlinger Weg, thus providing a 15,000 m² building with 12,000 m² of production space, but Factory I on Unter dem Holz is also getting a brand-new administration wing. Covering a total space of 3500 m² over six floors, it is being constructed adjacent to the current administrative building and plans are in place for it to provide seminar rooms for customer training, in addition to offices. Around 15 million euros are being invested in the project.

The wing's far smaller scale compared to the production building is reflective of HORN's continued pursuit of a lean management concept. According to Lothar Horn, Managing Director of Paul Horn GmbH: “We are investing in our future. This will be especially beneficial for our customers, as we are continuing to uphold the values of speed, unparalleled quality and precision. Our employees, our infrastructure of buildings, machines, plants, processes and organisational concepts, our products, and our commitment to technology and innovation are all part of this.” Another piece of land, this time measuring 4000 m², has also been purchased at the south side of Factory I. Although it is set to serve as a car park initially, there will be the opportunity to enhance the space over the long term.

The new administrative building will be constructed next to the main factory (1) by the end of 2016. South of here, there will be around 150 new parking spaces (2). Building work for Factory III is progressing on Dußlinger Weg (3). This will be bordered by two car parks (4).

A RECORD RESULT FOR HORN

Pedal Car Grand Prix in England

At the Pedal Car Grand Prix in New Milton, England, HORN's apprentices achieved a very respectable fourth place.

The result came at the end of a long road the apprentices had travelled. Participating in 2014's British Pedal Car Grand Prix had been out of the question as the race, then taking place in Ringwood, was already overbooked by the time they had finished building that year's pedal car – the third such project that HORN had run.

Back on the starting grid

This year, the apprentices did manage to make the journey to the UK on Friday, 10th July after a successful bout of training in Germany. The pedal car itself had already been sent in advance, but the rear carbon drive shaft broke during the process of unpacking the equipment and embarking on a test drive. Fortunately, the skills that the HORN apprentices had learned when training as industrial mechanics meant they were quickly able to produce a new steel drive shaft on a lathe.

Sunday: A day at the races

Once registration was complete, the pedal car had been approved, the transponder had been installed for clocking times, and the drivers had received their briefing, it was finally time for action, with four drivers, one pusher and one mechanic competing among a total of 45 teams. The car was given the number 31 and place 35 on the starting line, facing conditions of 16 °C and rain. What's more, a change to the rules had been introduced on the day of the race. It was no longer a case of the team who had completed the most laps after two hours being crowned the winner; instead, whichever team was the first to complete 60 laps would emerge victorious. Once a team had achieved that, the remaining cars on the track had to simply complete whichever lap they were on. The HORN pedal car began surging ahead right from the off. As time went on the vehicles began to spread out over the route, which covered around a kilometre and required teams to tackle chicanes, 180 ° curves, ascents and descents. After half the distance, the HORN team was among the top eight and continued to power forward. In the end, they crossed the finish line in fourth place – a vast improvement on HORN's previous best of 16th. Training, endurance and determination – all combined with a high-tech carbon pedal car – were the drivers behind this year's success. The winners were a team made up of triathletes representing NF Health & Leisure.

We would like to extend our congratulations to the race participants and the apprentices from HORN: **Moritz Fisch, Johannes Kümmerle, Maximilian Sauer, Jonathan Wandel, Jonas Wick and Tobias Baur.**

Jonathan Wandel and his teammates gave it their all at the Grand Prix in New Milton, England.

CBN hard turning: a dry machining method.

SEMINAR ON HARD MACHINING OF STEEL MATERIALS

In many applications, hard machining is used as an alternative to grinding. It offers a more flexible method of working with geometries, cuts down on the number of operations required, and enables machining in a clamp if, for example, the work involves partially hardened workpieces.

Hard machining subjects tools to exceptionally high levels of mechanical and thermal stress, necessitating the use of adapted cutting materials with appropriately high hot hardness and resistance to wear. These differ according to the production process: finest-grain carbides are primarily used for milling, while polycrystalline boron nitride (PCBN) is the material of choice for turning.

The economical nature of hard machining is propelling forward the attention that the industry is paying to it – and it therefore represents the perfect subject for a technology seminar offered by the HORN Academy. The seminar focuses on two key areas involving hard turning and milling hardened steel materials.

The first section compares the hardness of technical cutting materials and demonstrates that CBN – which features a Knoop hardness of 4700 N/mm^2, is the world's second-hardest material, and is resistant to temperatures of up to 1400˚C – offers the best possible conditions for hard machining during turning processes. CBN synthesis happens at 1500˚C and 60,000 bar, with its various substrates differentiated according to the volume of CBN they contain. Machining is performed by heating the cutting zone until the chips are softened. The seminar is also concerned with the special tool designs that apply in this case, as well as the designs of cutting inserts and cutting edges. Even carbides like CBN are subject to wear, and it therefore makes sense to identify the causes underpinning signs of wear so that appropriate countermeasures can be put in place.

The second section of the seminar, focusing on hard milling, looks at influencing factors and what makes the subject so complex. In addition to the two milling philosophies that can be applied to hard milling – HPC (high-performance cutting) and HSC (high-speed cutting) – it will also explore various milling strategies in depth, including climb milling and conventional methods, trochoidal milling, and circular interpolation, and will look at the effects that differences in average chip thickness have. Furthermore, the seminar will investigate strategies for profile and face milling, the benefits and drawbacks of climbing and conventional methods, plus the reduction in peak-to-valley and the potential for savings in polishing. It will deal with both the physical and mechanical characteristics of carbide grades and coatings, as well as their thermal resistance and layer construction.

SEMINAR ON BORE MACHINING

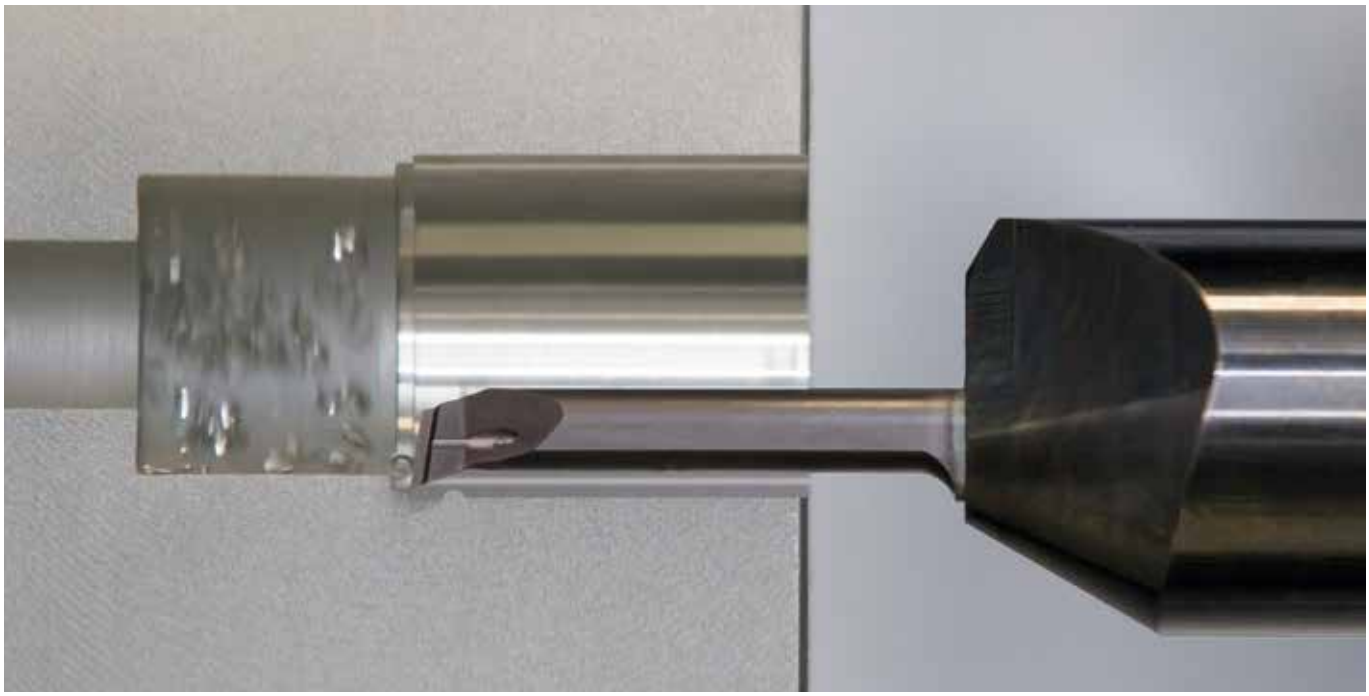
Efficiency and excellent quality

Boring undoubtedly ranks among the very oldest methods of machining. Possessing some unusual features, it also remains one of the most complex methods of working with geometrically defined cutting edges. Its significance in metalworking is often underestimated, when in fact some 70 percent of all machining operations that take place in the industry involve boring. This is precisely why the HORN Academy has launched a seminar for investigating the subject in depth.

The seminar explores bore machining through two extensive blocks of subject matter. The first section takes an all-round look at the subject, while the second approaches the topics of reaming and line boring in detail. When the two blocks are complete, the seminar is rounded off with practical workshops that use machines and workpieces, allowing theoretical knowledge to be put into practice and illustrated through real-life problems and solutions.

Entitled “Efficient boring”, the first section of the seminar deals with the principles of boring and the place it occupies among production technology, as well as providing an overview of all the types of drills available and where they are principally used. It also looks at the carbide tool material and the key grades that are used for manufacturing boring tools, plus the various drill shapes available. Machining important types of materials, as well as those that are problematic, is another subject that is explored in detail. In addition, this section looks at how to recognise characteristic signs of wear and how to prevent their causes.

“Reaming and line boring”, the second section, starts by setting out the strict requirements for the processes and discussing the need to adhere precisely to tolerances in skilled boring practices, as well as explaining the tool requirements that arise from this. The seminar provides a comprehensive overview of the various types of reamers available, their structures, and their main areas of application – and does the same for line boring tools. It also answers the question concerning what levels of surface quality can actually be achieved during reaming and line boring, and which cutting materials are required to do this. Additional subjects it explores are concentricity, angle error and eccentricity, the effects of interrupted cuts when creating transverse bores and of inclined bore entries, plus piloting and return strategies. A look at cutting data calculation and how to recognise wear characteristics rounds off the seminar's theoretical component.



Internal turning is a commonly used method of bore machining.

HORN is at home in more than 70 countries in the world

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