Issue 2/16

world of tools

HORN

THE CUSTOMER MAGAZINE FROM HORN

TOPICS:

- Special feature on modular tool systems
- Tangential milling
- AMB 2016
- Free-cutting steel as a material

EDITORIAL

Dear Readers,

"Modular" is the keyword that runs all the way through this issue of world of tools. The term "modular" crops up in all kinds of different contexts, whether that be modular construction kits in the automotive industry or modular concepts for home furniture, modular room units for buildings, computer modules or even modular tool systems. But why design something to be modular in the first place? The answer is that it creates flexibility and makes things simpler. Simplicity can be achieved by having standardised interfaces, for example, and flexibility by allowing these to be used in all kinds of ways. However, other aspects also have an important role to play. For instance, in the case of tools, a modular design also allows you to increase the level of stability and rigidity, in turn, improving accuracy and surface quality.

On top of that, we have the 409 and 406 tangential milling systems unveiled three years ago. These are now an inseparable part of our portfolio and are being used for a multitude of applications. In this issue, we'd like to show you how they can be used in the area of medical technology. Within this particular industry, where tools and workpieces are consistently subject to extremely demanding requirements. The industry itself is growing by around five per cent annually and, along with the automotive industry and its components suppliers, is one of our primary customer sectors.

I am looking forward to the forthcoming AMB fair in Stuttgart with great anticipation. The products that we have highlighted for you in the "Products" section will also be exhibited at the HORN stand in Stuttgart. Some of these will be available for you to handle and inspect, others will be there for you to see in production on the machine. In particular, we'd like to draw your attention to advancements in the Supermini range. Everything here is new, from the substrate and microgeometry right through to the coating. As a result, we have managed to increase performance significantly, in keeping with the motto: HORN – leaders in grooving technology.

I hope you enjoy reading this issue.

Lothar Horn

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world of tools

THE CUSTOMER MAGAZINE FROM HORN

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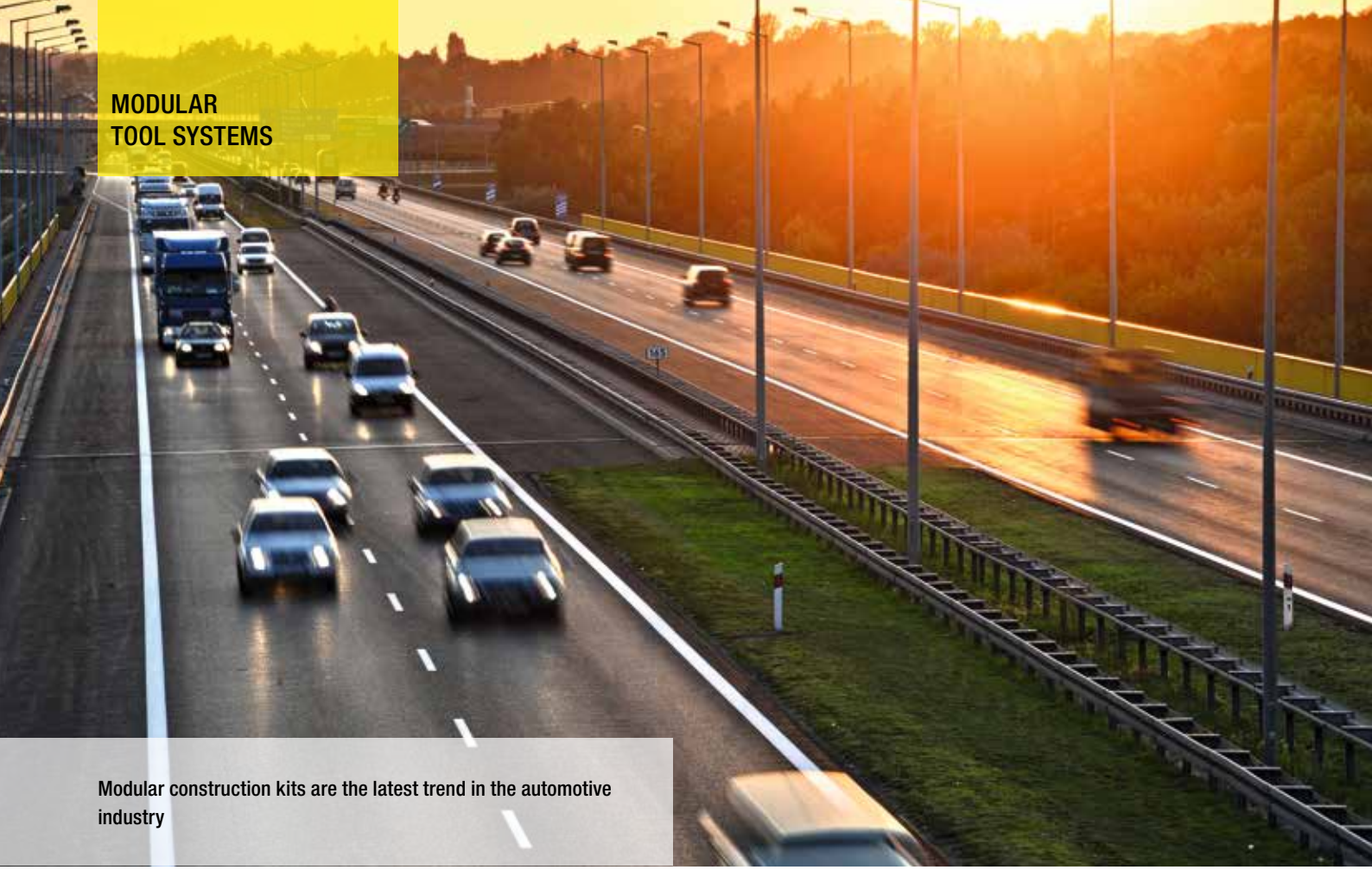


Modular construction kits are the latest trend in the automotive industry

A MODULAR WORLD

Flexibility through modular design

We encounter modular systems every day of our lives. One obvious and very well-known example is the family car. This is put together using the relevant manufacturer's configurator tool. After assembling it on screen from various individual modules, the exact variant that we configured arrives just a few weeks later. Then, if any parts have to be replaced because of wear or deformation, the workshop simply orders them from the manufacturer's extensive "modular construction kit".

Our imaginations are likely to have been kindled by modular construction kits when we were still children. Do you remember, for example, those days spent creating cars, houses, cranes and wind mills from the standardised components of a meccano set? It is exactly the same with the latest generation of kids, except for the brand names, which now include things like Lego or Fischertechnik as well. Of course, members of today's smartphone generation also enjoy playing with another type of module called apps. Even the text of this magazine is made up of modules – 26 basic letters and 10 digits. Thousands of different languages and dialects are spoken around the world and every written one consists of standardised letters or characters.

More flexible and cost-effective

Modern machining technology also relies on having lots of different modules. Take machine tools, for instance, with their drive systems, control systems, measuring systems, cooling lubricant systems, chip disposal devices and interfaces for each type of tool system. The technology has come a long way since the first simple techniques for clamping tool steel in turning applications and the first Morse tapers for milling cutters. In between the various machine interfaces and the carbide cutting edge, there are often several other interfaces for handling the specific machining task concerned. This calls for modular solutions with standardised interfaces to make application-specific tool solutions more straightforward and flexible. As well as increasing stability and rigidity, these result in improved precision and surface quality and, ultimately, in greater process reliability and cost-effectiveness.

For a prime example of flexible modularisation, you need look no further than the 105 "Supermini" that HORN has been offering for more than 25 years. With its standardised holder system, the 105 offers well over 1500 cutting insert versions for handling all kinds of machining tasks with hole diameters of between 0.2 mm (0.0079") and 6,8 mm (0,2677"). It really shows what it is made of when used for boring out, grooving, chamfering, threading, axial grooving, finish-boring, face turning, part of preparation, and broaching down to the smallest of diameters – and can cope with any metal/steel grades, including most exotic modern materials.

Another example of how standardized modules can be used to cover several interfaces at once is HORN's 842/845 modular grooving system. This consists of:

- **A basic holder for a turret with a BMT/MAZ connection or a VDI holder for side and star turrets**
- **A basic holder for turning and milling centres and for equipment such as MS multi-spindle lathes from INDEX**
- **Grooving tool holders**
- **A matching cartridge range with different grooving widths and grooving depths**

Modular system kit

The modular system kit offers a selection of base holders for turrets with BMT connections, based on standard machine types. Alternatively, VDI basic holders are available in various sizes along with a choice of basic holders for turning and milling centres. The matching grooving tool holders with integrated coolant supply allow the cartridge heights to be adjusted and their fastenings to be set in a normal or overhead position, on the left or on the right of the grooving tool holder. The new 968 series of base carriers is intended for use with multi-spindle lathes, the cartridges can be screwed onto these holders directly. Cartridges, which feature 845 and 842 interfaces, serve as the holder for the S100 grooving insert system with a range of geometries and substrates. Grooving widths of 1.2 (0.0472") to 4 mm (0.1574") are available with grooving depths of 22 (0.8661") to 105 mm (4.1339"). The cartridges are equipped with an integrated coolant supply in versions for clamping finger and support cooling. In addition, there are cartridges with an internal coolant supply for VC11 and DC07 ISO cutting inserts.

Both these examples are representative of the vast array of tool systems that HORN has developed over recent years with modularity in mind. Further examples can be found in the 311 milling insert that is compatible with various holders for all kinds of different machining tasks without having the complexity of multiple interfaces. The S100 part off grooving insert that is available with or without internal cooling for various holder systems, also the modular design of the tangential milling systems – the list could go on and on. Modularity increases cost-effectiveness, reduces the number of different items that have to be stocked, allowing flexible standard solutions to be utalized reducing lead times.

A selection of items from the 960 modular grooving system with through coolant and the 845 system interface.

Final operation on the adapter: parting off with the 960 system. Other HORN tools also show what they can do as part of a complete machining process.

MODULAR GROOVING SYSTEM HELPS TO CUT COSTS

Long tool life and high process reliability for stainless steel

Contract manufacturers generally need to have a wide range of metal-cutting tools but cannot afford for these to become too much of a cost burden. One example of a cost-effective solution for reducing the number of tools – particularly for parting off – is HORN's 960 modular grooving system.

Companies based in the Black Forest region have long been known for their reliability and precision. And when Sylvester Harter, Johannes Schmalz and Thomas Schmalz founded their company for the contract manufacturing of turned and milled parts back in 1991, they wanted to remain true to these principles. Today, SSH GmbH precision parts in Haslach (Kinzigtal) employs around 20 people. Its range of machined products encompasses workpieces with a diameter of 10 (0.3937") to 300 mm (11.811") and lengths of up to 800 mm (31.4961"). Approximately 95 per cent of the parts are made from stainless steel, mainly types V2A and V4A. However, it also has to machine non-ferrous metals, plastics and titanium on behalf of its customers.

The competitive way to produce adapters

Managing Director Thomas Schmalz and his team have acquired a wealth of experience in stainless steel grades that are difficult to machine. In spite of this, they still like to draw on the knowledge of external experts such as Karl Schonhardt from Technical Advice and Sales at HORN. His expertise was particularly sought after when it came to machining adapters made from V4A stainless steel. The workpieces had to be produced from a rod measuring $40^{+0.2}$ mm (1.5748"$^{+0.00787}$) in diameter on a Traub/Index TNX 65/42 turning/milling centre with ready-to-use results. Among the work operations that were critical for determining the functionality and costs were the processes of creating an internal groove, two external grooves and an undercut, plus the parting-off operation for the finished adapter. As for the last of these, tool life data for a competitor was already available. Thus, the challenge was to improve on the data significantly and create a positive impact on estimated costs as a result, based on the customer's system of repeat-ordering in batches of 800 at irregular intervals.

Modular grooving system increases production flexibility

Karl Schonhardt recommended using the 960 modular grooving system as a parting-off solution for the adapters. One example of this system's versatility is the way you can combine the various machine-specific modules in different ways. As a result, the user needs fewer tools, less space, leading to a reduction in tooling inventory.

Noteable components of this system are the height-adjustable basic holder, with a BMT/MAZ connection or VDI holder for side and star turrets, and grooving tool holder. Thanks to the 845 system interface, it is designed to accommodate various cartridges, into which indexable inserts from the 100 system can then be clamped. These can be supplied with various geometries and coatings for grooving widths of 1.2 (0.0472") to 4 mm (0.1575") and grooving depths of 17 (0.6693") to 55 mm (2.1654").

The cartridges (which are all available in a left-hand or right-hand options) are supplied with coolant internally via the clamping finger and via the support. Cooling via the clamping finger cools the chip, which has a positive impact on chip breaking and ultimately improves process reliability. Meanwhile, cooling via the support reduces flank wear and has a lubricating effect on the flanks of the grooving insert. The result is a surface with low roughness. The cartridges can be combined with grooving tool holders of various lengths. Allowing the optimum tool combinations to be achieved in accordance with the size of the counter spindle or the swing diameter of the lathe.

The impressive thing about the 960 system is that it offers a higher level of rigidity than part-off blades because the support for the cutting edge on the basic holder directs the cutting forces straight into the grooving tool holder. In turn, this results in flat parting-off surfaces even when working with larger workpiece diameters.

Reliable parting off for tricky materials

V4A steels are characterised by their high level of corrosion resistance, when machining, their tendency to harden results in a high level of tool wear. In addition, the Cr and Ni content reduces thermal conductivity and so the tools have to dissipate high chip temperatures. In light of these material properties, the following cutting data was selected for the adapter parting-off operation: speed n = 1200 rpm, constant cutting speed v_c = 150 m/min up to the speed limit of 3500 rpm and a feed rate of f = 0,06 mm (0.0024") per revolution, which was reduced to approximately 0,04 mm/U (0.0016"/rev) per revolution as the groove depth increased. The machining specialists deliberately opted for a

Thomas Schmalz (Managing Director of SSH), Karl Schonhardt (HORN sales representative) and Josef Hummel (fitter at SSH) (pictured from left to right) are delighted with the successful machining strategy that has increased the tool life by 130 per cent during parting off.

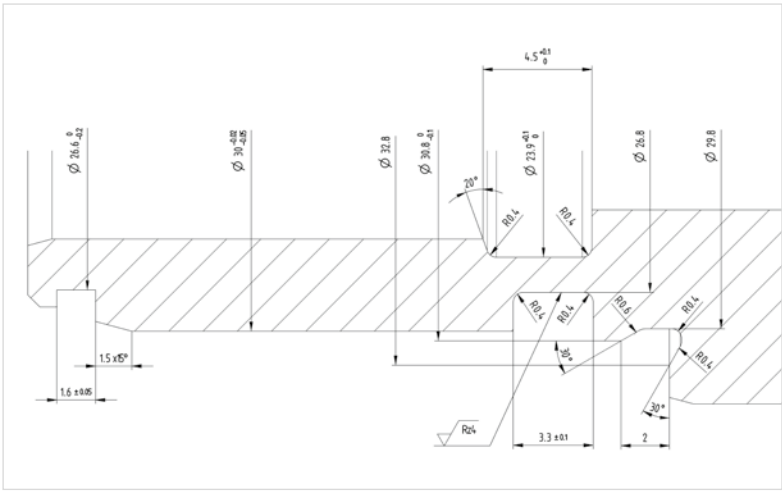
higher speed combined with a lower feed rate so that the chip would have good rolling properties and would be easy to remove from the work area.

Internal and external grooves with standard and special inserts

Before the parting-off operation could be considered, other HORN tools had to be put to the test for the grooving operations. Karl Schonhardt recommended using a 114 single-edged cutting insert to create the internal groove with a diameter of $26.8_{-0.1}$ mm ($1.0551"_{-0.0039}$) and a width of $4.5^{+0.1}$ ($0.1771"^{+0.0039}$) mm. To cut the external groove measuring $22.6_{-0.2}$ mm ($0.8897"_{-0.007}$) in diameter and $1.6^{+0.05}$ mm ($0.0629"^{+0.0019}$) in width, a type 312 triple-edged grooving insert was used. This is suitable for grooving depths of up to 6 mm (0,2362") in conjunction with a grooving width of 1.5 mm (0,0591"). For the second groove with its width of $3.3^{+0.1}$ mm ($0.12992"^{+0.0039}$) and radius r of 0.4 mm (0.0157") on the $26.8_{-0.1}$ mm ($1.05551"_{-0.0039}$) diameter, another type 312 cutting insert was selected, this time with a sintered chip shape geometry. To produce the corner undercut on the collar, a special type of 312 had to be supplied. Thanks to its particular shape, this can be used to finish the 2.5 mm (0.0984") wide undercut with radii of r = 0.6 mm (0.0236") and 2 x r = 0.4 mm (0.0157") including the 30° run-in and run-out on the 29.8 mm (1.1732") diameter.

Modularity put to good use

Thanks to the 960 system, the production technology and economic efficiency-related problems associated with parting off have become a thing of the past. In the words of Managing Director Thomas Schmalz: “The ready-to-use adapter can now



This simplified production drawing shows the internal groove and the three external grooves on the adapter.

be produced within 180 seconds. Compared with the rival system that we used to use before, the 960 system offers a tool life that is 130 per cent longer. The reasons for this significant increase in tool life include the high level of rigidity and the dual cooling via the clamping finger and support. Thanks to the modular system, we can change the various cartridges containing pre-set inserts on the machine easily and efficiently, reducing set-up times and tooling inventory. As a result, we intend to start using the 960 modular system for parting off Hastelloy, titanium and aluminium as well. When all aspects of supplier performance are considered, we feel we are being very well supported by HORN in light of its technical expertise, short lines of communication and fast delivery times (particularly for special tools). This is all the more important given the extreme time and cost pressures that we face as a contract manufacturer.”

System 960

The core components of the 960 modular grooving system are the basic holder, grooving tool holder and cartridge containing the cutting insert.

The compact design of the 968 parting-off system facilitates installation and makes it easier to perform tool changes in the cramped work area of a multi-spindle lathe.

NEW PARTING-OFF SYSTEM UNDERGOES FIELD TESTING

Impressive handling and amazing tool lives

When it comes to production for the automotive industry, even the slightest improvement to the work process strengthens competitiveness. It was with this in mind that one contract manufacturer set about optimising its parting off process for mass-produced parts. The 968 parting-off system from HORN opened up a promising way to make production future-proof.

Any contract manufacturer that wants to follow in the footsteps of Rich Praezision GmbH by becoming a popular supplier to various industries will need to excel at both a technical and a commercial level. The company, which was founded in 1949 by Wilhelm Rich and is now managed by his grandsons Gottfried and Wolfgang Rich, has a workforce of 40. With its two production facilities in Riederich (a town lying about 30 km south of Stuttgart), it specialises in batch sizes of 250 to 5000 items with diameters of 10 (0.3937") to 65 mm (2.5591"), as well as in the large-scale production of 10,000 items or more with diameters ranging from 8 (0.3150") to 30 mm (1.1811"). However, it also accepts turning and milling orders for prototypes and small batches also. Its customer base is just as diverse as its range of products and services, but it focuses primarily on the automotive sector. Whatever the requirements of the various industries served, both managers want the company to remain true to the corporate philosophy of its founder in all dealings with customers: loyalty towards customers and suppliers, quality and integrity.

Specialist for large-scale production in the automotive industry

Many customers draw on the expertise offered by Rich as early as the product engineering phase so that they can align their developments with the latest production technology and can produce and mount their workpieces or assemblies efficiently. To make sure that these customer requirements are thoroughly met (from the very first chip right through to documented quality inspection), the company's management is continually investing in employee qualifications, machinery, logistics and data processing equipment. This kind of ultramodern environment results in sophisticated serial parts, such as the workpiece that the company makes from grade 11SMn30 steel (material no. 1.0715). Once this has been produced on an Index MS32 multi-spindle machine from a bar measuring 26 mm (1.0236") in diameter, it undergoes fully automated cleaning, measurement and inspection, and is placed into storage ready for dispatch.

In terms of its ability to perform parting off in large-scale production, the 968 system certainly lived up to the expectations of the specialists, namely Dr.- Ing. Matthias Luik, Head of R&D at HORN; Wolfram Stiefel, Production Manager at Rich; Wolfgang Rich, Managing Partner of Rich; Andreas Jud, CNC fitter at Rich; and Frank Blocher, HORN sales representative.

The customer constantly calls off sufficient quantities to cover the demand for two to three weeks, adding up to an annual production volume of several million items.

Complete machining with excellent process reliability

The external shape of the workpiece resembles a letter “H”. On one of the outer sides, there is a conical projection and on the other there is an undercut for accommodating a small knurled collar. Various HORN tools are involved in manufacturing the turned part: A S224 grooving insert for pre-grooving the outer contours, a 312 cutting insert for pre-grooving the external groove, a 315 insert for finishing the external groove, a special version of the S224 grooving insert for creating the oblique groove on one front face and for finish turning the contour for the knurled collar, plus two tools from the Supermini system for the internal machining of two bores with a diameter of 1 mm (0.0393").

On completion of these and various other work operations, the workpiece is parted off. With a view to optimising the last of these operations, Managing Partner Wolfgang Rich turned to HORN once again to enquire the latest parting-off systems – in keeping with the maxim of “process-reliable comprehensive machining”. Frank Blocher from Technical Advice and Sales sent him the general information to look at first, before recommending the 968 grooving system as suitable for the company’s current requirements.

Parting-off systems for multi-spindle lathes

HORN developed its 968 modular grooving system specifically for use with the MS16 to MS52 range of multi-spindle lathes from Index. The type 968 base carrier (which is available in a left-hand or right-hand design) can receive various cartridges via its 842 interface. The cartridges, which are similarly available in left-hand and right-hand designs, are designed to accommodate the type S100 indexable inserts for grooving and parting off. These system combinations can be used to produce grooves and parting-off widths that are 2/2.5/3 (0.0787"/0.0984"/0.1181") and 4 mm (0.1575") wide and 17 (0.6693") to 34 mm (1.3386") deep.

The base carrier and the cartridges feature through coolant and the coolant can either be supplied via the turret interface oran external supply. All the base carriers are height-adjustable and there is a non-twist stop plate for changing the workpiece length. The base carriers are secured using a prism and clamps.

Parting off in the context of process optimisation

Rich began using the 968 parting-off system as early as the development phase. Wolfgang Rich had set out his most important requirements in advance: “Firstly, the quality of the part-off surface had to be right and secondly the work process had to be reliable and constant. That is why we tested the 968 system under the maxim of “comprehensive machining” as well, so that all the tools required for the turned part could be optimised simultaneously. Our timing expectations, particularly as regards

The 968 modular parting-off system that HORN developed in cooperation with Ernst Graf GmbH is specifically designed for use with the MS range of multi-spindle lathes from Index.

Cartridge and indexable insert from the 968 modular parting-off system.

parting off, were based on various factors, including the results achieved with a competitors product."

Once they had been adapted for the shape and material of the mass-produced part concerned, the recommendations of Frank Blocher were followed by testing various S100 indexable inserts made from AS45, Ti25 and HP65 coating and carbide grades and with the .3V. and .FY chip shape geometries. Thanks to the controlled chip flow concept, both chip shape geometries ensure high levels of production reliability. Following various trials, the technical engineers specialists finally opted for indexable inserts HP65 grade with the .3V. geometry.

The advantages of the 968 system started to emerge as early as the set-up stage thanks to its ease of handling. After that, the company selected a feed rate for the parting-off operation that could be varied in accordance with the diameter at a constant speed of n = 4500 rpm. In practice, this resulted in feed rate values of f = 0.03 mm (0.0012") per revolution to f = 0.07 mm (0.0028") per revolution based on grooving depths of 10 (0.3937") to 0 mm (0.0"). These parameters were used to produce around 10,000 parts in four changing cycles with the required level of process reliability. After that, the tools were changed, even though the grooving insert tool life would have been sufficient for yet another changing cycle.

Wolfgang Rich expressed his satisfaction as follows: "My employees found the process to be much more stable and the tool life to be longer. The cycle time achieved for all the turning work meant that we were also able to meet the calculated targets. However, the subjective impressions of our machine operators were just as important to me. Thanks to the high process reliability, their work is less stressful and they can even be given additonal tasks to do.

Parting off has an impact on competitiveness

Wolfgang Rich puts his production targets in simplistic terms: "The crucial factor is how many in-spec parts have been produced by clocking-out time. To achieve the best possible results in this regard, my team and I are working on various strategies that are specifically designed to reduce tool change times." In turn, these efforts are reliant upon the ability to make tool changeover as easy as possible for the fitter in a work area that is characterised by cramped conditions and dripping coolant or the ability to reduce the number of tool changes by selecting tools appropriately. He then goes on to mention some other things that he would like to see: "As far as I am concerned it's all about easy tool changes, particularly when it comes to parting off. My motto here is 'get the basic holder out, change the cutting insert, fit and clamp the holder'. The HORN parting-off system gives me exactly what I want in this regard. Nevertheless, I still have a suggestion for the design team: if the design were narrower, this system would make an even better impression on me than it has done already. But based on what I have experienced so far, I feel very optimistic about the prospect of discussing the tooling for our three other Index MS32 machines".

Smaller cutting widths with the 842 and 845 cartridges

To minimise the amount of material lost when parting off expensive materials, HORN has developed a range of part off inserts with ultra-narrow widths. The S101 cutting inserts (with their cutting widths of 1.2 mm (0.0472") and 1.6 mm (0.0630") make the 842 and 845 cartridge system suitable for an even wider range of applications by introducing smaller insert widths. They offer a maximum groove depth (T_{max}) of 17 mm (0.6693") combined with a maximum machining diameter (D_{max}) of 34 mm (1.3386") and are compatible with both the left-hand and right-hand cartridge designs. The cartridges are equipped with an integrated coolant supply to support cooling.

Ultra-narrow S101 cutting insert for the 842 cartridge.

Type 842 and 845 cartridges now also compatible with S224 cutting inserts

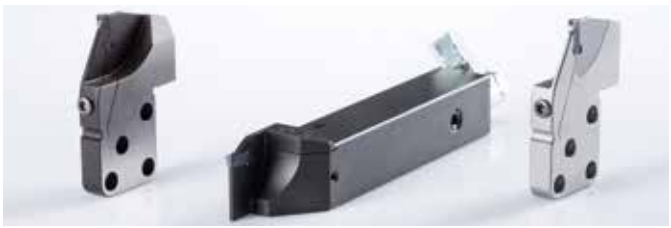
HORN is expanding its range of type 842 and 845 cartridges. These are now capable of accommodating type S224 double-edged indexable inserts. Available in cutting widths of w = 2 mm (0.0787"), w = 2.5 mm (0.0984") and w = 3 mm (0.1181"), all three cutting inserts offer a maximum groove depth of T_{max} = 18 mm. The maximum turning diameter is 54 mm. In the case of larger workpieces, a shallower groove depth applies accordingly. The cartridges are available in a left-hand or right-hand design. With the w = 2.5 mm (0.0984") and w = 3 mm (0.1181") grooving widths, the integrated coolant supply consists of both support cooling and cooling via the top clamp but is restricted to support cooling alone with a width of w = 2 mm (0.0787").

Type 845 cartridge with S224 two-edged indexable insert.

Cooling via the insert now also available with 842 and 845 cartridges

S100 cutting inserts with internal cooling via the insert are now available in cutting widths of w = 2.5 mm (0.0984"), w = 3 mm (0.1181") and w = 4 mm (0.1575"). Inserts with a width of 2.5 mm (0.0984") offers maximum grooving depths of 22 mm (0.8661") (845) and 23 mm (0.9055") (842) respectively, and a maximum diameter of 46 mm (1.8110"). The corresponding values for the 3 mm (0.1181") cutting width are a grooving depth of 34 mm (1.3386") with a diameter of 68 mm (2.6772"). For the 4 mm (0.1575") cutting width, the grooving depth is 42 mm (1.6535") and the maximum diameter is 84 mm (3.3071").

The cartridges are equipped with an integrated coolant supply via the insert. The coolant jet acts directly on the cutting zone and ensures optimum cutting conditions at this point. 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. Compared with conventional cooling methods, this system achieves higher cutting parameters, allowing the tool to be used more cost-effectively.



S100 with internal cooling for square shanks and for 842 and 845 cartridges.

Modular thread whirling system

HORN thread whirling technology is the efficient and cost-effective way to produce single and multi-start external threads and profiles using type M271 six or nine-insert tools. Given the extremely short machining times, thread whirling on Swiss-type lathes offers significant advantages over threading. With its base carriers and ring cassettes, the newly developed modular tool system offers customers a multitude of combination options that are tailored to the various Swiss-type lathes and drive units available on the market. The S271 high-precision system allows customers to choose between conventional whirling with six or nine indexable inserts per ring cassette or the new HORN turbo whirling method, which uses nine indexable inserts per ring cassette (three of which are roughing inserts and six of which are finishing inserts). The tool configurator on the HORN website makes it really easy to find the right machine/drive unit and tool combinations. The right cutting data is also provided thanks to the new HCT cutting data calculator, which can also be accessed via the HORN website.

Modular design for flexibility during thread whirling.

Modular die

HORN's modular die for pipe threads (patent pending), which is available in sizes of G¾ and G1 inch, is an easy swap system consisting of one basic holder and five individual inserts. In the event of wear, all you have to do is replace the inserts in the basic holder, thereby eliminating the regrinding work that would normally be required. The solid carbide cutting rings that used to be required for cutting pipe threads weighed around 275 g for a size of R¾ inch. By contrast, the weight of the carbide for all five cutting inserts on the new system is just 23 g. This also means that expensive raw materials can be handled with particular care. The basic holder has the same dimensions as the solid carbide cutting rings and so fits into the existing body.

Sustainable and user-friendly – the modular die in a variety of sizes.

The secure wedge-type clamping system for the cutting inserts and the self-contained holders, which are made from tool steel and offer excellent strength and damping characteristics, have improved tool life and productivity considerably for customers. When the tools reach the end of their life, it is no longer necessary to replace the entire die; instead, all you have to do is change the cutting edges inserts.

If one or more of the cutting edges becomes damaged, you can replace each of the relevant parts individually, which reduces costs significantly. Tough requirements are imposed on the tool cutting edge when machining new grades of brass with little or no lead content in accordance with EU Directive 98/83 EC. On all the grades tested so far, the machining results achieved by the modular die have been very good.

Five questions for Christoph Schlaginhaufen about “whirling”

Christoph Schlaginhaufen has worked at DIHAWAG, HORN's Swiss representative, for more than 19 years. As the company’s Technical Director, he has been a member of the Management Board since 2009.

The latest products go by the name of turbo whirling and modular whirling. What lies behind them and what are the advantages for users?

Turbo whirling is the name of a new thread whirling technology. Since the first indexable insert-based whirling tools were introduced more than 10 years ago, there have been no major advances– at least, not until now. What our customers needed were more cost-effective tools and, together, Dihawag and HORN have responded by developing a completely new type of whirling technology.

To be precise, what turbo whirling offers customers is improved cutting data by dividing up the cutting work. In turn, this results in noticeable time savings. The optimal cutting conditions make for longer tool lives as well as better surfaces without any burrs. Users are assisted by the online cutting data calculator, which makes programming easier. The high-precision modular system, which is very easy to use, cuts downtimes.

When is whirling the right solution to choose?

Whirling should be used whenever a workpiece has to be fully machined from a rod in a single operation. These workpieces usually take the form of screws for medical technology but could also consist of drive shafts or axles with special profiles, e.g. lubrication grooves. Whirling – along with overgrooving – is becoming increasingly important as a process-reliable alternative to turning in the case of long-chipping materials.

To what are the technical limits of whirling attributable – the tool, the whirling equipment or the machine?

That is a very important issue because up until now it was the tools that set the limits. Thanks to the HORN turbo whirling process, the cutting data is now much better and the feed rates are a lot higher. And now we are increasingly finding that the machine control systems or the whirling units are at their limits.

I am thoroughly convinced that the new carbide and coating technologies will provide us with even more scope for making improvements. Nevertheless, a check must always be performed on a case-by-case basis to see whether the measures are going to be cost-effective because the counteroperations are tending to take longer. As a result, the whirling time on its own will have no impact on the overall machining time.

To truly exhaust the limits of what is technically feasible, all the elements have to work together closely, from the machine and whirling unit right through to the tool. However, we already have plenty of ideas, concepts and sound observational values for achieving this.

What kinds of materials can be machined by whirling?

In principle, there are no limits to what can be machined. A completely new insert system has been developed for the turbo whirling process and we individually adapt the tools to suit the machining task and the material concerned. I am very excited about what other challenges might lie ahead for us in this regard.

What are you expecting from the two product enhancements?

We want to use the turbo whirling process to become the technology leader and set new standards. Trust and cost-effectiveness are core factors, particularly as far as the medical technology industry is concerned. That’s why we let our customers test the tools in relation to a set of jointly defined objectives and that is how we win them over.

HORN turbo whirling® – pre-whirling and finish-whirling in one single process

The newly developed HORN turbo whirling process optimises machining during thread whirling and increases cost-effectiveness. HORN has developed a set of cutting tools for whirling that feature a new cutting division concept. These are specifically designed for machining threads with a larger allowance.

To this end, individual cutting edges work as pre-cutters and machine the workpiece to the defined external diameter. In the case of nine-insert tool, the cutting division concept allows the machining work to be divided up so that each cutting edge is subject to equal load, meaning that individual cutting edges can achieve significantly longer service lives. The finishing cutting edges produce the finished thread flanks within the optimised working range. Regardless of the external workpiece diameter, combining a range of cutting edge profiles creates an optimum thread with reproducible tool lives.

HORN turbo whirling can be used to produce single-start and multi-start threads and profiles. What's more, the S271 precision-ground double-edged indexable inserts are tailored to the respective thread profile and the material to be machined. The indexable inserts are clamped in positive-fit, highly stable insert seats, either in the new modular whirling heads with optimised handling during insert replacement or conventionally in the Mono block tools.

During turbo whirling with the nine-insert whirling tool from HORN, the pre-cutters machine the workpiece to the defined external diameter. The finishing cutting edges then ensure that the thread flanks are geometrically flawless.

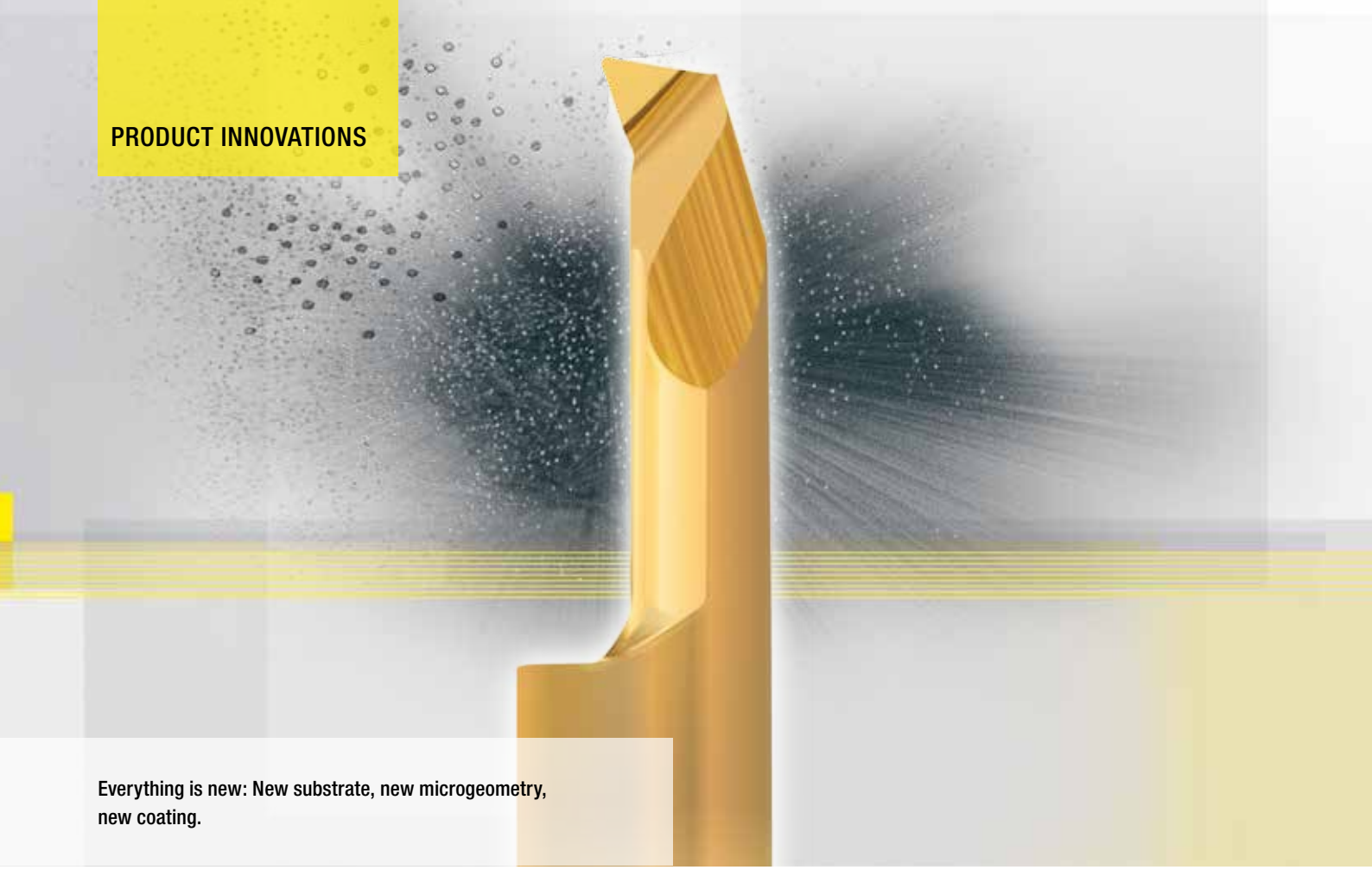
New six-tooth cutter with brand-new high-performance coating

The 64T six-edged grooving insert is the latest addition to the HORN grooving range. The type 64T insert is precision sintered and is currently available with a grooving width of up to 3.29 mm (0.1295") in the .00. geometric shape. As a neutral grooving insert, it can be used on either the left or the right in square shank holders with internal cooling. The holders measure 16 x 16 (0.6299" x 0.6299"), 20 x 20 (0.7874" x 0.7874") or 25 x 25 mm (0.9843" x 0.9843"). An adequately dimensioned clamping screw holds the grooving insert precisely, keeping it central in the insert seat and ensuring a high level of process reliability. The type 64T insert supports grooving depths of up to 3.5 mm (0.1378") and a maximum workpiece diameter of 65 mm (2.5591). The new EG55 high-performance coating grade considerably improves the tool life and makes the grooving insert the perfect all-rounder for machining all types of steel as well as a wide range of other materials.

The following application areas are being catered for initially:

- **Grooving and parting off for groove widths of 1.0 (0.0393") and 1.5 mm (0.0591")**
- **Circlip grooves acc. to DIN 471/472 with groove widths of 0.57 (0.0224") to 3.29 mm (0.1295")**
- **Grooving using full radius inserts with radii of 0.5/0.6/0.8/1.25/1.5 mm (0.0197"/0.0236"/0.0315"/0.0492"/0.0591")**

The new 64T grooving insert.



Everything is new: New substrate, new microgeometry, new coating.

THE ADVANCED SUPERMINI

Frequently imitated but never matched

Some new high-performance versions of HORN's 105 Supermini are set to be unveiled at AMB 2016. Featuring a new coating, a new substrate and a new microgeometry, this equipment will set new standards for boring out holes of between 0.2 mm (0.0079") and 6,8 mm (0.2677"). By introducing this equipment, HORN are responding to the wishes of its customers who are having to contend with higher and higher percentages of stainless/high-alloy/inhomogeneous steels and want to accelerate their throughput.

Suitable for hole diameters of between 0.2 mm (0.0079") and 6,8 mm (0.2677"), the 105 Supermini tool system offers more than 1500 cutting insert versions for many different machining tasks. It truly shines in a whole range of applications for boring out, grooving, chamfering, part-off reparation threading, axial grooving, finish-boring, face turning and broaching right down to the smallest of diameters. Its existing range of uses (machining of steel, cast iron, non-ferrous metals, hard and exotic alloy materials and machining of small and miniature parts with a special microgeometry) is now being extended by introducing high-performance versions for faster machining of demanding steel grades such as stainless and high-alloy steels as well as those that are inhomogeneous to varying degrees.

The Supermini – for bore machining.

Highly homogeneous tough substrate

To further improve the performance of the highly advanced 105 system, various adjustments had to be made one after another in a logical order: first to the substrate, then to the microgeometry and finally to the coating. During the first few test series, only the substrate was modified, with all the other parameters remaining unchanged. As part of the optimisation process, we were able to improve the performance by an average of 30 per cent simply by modifying the substrate. Nevertheless, it proved extremely difficult to create a highly homogeneous substrate because of the narrow process window.

Improved cutting ability combined with lower cutting pressure

In addition, we investigated the relationship between the microgeometry and the coating with regard to layer adhesion and residual stress. The tests revealed that although the modified microgeometry resulted in higher levels of cutting edge stress, the tougher substrate was able to absorb this. The sharper cutting edge geometry resulted in improved cutting ability and less cutting pressure – although a higher level of stress was exerted on the cutting edge.

Extremely dense coating

To counteract this higher stress, the coating specialists at HORN used a specially prepared substrate as the starting point for developing a coating system that was tailored to the combination of the new tough substrate plus more powerful cutting edge. They developed a completely new technology for depositing a denser layer with a more homogeneous structure. This new smoother layer improved the anti-friction properties significantly. Less friction means that less heat is transferred into the tool and, in turn, that the direct cutting edge is exposed to less thermal stress. The layer is topped with a golden top layer coat so that wear can be detected more easily. This complex optimisation process clearly revealed the relationship between the following factors: layer adhesion on the substrate, the layer structure, and the residual stresses. The adhesion of the first layer to the substrate by means of mechanical interlocking turned out to be crucial for ensuring a good balance between layer adhesion and residual stress.

Significant increase in tool life

Comparisons with existing substrates and coatings were carried out in the context of extensive trials and these demonstrated that the new solution resulted improving in a tool life that on existing data. Once secure in this knowledge, HORN made the “high-performance Supermini” available to customers for testing. The documented results of customer trials show that the new EG35 grade is improved: when used on Co28Cr6Mo0,2C with a strength of 1000 N/mm^2, the tool life was 60 per cent better. In the case of 11SMN30+C, the tool life increased by more than 100 per cent and with 40CrMoV13-9 the increase was even greater compared to competitors inserts.

Launch scheduled for the AMB in Stuttgart

The new high-performance version of the Supermini for boring out featuring the new substrate, new microgeometry and new coating will be available as of AMB 2016. The new 105 type really stands out thanks to the brand-new TiAlN coating with its golden top layer for detecting wear, excellent hardness, extremely dense layer structure and superb layer adhesion. The in-house coating process makes for short delivery times and even enables “GreenLine” processing. The Supermini is available with diameters ranging from 0.2 mm (0.0079") to 6 mm (0.2362") as standard. The standard lengths range from 5 x D for a diameter of 0.2 mm (0.0079") and up to 35 mm (1.378") for a diameter of 6 mm (0.2362"). As with all the other versions of the Supermini, the high-performance cutting inserts – come in a right or left-hand versions – fit into the tried-and-tested holder system that is available with or without internal cooling.

The Supermini is one of HORN’s core products and core competencies.

Trochoidal machining for increased productivity

Faced with enormous cost pressures, manufacturers are having to rethink their conventional machining strategies, particularly when it comes to the rough machining of hard-to-machine materials. ProfitMilling, a trochoidal machining tool developed by software provider DP Technology in conjunction with HORN, is blazing a new trail in the area of rough milling.

The subject was first broached about three years ago when HORN came into contact with Esprit (Esprit being the name of the CAM software supplied by DP Technology). Although trochoidal milling was originally developed for materials that are difficult to machine, it can also be used on other materials such as casing covers made from aluminium. This strategy is the key to achieving a rough machining process that leads to smarter and more efficient tool paths. More material can be removed in less time but without any loss of quality. Trochoidal milling results in time savings of up to 75 per cent and increases tool life significantly. The ProfitMilling strategy offers advanced technology for optimum results by perfectly combining the pressure angle, machined volume, lateral cutting pressure and machine acceleration.

Advantages of trochoidal milling compared with traditional pocket milling:

- **Reduces cycle time by up to 75 Percent**
- **Increases tool life by up to 500 Percent**
- **Shorter programming time**
- **Lower energy consumption due to shorter machine cycle time**
- **Improves productivity, even on machines with a low to medium spindle output**
- **Available for 2/2.5/3/4/5-axis rough machining**
- **Greater depth infeed simultaneously combined with higher feed rate**
- **Dynamic feed rate**

This example of trochoidal machining shows an aluminium block being machined with a contact depth of 20 mm (0.7874").

The finished casing component mainly undergoes trochoidal rough machining.

Instead of just checking one machining parameter, the process monitors a variety of important cutting and machine properties. The tool path is calculated from the machined volume and the lateral cutting pressure, but the tool pressure angle and material removal are kept within a defined range. The feed rate adapts dynamically to the tool path and is optimised in accordance with the machine's capabilities. This results in lower temperatures, which in many cases enables minimum lubrication or even dry machining.

ProfitMilling results in uniform tool paths, including uniform transitions and infeeds. The characteristic features of the process are a constant tool pressure angle and a high level of process reliability. What's more, the entire tool cutting edge can be utilised, which leads to a longer tool life.

DR small, the smallest of modular quick-change reaming systems

High-precision reaming with system sizes ranging from 7.600 mm (0.2992") to 13.100 mm (0.5157").

The HORN product range includes the smallest patented quick-change reaming system in the world. The four system sizes offer diameters ranging from 7.600 mm (0.2992") to 13.100 mm (0.5157").

The system allows the reaming cutters in the machine to be changed quickly and easily with maximum repeat accuracy. The high degree of flexibility in terms of cutting materials, and cutting edge and shank systems means that a vast array of applications are catered for. DR small cuts the costs per bore hole substantially, increases productivity and reduces logistics costs thanks to the easy swap system, which does away with the need for regrinding work. The high-precision point between the shank and exchangeable head features keys and slots with compensation for overdimensioning. It enables a high level of force transmission to be achieved with a changeover precision of less than 5 µm (0.0001969"). The indexable inserts are held in place by a central clamping screw. Steel or carbide shanks are available in different versions for through holes or blind holes. The main difference between these lies in the type of internal coolant supply. DR small, the revolutionary system for reaming small diameters, is a cost-effective alternative to solid carbide reamers.

406 and 409 tangential milling systems

The optimum system solution for high-performance milling: HORN's patented range of highly successful tangential milling tools that go by the name of the 406 and 409 systems are to be supplemented at every level with the introduction of new face, corner, screw-in and end mills.

The face and corner mills will be available in standard diameters of 40 mm (1.5748") to 250 mm (9.8425") with a wide and narrow tooth pitch. These products will offer maximum performance for meeting the stringent requirements of machines and workpieces alike. The existing screw-in and end mills from the 406 system are to be supplemented by solutions with diameters ranging from 16 mm (0.6299") to 40 mm (1.5748") that have been specially developed for use with driven tools. This will provide a comprehensive choice of efficient options for handling challenging machining tasks.

Diverse range: The HORN 406 and 409 tangential milling systems.

All the tool holders feature an internal coolant supply for optimum cooling and chip removal.

The indexable insert, which is carbide grade AS4B has a tough basic substrate, a TiAlN coating and is suitable for all kinds of applications within the main machining groups P, M and K.

The positive cutting and axial angles enable a soft cut and have a very beneficial effect on the machine in terms of quiet running and power requirements.

By using this system of cutters, you can ensure process reliability in a broad range of applications along with maximum performance and cost-effectiveness.

The HORN range is to be supplemented by milling cutters from Boehlerit.

COMBINING STRENGTHS

Sales cooperation between HORN and Boehlerit

At AMB 2016 in Stuttgart – Europe's second most important metalworking trade fair after EMO – HORN will be unveiling a strategic innovation. Two independent carbide and tool manufacturers are about to embark on a joint sales cooperation for ISO turning and milling tools: HORN in Tübingen and Boehlerit in Kapfenberg (Styria, Austria). As part of this, HORN will be responsible for selling Boehlerit-branded ISO turning and milling tools in Germany, France, the UK, the USA and China.

The aim of this sales cooperation is twofold. Firstly, it will enable the two medium-sized companies to combine the product and sales synergies of their organisations and, secondly, it is an opportunity for the family-run businesses to grow together on carefully targeted markets. As far as HORN is concerned, the Boehlerit range of ISO turning tools perfectly complements the products from its own internationally leading grooving range. Similarly, the new Boehlerit milling range will enable HORN to enhance its own portfolio of high-performance products by introducing a wide selection of top-performing and highly productive milling tools. In this way, HORN will be able to build on its leading position as a supplier of tools for technically demanding applications by establishing itself in the area of general machining as well. From Boehlerit's perspective, this sales cooperation is the key to opening the door to the defined markets. Incidentally, a similar sales cooperation has already been running in Brazil for many years, where Boehlerit has been selling HORN tools with very successful results.

By agreeing the new sales cooperation, HORN is responding to the wishes of its customers, who have repeatedly asked for a wider range of products. As a one-stop shop for equipment, HORN has always had to collaborate with other partners to provide a wide range of tools – but it has not always been happy with the quality. And that's because compromise is not part of HORN's vocabulary. HORN always strives to offer its customers the best possible solution. And the high-performance carbide tools from Boehlerit certainly do fit in with its concept of "best possible solutions". This is because Boehlerit utilises the development potential provided by its neighbour Böhler Edelstahl, which is also based in Kapfenberg. Boehlerit's carbide lab and the steel lab operated by Böhler (the world market leader for stainless steels) are collaborating extremely closely in the area of "cost-effective machining of high-strength and demanding steel grades". When supplementing their own tool systems with one another's products, HORN and Boehlerit will not be treading on each other's toes either with regard to the products themselves or with regard to the agreed geographical area. Over recent years, HORN has increased the size of its field sales force significantly and this investment will certainly pay off within the context of this project: there will be no shortage of competent consultants for the new comprehensive range of products.

Universal steel machining

The Boehlerit range of ISO turning products

In addition to the carbide and coating used, the new geometries that Boehlerit has developed in what it calls the “chip channel” will also play a key role in improving cost-effectiveness. They used a high-speed camera to carry out a precise chip breaking analysis for each turning application so that the best possible chip flow characteristics could be developed. This has resulted in optimum turning geometries for machining steel and even in solutions for the problems posed by special steel grades and superalloys. A new and harder gradient carbide ensures a high degree of machining reliability and a much more wear-resistant MT-CVD carbide coat results in higher cutting speeds. Primarily, this is achieved by increasing the percentage of the TiCN layer. The patented Nanolock TiCN bonding layer safely bonds the significantly harder Alpha-Al2O3 (HV2700), which has better insulating properties, and increases the service life by 60 per cent for a high degree of universality in steel machining.

The new LCM20T turning grade for indexable inserts enables cutting speeds of more than 200 m/min to be achieved when turning stainless steels. The reliable, heat-resistant carbide of the new turning grade exhibits high stability against plastic deformation, as does the BCS20T titanium grade. The peripherally ground CNGG 120408-BCU inserts, which are available in the Steeltec grades LCP15T and LCP25T, offer a high degree of machining reliability for an extremely wide range of steel materials, as does the Supertec LC415Z grade, which has proven itself to be ideal for superalloys and stainless steel.

The Boehlerit range of milling tools

Boehlerit’s range of high-end milling tools is based on eight innovative tool systems. These include two multifunctional tool systems that support two different machining operations with just one main body, thereby cutting the body-related and storage costs. What’s more, the range also encompasses everything from extremely economical high-feed tools through to face milling cutters with indexable inserts whose technical features include 16 cutting edges in the rotation direction. In total, there are 12 new milling grades that are perfect for the many milling tasks encountered when face milling and corner milling all the latest materials. These manage to combine machining reliability with cost-effectiveness. One particular highlight of the new milling range is the patented and innovative TERAspeed 2.0 AlTiN layer. The high aluminium content of this layer and its innovative nanostructure have made it possible to combine conflicting properties for the first time ever – such as remarkable toughness, extreme layer thickness and wear resistance. Another innovative carbide coat that has been specifically designed for milling is the thick PVD AlTiN Goldlox top coat; with its high wear resistance at high temperatures, this improves tool life significantly when working with various types of steel. Other positive features of the range are the tough and wear-resistant grades for stainless steel and superalloys.

One more thing: Boehlerit relies exclusively on conflict-free materials to produce its carbides.

Boehlerit ISO inserts are being used to complement HORN’s grooving products.

HORN TITANIUM MILLING CUTTERS

An extensive range of tools

The machining of titanium is not without it problems. Its low thermal conductivity prevents effective heat dissipation. As a result, the cutting heat is concentrated on the cutting edge and on the tool surface. Consequently, the chip has to be removed from the machining zone very quickly. Chip forming is not easy in the case of titanium and the chips bounce back immediately after the cutting edge when they cool down. The ductility of titanium poses yet another problem. When subjected to the cutting pressure, titanium recoils and exerts pressure and friction on the flank. Moreover, titanium has a tendency to stick and act as a lubricant. This calls for special machining solutions.

Titanium offers high mechanical strength and is a good conductor, but not of heat. It also exhibits low thermal expansion. Its strength properties are similar to those of tempered steel and it even retains these at temperatures of up to around 200 °C to 635 °C. Depending on the alloy, the tensile strength ranges between 300 and 1150 N/mm^2. And yet, with its specific weight of 4.51 g/cm^3, titanium is almost 50 per cent lighter than steel. Its melting temperature of 1660 °C is higher than that of steel. Titanium offers an extraordinarily high level of corrosion resistance, particularly when exposed to chloride solutions, seawater and organic acids. Titanium and its alloys are used in numerous sectors because of their special properties. These include: aviation and aerospace, traffic/medical/power engineering, motor racing, the chemical industry and the jewellery making trade.

Special tool solutions

HORN has developed an impressive array of special tools for machining titanium materials such as Ti6Al4V. With their sharp cutting edges, positive cutting angle, large relief angle and polished cutting edges, these tools are designed to overcome the main problems encountered during titanium machining. The TSTK cutting material grade that HORN has developed for its solid carbide milling cutters is specifically intended for machining titanium in the aviation/aerospace and medical technology industries. As well as offering good tribological properties and high temperature resistance, this introduces minimal heat into the substrate and acts as a kind of thermal shield. Another im-

A comprehensive range for machining titanium.

portant aspect that had to be considered when developing the solid carbide end mills was that they had to have different helix angles and different pitches. This ensures a soft and gentle cut while avoiding vibrations. Sufficient quantities of coolant are essential when machining titanium. The HORN titanium range includes a completely new line of solid carbide milling cutters with diameters ranging from 2 mm (0.0787") to 20 mm (0.7874"). These are available with four or five cutting edges and in 2 x D and 3 x D versions.

Structural components for the aerospace industry

Structural components made from titanium and titanium alloys now account for 15 to 20 per cent of an aeroplane's weight, a percentage that is twice as high as for the previous generation of aircraft. Around 80 per cent of all titanium applications are found in the aviation and aerospace industries. It is the titanium components that provide the structure for the fuselage and for the wing profile. They are installed in the tail unit, the undercarriage, the air brakes and landing flaps, the door frames, the cross members and the seats. For these structural components, the metal removal rate for the blanks (often forging blanks) sometimes exceeds 95 per cent. The forging process creates residual stresses in the component. When these structural components undergo milling, the high metal removal rate alters the residual stress behaviour considerably, causing deformation of long and narrow components. Once the workpieces have been released from the clamping table, warping of up to several millimetres may occur. The difficulties encountered during machining and the increasing volume of titanium components are only one side of the problem; the other is the introduction of modern alloys. In addition to the conventional aircraft alloy Ti6Al4V, a new material with a strength of 1400 N/mm^2 and even more stringent machining requirements is coming to play an increasingly important role. This material is called Ti5553 (Ti5Al5V5Mo3Cr).

New milling cutters for high-tech machining in the aerospace industry.

The entire process chain has to be just right

In order to machine titanium successfully, you have to get the complete process chain exactly right. This starts with the correct choice of tool in terms of the substrate, geometry and coating, and extends right through to the selection of tool holders with a precise positive fit, high level of concentricity and high damping capacity. As for the machinery, high-torque tool spindles and modern, dynamic five-axis machining centres are required to ensure a high machining capacity.

Other materials for the aerospace industry

HORN does not just offer tools for aerospace components made from titanium but also has impressive solutions for machining aluminium and CFRP as well. The high feed rate milling cutters from the DAH 25, 37 and 62 system are ideal for large structural parts made from titanium. Thanks to their face and helical interpolation, they are perfectly suited to pocket milling. The arbor milling cutters from the DAH system are great for machining forged titanium parts, as well as other aerospace materials such as Hastelloy, Inconel or Astroloy. HORN also offers an extensive range of solid carbide milling cutters for high-strength steels in the form of its DS system. For tackling aluminium parts, the HORN aluminium range includes a whole host of special solid carbide and indexable insert milling cutters. Meanwhile, CVD-D or PCD-tipped milling cutters made from solid carbide are perfect for machining both small and large CFRP components alike. More often than not, the best results can be achieved by using special tools. And that is where conversations between the HORN field sales force and the customer really come into play.

Stability, quiet running and extreme cutting depths with tangential milling technology for heavy-duty machining.

HEAVY-DUTY TANGENTIAL MILLING SYSTEMS

Higher, faster, further

Time and cost factors are becoming increasingly intense, including in the area of milling, and this calls for more efficient processes: higher cutting speeds, higher feed rates, greater chip thicknesses, shorter cycle times and longer tool lives – in short: lower unit costs. A process that has long been used for milling applications is about to overtake conventional milling with radially arranged cutting edges as the market's preferred solution for volume cutting. That process is called tangential milling.

Over recent years, tangential milling systems have become the workhorses of the machining industry. During tangential milling, the cutting forces are directed towards where the cutting edge is most stable. Because such large infeeds are possible, this process achieves formidable material removal rates and high levels of productivity combined with good-quality surfaces. In contrast to milling with radially arranged cutting edges, the tan-

A selection of items from the 409 tangential milling system.

The milling cutters are equipped with rhombic indexable inserts, which are screwed on tangentially.

406 end mills for cutting depths of up to 6.3 mm (0,2480").

gential cutting bodies are circumferentially arranged. Thanks to this tangential design, the main body of the milling cutter has a much bigger effective cross-section than radial tools. This offers extra scope for improving stability and quiet running characteristics, particularly when performing heavy-duty machining with considerable cutting depths. Having a large number of effective cutting edges results in good cutting force distribution. The favourable application force and clamping force conditions and the extreme stability of the solid cutting edges enable high cutting speeds and large chip thicknesses to be achieved together with long tool lives. When the costs are considered in their entirety, these benefits outweigh the price advantages of universal cutting inserts such as DIN/ISO indexable inserts featuring up to eight or even ten cutting edges.

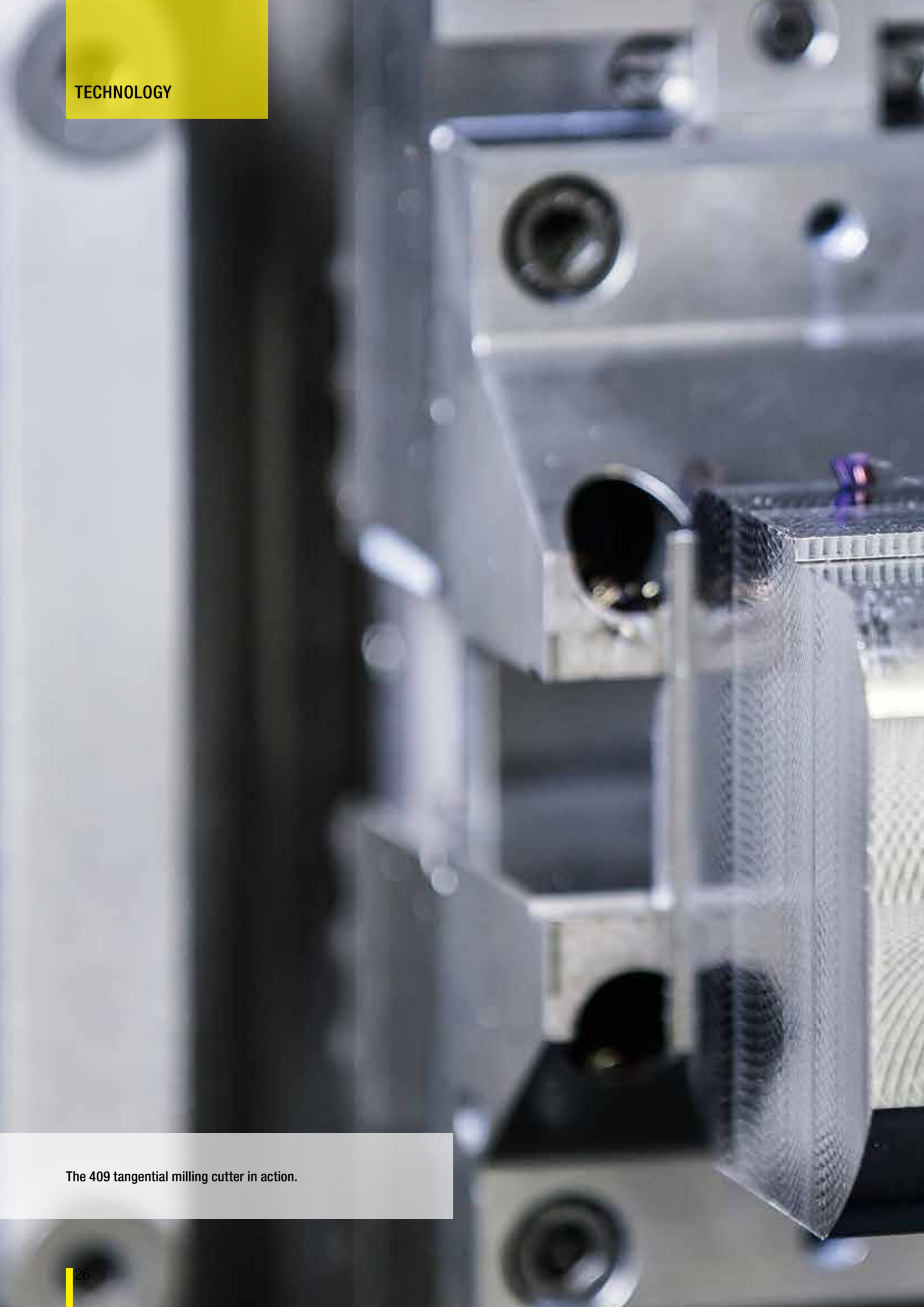
60 Percent longer tool life

The patented 409/406 tangential milling system from HORN cannot fail to impress with its rhombic indexable inserts. It includes end mills with cutting edge diameters of 32 mm (1.2598") and 40 mm (1.5748") and arbor milling cutters with cutting edge diameters of 40 mm (1.5748"), 50 mm (1.9685"), 63 mm (2.4803") and 80 mm (3.1496"), which are all equipped with the type 409 cutting insert. The system is rounded off by 45° face milling cutters, 60° milling cutters, cutter heads, and helical and side milling cutters. The precision-ground rhombic indexable inserts achieve a high level of precision with very good surface quality. The positive cutting and axial angles ensure a soft cut. The secondary cutting edge with integrated trailing chamfer produces optimum face surfaces. An additional flank chamfer makes for a stable wedge angle and a very smooth milling process. The milling cutters with a corner radius of r = 0.8 mm (0.0315") achieve cutting depths of up to ap = 9.3 mm (0.3661") and are suitable for milling 90° shoulders. The indexable inserts are made from the new AS4B grade and a tough basic substrate, have a TiAlN coating and offer long tool lives for both rough machining and finishing work. This is backed up by effective internal cooling via the holder with the coolant lubricant being released in the direction of the cutting edge cutting zone.

The cutting edge geometry was developed by simulating the chip shape to ensure optimum chip flow. Additional "projections" attached to the circumference of the cutting inserts also result in an improved relief angle for the individual secondary cutters and, furthermore, provide extra protection on the flat side for the main cutting edge, which is set back as a result. The main body of the milling cutter has a specially treated surface and enjoys long-lasting protection against the abrasive chips thanks to its extreme hardness and strength. When a type 409 tangential milling cutter made from tempered 42CrMo4 steel and with rhombic indexable inserts was compared with similar tools available on the market, the tool life was found to bea greater improvement. The successful type 409 milling system featuring precision-ground indexable inserts has now been expanded through the addition of directly pressed and precision-sintered indexable inserts. These have the same rhombic shape as the precision-ground cutting inserts and are compatible with all 90° corner mills and 45° face milling cutters from the 409 system as well as all shell end mills.

Perfect interplay

The six types of milling cutter in the M409 system, which are available with several different diameters, are all designed for use with an R409 indexable insert. The only difference in the case of the side milling cutter is that the L409 left-hand design is required as well. For smaller dimensions we recommend the smaller M406 system, which still offers high material removal rates. Given that the M409/406 system is extremely cost-effective for volume cutting and large-scale production, special solutions are – of course – also involved. However, these call for a detailed analysis of the interplay between the workpiece, workpiece clamping, material, speed and feed rate while also taking account of the machine's spindle output.



The 409 tangential milling cutter in action.

LIGHT-CUTTING AND HIGH-PERFORMANCE

Armbruster GmbH, a company based in Steinach in the Kinzigtal area of the Black Forest, produces a wide variety of precision parts: medical instruments and implants as well as components for the measuring technology and aviation/aerospace industries. These are complex products and the professionals that rely on them need a partner they can depend on. In turn, the manufacturer also needs a fully dependable partner. As far as the company is concerned, HORN is a key tool partner.

Although only founded 20 years ago, Armbruster has grown considerably since then and now employs 65 full-time members and 20 part-time members of staff. Year upon year, it has invested huge sums in powerful new machinery and buildings. It has been forced to move locations several times because of the constant need for more space, eventually landing in its current industrial building, which offers plenty of scope for expansion. The machinery is amazingly modern and powerful, a clear reflection of the company's high level of in-house added value and the precision of its products. This machinery includes all the machining technologies that Armbruster needs. The range of materials covers 80 different high-quality types, including many high-alloy stainless steel grades, several grades of titanium, and 24 types of plastic and composite material (from CFRP through to fibre-reinforced PEEK). The sheer diversity speaks for itself.

Casing made from X155CrVMo 12-1 – even this extremely tough and abrasive material can be machined on five sides without any problems using the flat clamping concept.

A clear focus on medical technology

The company has a clear focus on products and parts for the medical technology industry, which account for 60 to 70 per cent of its output. Tobias Armbruster, who manages the company together with his brother Florian, is very proud of its extraordinary product range. “We produce surgical instruments for treating bone fractures and equipment to assist with knee joint, hip, shoulder and spinal implants, as well as the actual implants themselves. As you can see, our product range is extremely sophisticated and ambitious. Naturally, the requirements for special industrial products and for measuring technology and aviation/aerospace components are no less complex and precise.” The batch sizes can be anywhere between 1 and 2000 parts but I would say that batch sizes of 100 to 500 parts are more typical. Around 5000 parts are constantly in demand, which provides a clue to the health of the order figures.

“What we need are easy cutting milling cutters”

“We have a high degree of automation and an extremely flexible approach, working night shifts even at the weekend”, explains Hubert Griesbaum, a technical engineer at the company. “In the last six weeks alone, we have turned out 180 different parts on our Integrex machines.” The concept of five-sided machining runs all the way through the product range. “It was 20 years ago that we came up with our own special and secure clamping system with the smallest of clamping heights”, says Griesbaum. “However, when tackling parts that have a tall design height and a large overturning moment, this means that we need milling cutters that are particularly easy cutting. I can explain this for you through reference to two industrial parts: a casing and a holder.” The first part, a casing made from the tough steel grade X155CrVMo 12-1, is extremely difficult to machine and falls into cutting class 2 (1 = poor/10 = good). This means that the material is highly abrasive and causes flank wear. We have also experienced problems repeatedly due to the high machining forces and the delicate clamp. The second part, a holder made from the material 90MnCrV8, falls into cutting class 5 and so causes less wear but because of its tall design height and the flat clamping concept with a large overturning moment, it is difficult to machine.

“Rough machining time halved, tool life tripled”

Hubert Griesbaum: “After conducting lots of trials, we have now identified our preferred milling cutter for the rough machining work: a type 409 milling cutter from HORN with a diameter of 50 mm (1.9685") and seven cutting edges. Thanks to its low cutting forces, this easy cutting tangential milling cutter generates minimal overturning side load forces on the workpiece. At the same time, we have managed to halve the rough machining time but

the life of the milling cutting edges is now further improved. This represents a considerable cost and time saving."

He goes on: "Given that we usually only produce in small quantities, we do not have much experience of what would constitute reliable cutting values for each individual part. And because the clamping situation is the same across the board, we approach each of the material groups with the same cutting values. Consequently, we have succeeded in improving our process reliability significantly."

The advantages of HORN type 409

Karl Schonhardt, the responsible HORN sales representative, happily lists all the benefits of the 409 tangential milling system: "The patented M409 tangential milling system from HORN cannot fail to impress with its rhombic indexable inserts. The precision-ground rhombic indexable inserts achieve maximum possible precision and optimum surface quality levels. The positive cutting and axial angles ensure a soft cut while the secondary cutting edge with integrated trailing chamfer produces outstanding face surfaces. An additional flank chamfer makes for a stable wedge angle and a very smooth milling process. The milling cutters with a corner radius of r = 0.4 mm (0.0157"), 0.8 mm (0.0314") or 1.2 mm (0,0472") achieve cutting depths of up to ap = 9.3 mm (0.3661") and are suitable for milling 45°, 60°and 90° shoulders. The indexable inserts are made from the AS4B grade and a tough basic substrate, have a TiAlN coating and offer long tool lives for both rough machining and finishing work. This is backed up by effective internal cooling via the holder with the coolant lubricant being released in the direction of the cutting edge cutting zone. The cutting edge geometry was developed by simulating the chip shape to ensure optimum chip flow. Additional projections attached to the circumference of the cutting inserts also result in an improved relief angle for the individual secondary cutters and, furthermore, provide extra protection on the flat side for the main cutting edge, which is set back as a result."

From left to right: Claus Dold (Production Manager), Waldemar Zeiger (CNC miller), Florian Armbruster (Director) and Karl Schonhardt (HORN sales representative): "Substantial cost savings with the type 409 milling cutter from HORN."

Stefanie Heindel started working for HORN in 2011. She has been involved in event management since 2014.

HORN EVENTS

A look behind the scenes

So Ms Heindel, what do you think makes a successful event?

In my view, a successful event starts at the planning stage. Getting heads together is really important to me as far as this is concerned. If all the people involved have been able to contribute their ideas and suggestions and are happy to be there, our guests will be able to tell. If everyone goes home happy at the end of the day, I consider it to have been a successful event.

What are your responsibilities in relation to events?

They start with the need to identify a suitable date but also encompass everything from liaising with all the departments involved, managing the registration process, creating the training documentation, and booking hotels and catering services through to offering support during the event and doing the follow-up work. The exact nature of my responsibilities depends on the type of event: is it a seminar, a factory tour, an internal event, and so on and so forth.

You are the immediate contact person for the participants. When do they get in touch with you and what can they expect from you?

The first point of contact is when someone registers for an event or when interested parties want to obtain on some information in advance. I provide the participants with all the key information they need concerning the planned order of the event and how long it will last, I offer hotel recommendations and tell them where they can park, and plenty more besides. I also greet the participants in person at the beginning of the event so that they can come straight to me if they have any questions or concerns.

What are the biggest challenges in the run-up to the event?

For me, the biggest thing is identifying a suitable date. There are often several departments involved and so it is not always easy to reconcile the competing demands. The closer we are to the date, the harder it is to put everything in place. I really value the fact that the people within our organisation are so willing to liaise in this way and are used to working towards targets.

How many events are you involved in each year?

If you count the trade fairs as well, it adds up to around 30 events a year. This total also includes internal training courses, customer seminars and large-scale factory tours. HORN exhibits at approximately 50 trade fairs globally every year. This shows that even though digitalisation is on the rise, it has not rendered face-to-face contact redundant. On the contrary, it is prized as a form of added value.

What makes HORN events different from other events?

According to the positive feedback we repeatedly get from participants, it is the way everyone gets on so well together. The other distinctive thing about our seminars is the mixture of theory and practice, which includes practical elements that allow the participants to bring their own personal concerns and interests to bear. What's more, we are careful not to use the events as a platform for advertising specific products. Instead, we focus on imparting knowledge about the application or technology concerned.

Are the events also farmed out to the subsidiaries?

Some of the technology seminars offered by the HORN Academy are also available at the subsidiaries.

What is your favourite event personally?

The technology seminars that I've just mentioned, which are held twice a year. Although, they take a long time to prepare and require lots of effort, it is precisely this type of challenge that makes my job so interesting. To put it simply, having direct contact with our customers before, during and after the event is something that I enjoy very much.

The seminars focus on the various technologies and applications rather than on the products per se.

The presentations given during the technology seminars are complemented by practical application examples at the demonstration centre.

The HORN stand at the AMB covers three levels.

HORN AT THE AMB IN STUTTGART

People, products, solutions and discussion

Paul Horn GmbH first exhibited at the AMB in Stuttgart back in 1982 and was one of the earliest exhibitors.

The trade fair has always been an opportunity to make and maintain contacts, to discuss projects in advance and to address problems and challenges. The size of our exhibit in Stuttgart illustrates just how far we have come in these areas: what was once a fairly simple yet well-attended stand has now become a three-storey complex. However, the three-storey stand concept was devised out of necessity. Due to the fact that the AMB has been oversubscribed for years, there was no opportunity to expand outwards. Consequently, we decided to go upwards instead. Nevertheless, we were determined to remain true to our principles: stand to be staffed by our own employees, direct contact with customers and visitors, products available for people to pick up and touch, and competent and genuine advice. Over time, advances have certainly been made with regard to the tool technology, machinery and available presentation methods.

HORN at AMB 2016 – the next chapter of the success story.

The HORN stand: A platform for meeting and sharing through discussion.

History of the AMB

- 1982: AMB founded as a trade fair for machine tools and precision tools. The original site in the Killesberg suburb offered more than 35,000 square metres of exhibition space.
- 1988: Size of exhibition halls at the Killesberg site increased to 50,000 square metres.
- Since 2008, the AMB has been held at the new exhibition grounds next to Stuttgart airport. In 2006, only 800 companies had exhibited at the AMB, but just two years later the figure stood at 1306. The visitor numbers also leapt dramatically from 50,000 to more than 85,000.
- In 2010, the trade fair managed to increase the number of exhibitors even further, with the visitor tally also rising to more than 86,000. At the same time, it saw an increase in the volume of international visitors and exhibitors.
- In 2014, the number of visitors exceeded 90,000 for the first time and the number of exhibitors – spread across an exhibition space of 105,200 square metres – rose to well over 1300.
- In 2016, the first ever AMB Iran was held in Tehran.
- In 2018, the Messe Stuttgart exhibition and trade fair centre will open its new Hall 10, which will be called the Paul Horn Hall. This will take the gross overall exhibition space available at the new site up to 120,000 square metres from 2018.

The HORN exhibit in 1982.

HORN at the AMB in 1986.

Free-cutting steel is predominantly used in turning applications.

FREE-CUTTING STEEL AS A MATERIAL

Appealing and widely used

Free-cutting steels are machined on CNC-lathes or turning centres in large volumes in order to produce turned parts. During this process, they generate short-breaking chips so that this largely automated machining operation remains trouble-free. Free-cutting steels are principally used to mass-produce small parts that are subject to low loads and require a high metal removal rate, such as connecting and fastening components, small shafts, hydraulic parts, fittings and similar products.

Free-cutting steels are unalloyed or low-alloy quality steels with a higher sulphur and phosphorus content. They are 0.07 Percent – 0.65 Percent carbon, 0.18 Percent – 0.4 Percent sulphur, 0.06 Percent – 0.11 Percent phosphorus, 0.6 Percent – 1.5 Percent manganese, 0.05 Percent – 0.4 Percent silicon and – if particularly good chip breaking characteristics and a smooth surface are required – 0.15 Percent – 0.3 Percent lead.

Alloying the steels with phosphorus or sulphur creates brittle inclusions that make the chips break more easily. Lead results in heterogeneous lead inclusions that are finely distributed in the steel and which facilitate chip breaking and improve surface quality. Sulphur, in conjunction with manganese, creates soft linear manganese sulphide inclusions in the steel structure and also promotes chip breaking.

Details of the most important free-cutting steels can be found in DIN 1651/EN 10087 and EN 10277-3. Examples of unalloyed steel grades include 9S20, 11SMn30, 11SMnPb30 or 11SMnPbBiTe37. The relatively low tensile strength of these materials ranges from 380 to 570 N/mm^2.

Choosing the right material

The mass-produced turned parts sometimes have to meet stringent requirements with regard to their dimensional accuracy and surface quality. They are machined in several operations. Often, several machining operations run in parallel – with different cutting speeds according to the diameter.

When optimising the machining processes, a factor that is becoming increasingly important is the need to select the most suitable material. This can play a major role in reducing the production costs, not so much because of the price of the material itself but more in terms of the machining speed. A free-cutting steel with a lead content of around 0.15 Percent to 0.30 Percent is the key to achieving cutting speeds that are 75 per cent higher while doubling the life of the tools. At the same time, the lead protects the tool by acting as a lubricant.

The different levels of quality mean that not all free-cutting steel is alike.

The more complex the turned parts, the more important it is to ensure optimum machinability of the steel used. This applies regardless of the machining operation involved. As a result, a steel with the maximum possible range of machinability will generally be required so that it can meet the requirements of fast and complex cutting conditions as well as slow and straightforward ones.

The material itself poses relatively few problems from a machining perspective. However, because every split second and every penny really counts when mass-producing large quantities, machine tools are being pushed to their kinematic limits and the load on the tools is being stretched to the maximum. Multi-machine operation combined with up to 18 shifts per week means that ultimate process reliability is required. High machining rates demand maximum performance from the tool cutting edges and from the cooling this can sometimes only be achieved thanks to experienced machinists and tool specialists who know all the tricks of the trade. Although the tool cutting edges have long lives, these vary and so cutting edges frequently have to be replaced.

Tool requirements

High cutting speeds and large infeeds result in chip impact and exert a heavy load on the corners of the cutting inserts. Nominal diameters with strict tolerances and the demand for high surface quality call for good cutting edge quality and stability, sometimes even with different degrees of cutting edge rounding. Profile inserts produce grooves of different depths with different machining rates and cutting speeds. As a result, the profiles of these die inserts are given different microgeometries to compensate for the different contact conditions. Cutting inserts for grooving and parting off require chip control geometries to prevent damage to the flanks and faces. Burr-free machining is necessary in the case of all geometries.

Once the machining process has finally been optimised for large-scale production, all the parameters have been set correctly, the power reserves have been exploited to the full and everything is working perfectly, the batch then changes or the company starts using steel from another manufacturer. Although the steel grade and material number are identical, they then find that the machining behaviour has changed to a lesser or greater extent. In recent years, machinists working with free-cutting steel have increasingly been complaining about fluctuations in quality despite using identical grades of steel. But what are the reasons for this?

Fluctuating batches

Free-cutting steel is an extremely price-sensitive material. Dealers purchase it from wherever they can get it the cheapest. DIN and EN standards provide protection against poor quality and stipulate the required alloy content. So wherein lies the problem? To answer this, you have to ask where the cheap steel comes from. Often it comes from China, Eastern Europe, Russia or Brazil, for example – places where they will throw anything that the local scrap market has to offer into the blast furnaces and smelting plants even though the scrap merchants are not that concerned about how well the materials have been sorted. Despite the fact that these countries manage to meet the composition criteria for the respective steel grade, the use of automotive scrap metal, for example, leads to impurities in the form of various metals. Although these are present in such small quantities that they do not have to be eliminated, they still affect the quality of the steel and its machinability. Examples include microalloys involving aluminium, copper, magnesium, chromium, nickel, molybdenum, titanium and vanadium. Although these impurities are not allowed to exceed a maximum content limit as defined by material standards, even extremely low concentrations and reactions between them can be detrimental to the formation of the structure and have a negative impact on the properties of the steel and its machinability.

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

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