№ 01 2020

world of tools

HORN

SPECIAL FEATURE: AUTOMOTIVE

DEAR READERS,

Particularly since the diesel scandal, the automotive sector has found itself at the centre of many public and political discussions. Nevertheless, this sector is still – and is set to remain – a core industry within Germany, Europe and the rest of the world. New drive concepts are bursting onto the market. And existing drive trains are being revised and further optimised. There is certainly a lot happening in this area, but we must remember that holistic thinking is just as important in this sector as it is in others. For example, the energy mix within the respective countries should be considered and we should give the technologies the chance to prove themselves and become established instead of rigidly setting our sights on one solution.

How do you go about making vocational training attractive these days? Well, by demonstrating what is possible and how varied each trade can be. And that is precisely where EuroSkills 2020 comes in. This year, the European vocational skills contest is taking place in Graz, Austria. As a silver sponsor of the event, we are investing in the advancement of young professionals, the recruitment of young talent and – in turn – our common future. We are proud to be able to play our part.

Making a difference is what counts. Nowhere is this more apparent than in the area of composite machining. Here, it makes a major difference, for example, whether I crush CFRP fibres with PCD tools or slice through them with sharp CVD-D cutting edges. As a manufacturer of precision tools, our job is not only to be familiar with the tool itself but also with the overall production conditions – such as the machine, workholding equipment, control and material – and to know how to master them. Particularly with regard to the material, we believe it is important for our company to possess the relevant know-how and experience internally.

We hope that you gain some fascinating insights from this issue and that you really enjoy reading it.

Markus Horn, Lothar Horn and Matthias Rommel

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AUTOMOTIVE

HOT TOPIC: ELECTRIC DRIVES – A NEW ERA

Gear cutting also has a role to play in manufacturing electric motors: here you can see gear teeth being produced by the gear skiving process.

NEW TOOL CONCEPTS FOR THE AUTOMOTIVE INDUSTRY

When buying a new car, people nowadays no longer face a binary choice between a diesel or a petrol engine. Instead, they have a multitude of options as far as the drive concept is concerned. Among the public and politicians, there is currently a lot of interest in electromobility. But is electromobility really the solution to the problems that stem, in part, from the use of combustion engines? After all, electric cars are not CO_2-free. In addition to the emissions that occur during their production, considerable CO_2 emissions are caused in virtually all EU countries as a result of batteries being charged using power generated by their respective national energy production mix. "Given that battery-powered electromobility also presents considerable weaknesses, I believe that this drive concept is only an interim solution. Hydrogen fuel cells and synthetic fuels that could be burnt without generating CO_2, on the other hand, do actually have the potential to provide a long-term solution", says Lothar Horn, Joint Managing Director, Paul Horn GmbH.

Anticipated tool requirements

Trends in the number of vehicle units are a key factor within the automotive industry, but so is the movement towards high-efficiency engines and hybrid concepts. To accommodate this shift, the automotive industry is starting to demand new tool concepts. On the other hand, the fact that less machining is needed to produce electric vehicles means that significantly fewer tools are required. This is down to the variety of components. Whereas previous drive concepts relied on having 4,000 different components, a purely electric drive can make do with approximately 320. With hybrid solutions, by contrast, there is an increase in the number of components required. Over the coming years, hybrid vehicles are set to grow their share of the total passenger car market. As a result, we are going to see a corresponding increase in the amount of machining over the medium term. However, the question remains as to how the absence of certain components in pure electric drives can be compensated for. In the words of Lothar Horn: "First and foremost, it truly makes sense for companies like ours to position

"THERE IS STILL LOTS OF POTENTIAL FOR MODERN DIESEL AND PETROL ENGINES, EVEN IN THE FUTURE."

Lothar Horn, Joint Managing Director, Paul Horn GmbH.

The automotive industry has always been – and remains – a major source of inspiration for the HORN tool portfolio.

themselves more broadly and, in so doing, make themselves less dependent on one sector. Machining encompasses a multitude of sectors, such as aerospace technology, mechanical engineering, chemicals, medical technology, and tool and mould making. Consequently, the development path that a company takes or wishes to take is ultimately a strategic decision. The fact that hybrid drive solutions result in more machining whereas pure battery-powered drive solutions call for significantly less is one facet of this decision-making process."

Tool solutions for electric motors as well

Turbochargers are often used to boost efficiency. These are generally made from highly heat-resistant materials that are difficult to machine. Hybridisation also increases the efficiency of combustion engines. It is always worth checking whether major leaps in performance can be achieved within the manufacturing process by using customised special tools. In this context, new machining possibilities such as gear skiving also come into play. This process for manufacturing gear teeth has been in use for over a century – but has only been incorporated into a wider range of applications since machining centres and multi-tasking CNC lathes with fully synchronised spindles and process-optimised software have been able to accommodate the highly complex technology. However, it is important to note that this is not just a solution for the electromobility sector, but is one that offers a wide range of applications for the aerospace industry and many others besides.

Electromobility is competing with other industries for raw materials

Battery-powered electromobility, which currently relies on lithium-ion rechargeable batteries, also carries further implications. Like many others, the batteries require cobalt. And while it is true that electromobility applications are easily the biggest growth area for rechargeable batteries, technologies for storing renewable energy and other mobile applications are increasingly going to have an impact on future demand for batteries as well.

Outlook

VDMA forecasts currently predict that annual production of passenger cars will increase globally in the long term. The volume of machining associated with this is dependent on the type of drive technology. Furthermore, the VDMA studies indicate that hybrid (mild hybrid and plug-in hybrid) vehicles are likely to assume a bigger share of the market than purely battery powered electric vehicles in the future, which will mean an increase in the volume of machining. "Until a long-term solution is found for the drive train, customers will continue to have a multitude of options – and that includes modern diesel and petrol engines", says Lothar Horn.

AUTOMOTIVE

NEW COATING, HIGHER PERFORMANCE

Together with experts from Paul Horn GmbH, key people at GKN Driveline have spent more than two years on an optimisation and testing project. Their aim? To optimise the milling process for producing constant velocity joints for the automotive industry. By switching over to HORN's proprietary AK6 coating for the SX tool system, the partners were able to achieve greater process reliability and, in the case of certain components, managed to virtually double tool life compared with the previous coating.

AUTOMOTIVE

NEW COATING, HIGHER PERFORMANCE

SMALL PRODUCTION TOLERANCE COUPLED WITH HIGH SURFACE QUALITY

Milling the outer race.

There is a component that can be found in any car: the homokinetic joint (also known as a constant velocity joint). It is used to transmit torque and angular velocity evenly from the drive shaft to a second shaft that is positioned at an angle in relation to the first. Constant velocity joints transmit rotary motion to the next shaft uniformly. The most common joints found in vehicle construction are those that transmit the power from the gearbox to the driven wheels. Constant velocity joints are capable of transmitting rotary motion up to an angle of 50 degrees. In addition to fixed ball joints, plunge joints are also used. As well as allowing angular motion, these also support axial motion to prevent power transmission from being interrupted during steering or suspension movements.

At the heart of the homokinetic joint lie the balls that travel along precision-milled ball tracks. They have a very small production tolerance and also require a high surface quality to be achieved. "The tight tolerances and our production quality are key to the long service life of our joints", says Tobias Lotz, a tool designer at GKN. He then adds: "Form tolerances are to within microns".

An overview of the components making up a homokinetic joint.

Continual process optimisation

A drive train contains both fixed ball joints and ball plunge joints. The specialists in Offenbach mill the ball tracks into the joint journal, the outer race and the inner race. "Due to the high quantities involved, we are constantly working on continuous improvement of processes", says Lotz. The first milestone in optimisation was achieved back in 2011 when those in charge switched to an insert that was centrally screwed into place onto the SX exchangeable head system. Thomas Kühn, a product specialist and application engineer at HORN, recalls the situation as follows: "By changing over to the SX system, we were able to increase the production output by a third. In addition to eliminating a machining step, the SX tools brought the added benefit of considerably longer tool life."

OUTPUT INCREASED BY A THIRD.

With a view to optimising the process again, the aim being to increase tool life further, the key people working with Darius Kalesse and Tobias Lotz at GKN contacted the HORN field sales team. "The ball track milling process was already functioning very well, so we had to identify a new point of the process to tweak", explains Kühn. This turned out to be the search for a new insert coating. The task was undertaken in collaboration with the engineers and R&D team responsible for coatings at HORN. The researchers therefore received assistance from a renowned manufacturer of coating systems and materials.

Until then, HORN had been applying an aluminium chromium nitride-based (AlCrN) coating to its SX tools. This former coating had a thickness of four microns (0.00016"). The collaborative development resulted in a new coating called AK6. The highly heat-resistant coating has very good adhesion. In addition, the sputter technology eliminates the problem of droplets forming in the layer as it is applied. The advantage of this is that it creates a very smooth tool surface structure, which is beneficial because any flaws and roughness in the tool coating have a negative impact on tool life.

Tool life virtually doubled

"We always test new tools on workpieces that are associated with a shorter tool life, as a kind of endurance test", explains Darius Kalesse. During the initial trials with the new coating, significant improvements quickly became apparent. "Taking into account all the development stages, trials, fine-tuning and testing – including on small batches – it took around two years to complete the switch", explains Stefan Bachmann, a HORN field sales representative. All the parties involved were extremely satisfied with the results of the intensive collaboration. The new AK6 coating has a thickness of just under six microns and, depending on the workpiece, allows an increase in tool life of between 30 and 70 per cent.

THE RESULT OF INTENSIVE COLLABORATION.

A partnership spanning almost 25 years. Pictured left to right: Tobias Lotz (GKN Driveline), Thomas Kühn (HORN), Uli Schuppert and Eugen Kusmaul (GKN Driveline), Stefan Bachmann (HORN) and Darius Kalesse (GKN Driveline).

Milling the inner race.

The machining process for the ball tracks is as follows: Each ball track is produced using a two-part cycle. The tool rough machines and finishes each ball track at a cutting speed of 200 to 300 m/min (656.16798 feet (ft)/min to 984.25197 feet (ft)/min). The tools have either four or five inserts. Depending on the size of the component, it takes between 35 and 50 seconds to machine six, eight or ten ball tracks.

Tracks are milled into the component while it is still soft. The ball tracks are then induction hardened, the associated distortion having been factored into the tool profile. Thus, the necessary track contour – which has to be accurate to within microns – is only achieved after the heat treatment process. "When grinding the elliptical edge profile of the ball track milling cutters, we achieve a form tolerance of less than 0.005 mm (0.196"). This means that the shape of the cutting edge can be precisely tailored to the anticipated distortion due to hardening", asserts Kühn.

High stability

The SX tool system is an enhanced version of the 42X family of ball track milling cutters from HORN. However, a central clamping screw meant that the 42X system had a limited milling depth. The enhancement process led to the development of the SX exchangeable head system. The cutter head is connected to the tool body interface via a stable and robust thread that is nevertheless highly precise. This results in several advantages: high stability thanks to the generously dimensioned mating thread, broad support provided by the large contact surface and highly accurate insert exchange that always achieves alignment within the centre of the tolerance band. In addition, changing the cutter head is an easy and user-friendly process.

TOOL SOLUTIONS THAT SET NEW BENCHMARKS.

GKN has been collaborating with HORN since 1996. Over this long period, HORN has managed to improve a large number of critical machining tasks. HORN is also willing to take on technologies that it has never encountered before, such as profile broaching on large broaching machines. The Tübingen-based tool manufacturer analyses these and offers tool solutions that set new benchmarks. "The projects undertaken with HORN are always productive. They are very well documented and technical support is fast and delivered in a true spirit of partnership", states Lotz.

A global player

GKN Driveline is represented globally in more than 30 countries via its workforce of around 50,000 employees. With a market share of approximately 40 per cent, the company is a market leader in the production of drive shafts and side shafts. As a global supplier to the leading vehicle manufacturers, GKN Driveline makes and delivers a wide range of drive systems – for everything from small, low-cost passenger cars right through to highly advanced premium vehicles with demanding requirements in terms of driving dynamics.

AUTOMOTIVE

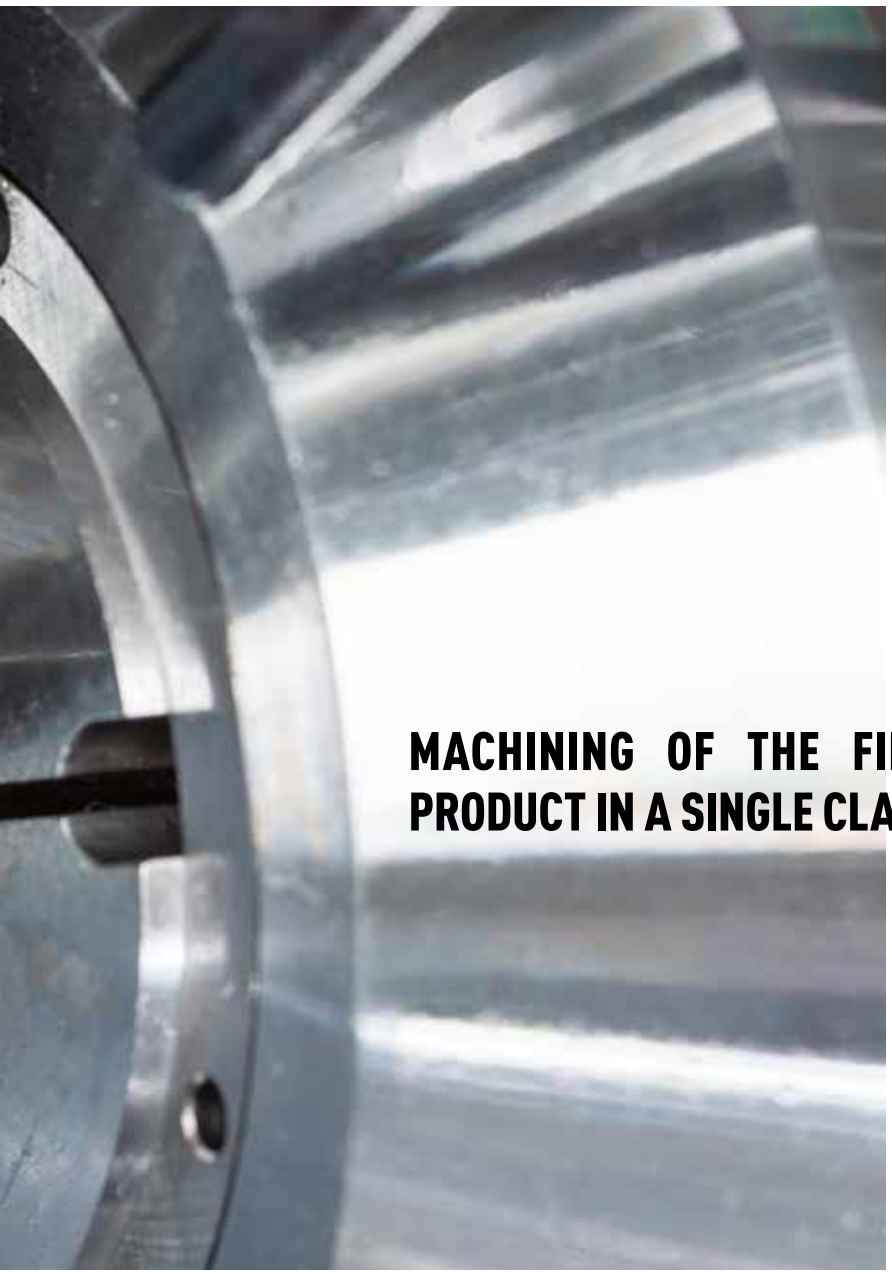
SUPERCARS SHOW THEIR TEETH

Supercars come with a hefty price tag. They are the embodiment of technical perfection, high speed and breathtaking driving dynamics. Many individual high-tech components go into making these high-end sports cars, which can only be described as works of art. One such component is manufactured by Beutlhauser, a company based in Salzweg, Bavaria. Technical Director Michael Beutlhauser recently decided to transform the machining strategy for producing gears on the shaft. This resulted in huge time savings, lower tool costs and higher accuracy. Gear cutting tools from Paul Horn GmbH are one of the factors behind this success.

CHANGE OF STRATEGY FOR CUTTING GEARS.

Many drivers dream of owning sports cars – which we see as being packed with emotion, passion and pure driving pleasure. One step up from these are the super cars and, in particular, the new category of hypercars. These models reflect the entire expertise of the car manufacturer. They are the epitome of what is technically feasible and are perfectly conceived and made, from the design right down to the finest detail. Regardless of the make, top speeds in excess of 350 km/h and high acceleration are guaranteed to send the adrenalin pumping through the driver's veins. This adrenalin rush usually begins when they pull out their credit card at the car dealership to pay and a seven-figure sum appears on the card reader.

Broaching the gear teeth with the S117 system.



MACHINING OF THE FINISHED PRODUCT IN A SINGLE CLAMPING.

Beutlhauser and his team may not have had the joy of owning such cars, but they still managed to travel at top speed when changing over their production process for an actuator gear shaft. "Before we changed the process, four operations had to be completed to create the gear teeth on the shaft. The teeth were being produced on special gear cutting machines using outdated tools. Our set-up costs were enormous and we were being forced to handle the workpieces far too often", explains the Technical Director. In the hope of obtaining some new solutions, Deputy Production Manager and Head of Tool Planning, Marcel Kanzler, contacted his tool suppliers. "We received several offers and carried out trials", says Kanzler. Together with the Production Manager, he then decided to change the production process.

HORN provided the solution

HORN's proposed solution consisted of the S117 tool system for gear tooth broaching and the 613 tool system for gear milling. "We had to make use of both processes because the shoulder on the front teeth did not allow milling", says HORN field sales representative Martin Weiss. The process solution met all the requirements set by Beutlhauser: machining of the finished product in a single clamping, higher precision, improved tooth surface quality and time savings. "The time savings are huge. We are now achieving a machining time of just under four minutes per component", says Kanzler. Beutlhauser GmbH & Co. KG produces around 25,000 of these heat-treated steel components a year.

The gear cutting process was successfully upgraded thanks to Marcel Kanzler, Michael Beutlhauser, Martin Weiss and Johannes Weidner (HORN).

The broaching process works as follows: The outside diameter is turned on a Citizen M32 CNC Swiss-type lathe. The system S117 broaching insert has a special shape and four cutting edges. During the process, the machine positions the tool in front of the workpiece. It then starts with axial stroke movements, cutting the teeth longitudinally into the pre-turned blank. After that, the tool retracts and, once clear of the workpiece, returns to the start position. The infeed of the individual strokes is 0.05 mm (0.00197"). It takes twelve strokes for the insert to complete four of the 28 teeth. The feed rate can be programmed at between 3,000 and 5,000 mm/min (118.11024" to 196.85039"/min). Each insert has a tool life of 500 workpieces. The required surface quality is achieved.

Six teeth withstand the cutting pressure

"HORN was the only tool manufacturer to offer us milling tools with six teeth. Because of the high cutting pressure, other manufacturers only recommended tools with three teeth", explains Kanzler. In spite of the high cutting pressure generated by six teeth, the tools from HORN are extremely stable. "The six teeth offer us higher milling performance and allow us to run the machine at higher feed rates", says Weiss. The type 613 circular milling insert has a tool life of 1,000 workpieces. The involute profile of the cutting edges is precision ground. The cutting speed is v_c = 310 m/min and the feed rate is programmed to a value of 600 mm/min (23.62205"/min). The tool mills each set of eight teeth to the full depth of 2.1 mm (0.083") in a single operation. A conventional milling direction is used.

HORN's product portfolio comprises a wide range of tools for the production of various gear tooth geometries with module 0.5 to module 30. Whether this involves gear teeth for spur gears, shaft/hub connections, worm shafts, bevel gears, pinions or

UNIVERSAL MACHINES WITH FULLY SYNCHRONISED SPINDLES.

customised profiles, all these tooth profiles can be manufactured extremely cost-effectively with milling or broaching tools. The gear skiving product range is yet more testament to the company's gear production expertise. It is a process that has been in use for over a century – but has only been incorporated into a wider range of applications since machining centres and multi-tasking CNC lathes with fully synchronised spindles and process-optimised software have been able to accommodate the highly complex technology.

The partnership between Beutlhauser and HORN has only been in existence for just under two years. Prior to this, Beutlhauser tended to use HORN tools for standard applications. "In the course of changing over the gear cutting process, HORN and its application engineers have demonstrated their effective problem solving skills. We are extremely satisfied with the collaboration", says Technical Director Michael Beutlhauser.

Gear milling with the 613 system.

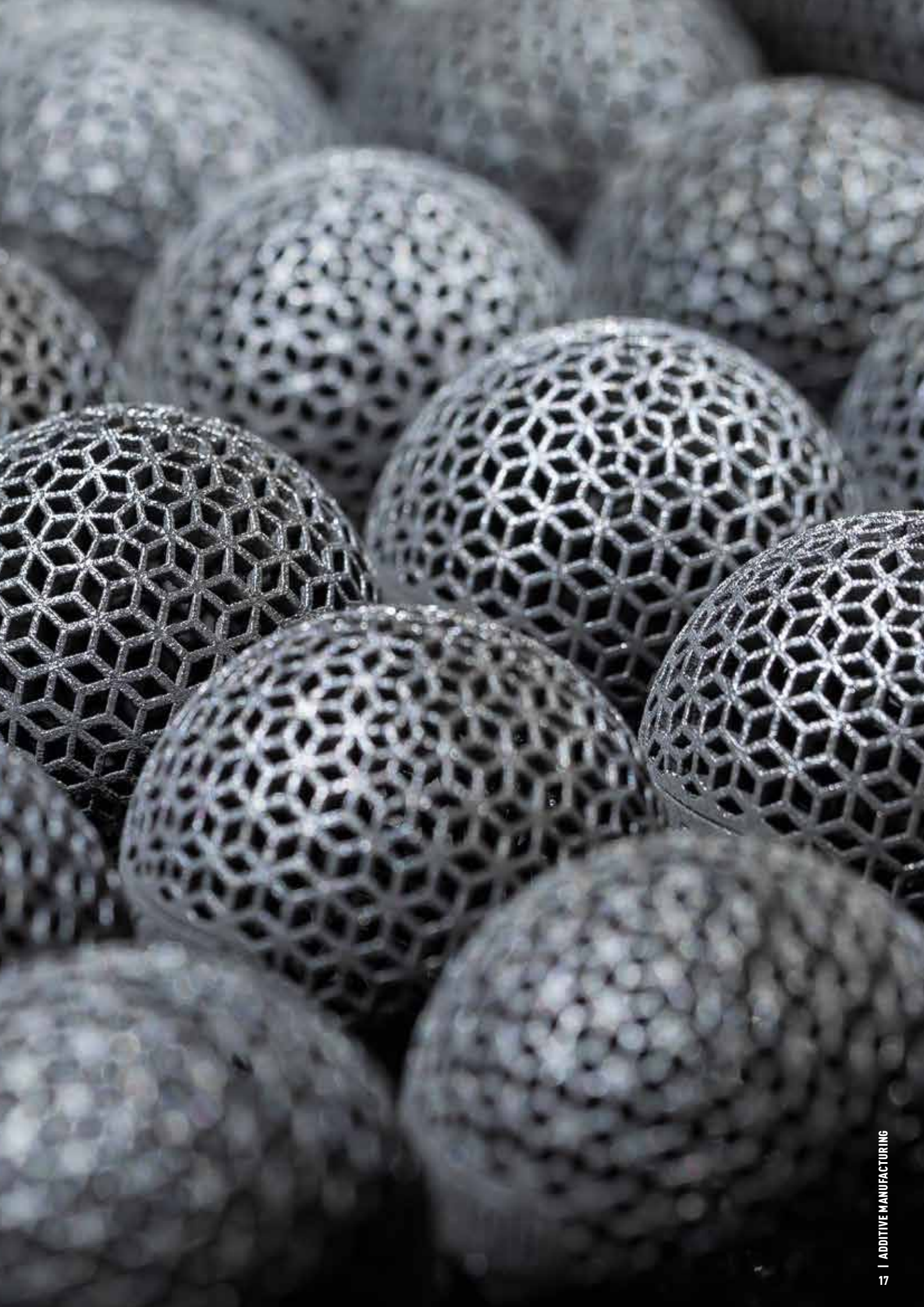
Beutlhauser regards itself as a specialist in the production of metal products: turned and milled parts, formed parts, contact and die pins, and stamped as well as punched and bent parts. The Bavarian company has been implementing extremely high-tech customer concepts since 1993. Aside from the automotive sector, Beutlhauser also supplies parts and components to the aerospace, sensor, electrical engineering and medical sectors and to customers working in jewellery manufacturing. The company demonstrates a high level of expertise in many other industries as well.

ADDITIVE MANUFACTURING

3D PRINTING AT HORN

"We were captivated by additive manufacturing right from the start and were keeping a very close eye on advances in the area of 3D metal printing. As soon as the machine technology had matured to the point where we could use it in the manufacture of precision tools, we bought our very first system. To be precise: a DMG Mori LASERTEC 30. Originally, we purchased the machine for the R&D area so that we could make special tools and prototypes. During the initial period, we found that we were constantly having discussions with our customers about 3D printing. To begin with, these were purely technical discussions but as time went by they led to more and more concrete enquiries for 3D-printed components. Due to the strong interest from customers, we eventually came up with the idea of setting up an additional contract manufacturing business unit for additively manufactured components. Currently, we have two DMG Mori LASERTEC 30 (2nd Generation) machines in operation."

Matthias Rommel, Joint Managing Director, Paul Horn GmbH.



ADDITIVE MANUFACTURING

3D PRINTING AT HORN

HORN launched its additive manufacturing project in spring 2018. This led to the dedicated production area that exists today with its two 3D printing processes (selective laser melting). The tool manufacturer uses additive manufacturing to produce its own tools – particularly when making prototypes, special tools and tool holders – and to optimise coolant attachments. Having recognised the advanced possibilities offered by additive manufacturing, HORN is making the technology available to its customers and partners as well.

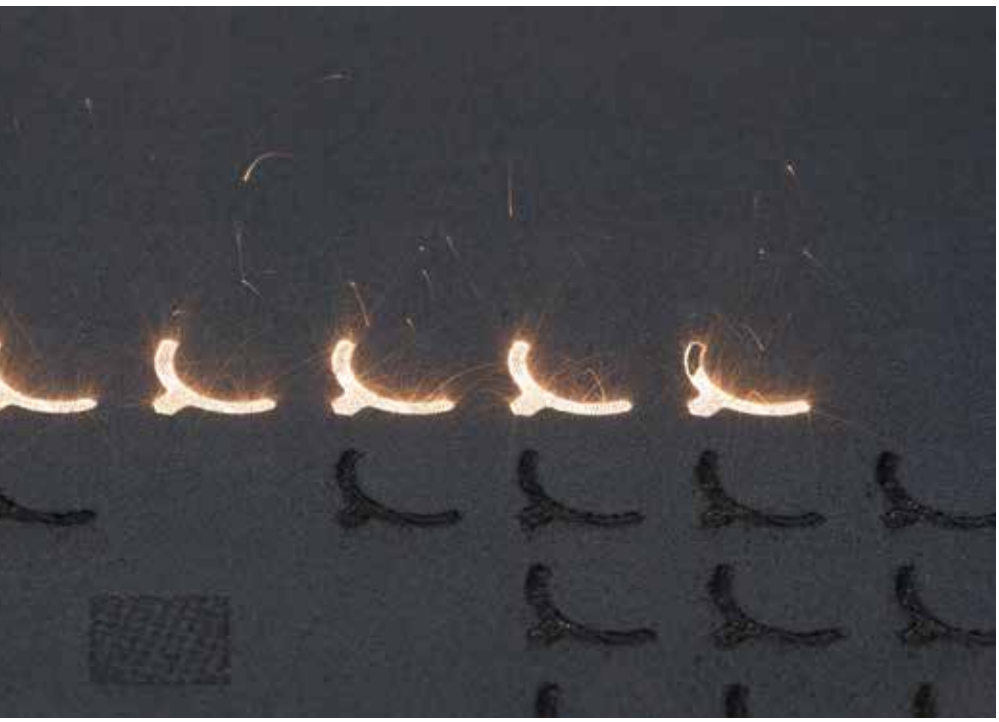
It makes sense to use additive manufacturing if it generates a technological advantage. However, in many cases there is no economic benefit to using additive manufacturing for a component produced by conventional methods. One example would be a turned part that can be produced relatively quickly on a Swiss-type lathe. Not only that, but additive manufacturing would also be too expensive in terms of post-processing. Other disadvantages compared with conventional production include the relatively poor surface quality (R_z30), relatively low accuracy of typically +/-0.1 mm (0.00394") and the high cost of powder compared to bar.

Greater design freedom

As the complexity of the component begins to rise, additive manufacturing becomes more relevant. This may be driven by the need for lightweight design, special cooling channel layouts and small batches of components of highly complex geometry. Consequently, the disadvantages have to be weighed against the benefits of greater design freedom, lightweight construction, quick adaptability and speedier production of more complex components. In the future, it therefore makes sense for this option to be included in preliminary considerations as part of each design process.

RAPID PRODUCTION OF COMPLEX PARTS.

With 3D printing, even complex shapes can be produced relatively easily.



Layer by layer, the component is melted by the laser.

ALL PRODUCTION PROCESSES IN-HOUSE.

Specialists analyse the raw material from various perspectives. During this process, HORN draws on the extensive expertise of Horn Hartstoffe GmbH, which has been analysing carbide powders for years and already has the required measuring equipment. If the parameters are satisfactory, test pieces are printed. These then undergo metallurgical analysis. To ensure that data is generated quickly, reliance is placed on both Horn Hartstoffe and the new HORN analysis centre (HAZ). It is here that employees generate suitable micrographs for pore analysis and carrying out further material tests.

From unfinished parts through to finished components

HORN uses the selective laser melting process, which is also known as powder bed fusion. In this technique, metal powder is applied in layers to a platform that is lowered incrementally. On each successive layer, the relevant area is targeted and melted by the laser. This process is repeated until the required component height has been achieved. By way of materials, HORN uses aluminium (AlSi10Mg), stainless steel (1.4404), tool steel (1.2709) and titanium. However, other materials are currently being tested. The maximum build volume is 300 x 300 x 300 mm (11.811 x 11.811 x 11.811").

As HORN keeps all production stages in-house, the specialists within the production area are able to respond to customer requirements directly. Parts are produced in various designs according to customers' requirements. HORN also assists with the design process and with the selection of appropriate powder parameters. Depending on what customers require, HORN can produce everything from semi-finished parts right through to finished components. Another advantage is the ability to make use of the available machinery and appropriate measuring equipment. This saves time and has a direct impact on all production processes.

"WE SPOTTED THE TREND AND INVESTED IN ADDITIVE MANUFACTURING BECAUSE WE HAVE THE NECESSARY POWDER PROCESSING EXPERTISE AND ARE ALSO IN AN IDEAL POSITION TO CARRY OUT POST-PROCESSING. THE STREAM OF ENQUIRIES AND ORDERS SHOWS THAT WE WERE RIGHT TO SET UP THE NEW BUSINESS AREAS", SUMS UP JOINT MANAGING DIRECTOR MARKUS HORN.

Markus Horn, Joint Managing Director, Paul Horn GmbH.

PRODUCTS

ADDITIVE MANUFACTURING

Printed coolant attachments

For reliable chip control during high-performance reaming, HORN offers additively manufactured coolant discs engineered to customer requirements. Reaming through-bores or deep blind holes often presents a technical stumbling block for conventional solutions. Long-chipping materials and materials that are difficult to machine make it necessary to modify the tool system as well as the internal coolant supply. With its 3D-printed coolant disc, HORN has developed a solution to this problem that can be screwed onto the tool shank. This results in extended tool life – thanks to the direct, targeted cooling – and, above all, reliable chip removal. Additive manufacturing technology enables the coolant outlets to be designed freely. The form of the outlets prevents chips from getting inside. Furthermore, the cross-section and exit angle of the cooling channel can be adapted to suit the specific machining task and material to be machined.

REAMING THROUGH-BORES OR DEEP BLIND HOLES OFTEN PRESENTS A TECHNICAL STUMBLING BLOCK FOR CONVENTIONAL SOLUTIONS.

The tool shank facilitates the removal of chips from the machining zone thanks to its polished and coated flutes. The coolant supply reduces the cross-section, resulting in an increased flow rate of the coolant without any drop in pressure. The tool system can be converted for blind hole cooling, shoulder cooling, or combined shoulder and blind hole cooling. The overall combination of the solid carbide reaming insert, the tool shank and the 3D-printed coolant discs demonstrates HORN's expertise in hole machining and reaffirms the company's status as a problem solver and technology leader.

PRODUCTS

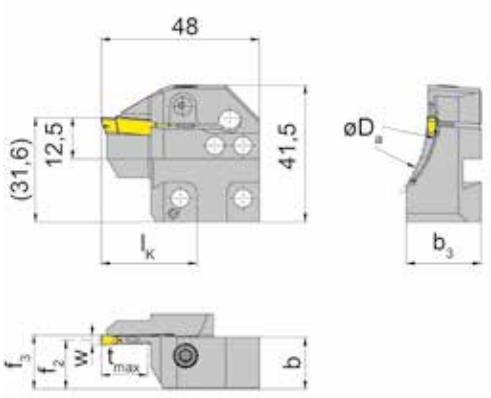
224 SYSTEM AXIAL

S224 face grooving system

HORN has expanded its range of face grooving products. To accommodate axial grooving operations with diameters ranging from 38 mm to 1,000 mm (1.496" to 39.370"), HORN is now offering new holder variants for the 224 grooving system. The tool manufacturer is extending its modular concept so that various types of cartridge can be clamped using a single base holder. The internal coolant supply allows direct cooling in the contact zone while simultaneously increasing tool life. In addition, the high coolant pressure ensures improved chip removal from the groove. Thanks to the wide range of chipbreaker geometries and substrates available with the 224 double-edged system, the tool system can be easily adapted to the machining task as well as the material to be machined.

HORN offers the axial holders in the following versions: LAK (left, external), RAK (right, external), LIK (left, internal) and RIK (right, internal). The maximum groove depth (t_{max}) is 14 mm (0.552"). Groove widths (w) range from 3 mm to 6 mm (0.118" to 0.236"). The internal coolant supply is via a transfer point on the base holder. However, the cartridges can also be used on older HORN holders without coolant transfer.

THE TOOL MANUFACTURER IS EXTENDING ITS MODULAR CONCEPT USING CLAMPING CARTRIDGES.



PRODUCTS

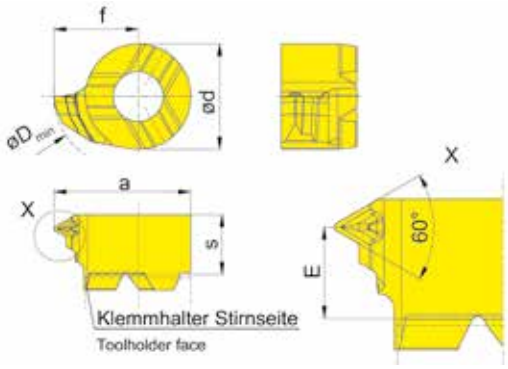
THE MINI SYSTEM 108/114

Targeted chipbreaking

HORN has extended the 108 and 114 Mini systems by adding a new GM threading geometry that is suitable for turning ISO metric internal threads in partial and full profile. The chipbreaker geometry enables the production of short chips, even with long-chipping materials and those that are difficult to machine. This reduces the risk of chip build-up and prevents swarf from becoming entangled around the tool holder, thereby increasing process reliability. Targeted chipbreaking also makes it easier to handle the chips. The 108 system is suitable for metric internal threads from a diameter of M10 with pitches of 0.5 to 1.25 mm (0.019" to 0.049"). Meanwhile, the 114 system is suitable for pitches of up to 2.5 mm (0.099"). The inserts are available in partial and full profile design. Standard turning tool holders from the Mini system may be used.

Mini type inserts screwed onto the face of the holder are among HORN's core products. The tool system is suitable for turning and milling applications. The precision tools have particularly proven their worth for internal profiling and internal grooving applications. Thanks to the low-vibration carbide tool holders, the inserts produce excellent surface finishes even with longer throat depths and also ensure high process reliability. The extensive Mini system range offers inserts in a variety of sizes for various internal diameters, as well as different geometries and substrates and CBN or diamond tips.

MINI TYPE INSERTS SCREWED ONTO THE FACE OF THE HOLDER ARE AMONG HORN'S CORE PRODUCTS.



PRODUCTS

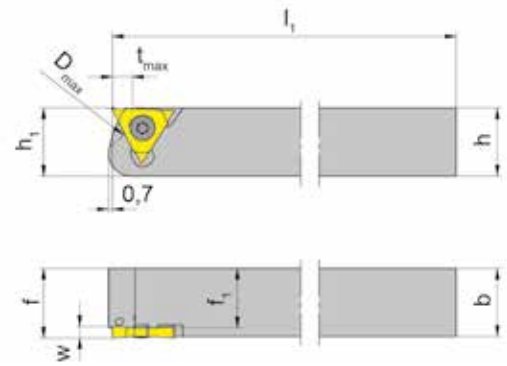
32T SYSTEM

32T system

HORN has developed the new 32T system for use on Swiss-type lathes and for grooving and parting off on smaller fixed-head lathes. The tool manufacturer is expanding the tool system by introducing versions for threading, grooving and longitudinal turning as well as for full radius grooving. The central clamping screw offers high changeover accuracy of the cutting insert and direct entry into the insert seat of the tool holder. Additionally, there is no need for clamping elements, which could potentially have a detrimental effect on chip flow. The head of the clamping screw does not introduce interference contours and therefore permits both grooving and parting off directly at the spindle. The precision-sintered grooving insert can be used as a neutral insert and as both a left-hand and a right-hand insert. The 32T system completes HORN's portfolio of triple-edged cutting inserts by offering a solution for smaller-scale applications.

The maximum groove depth of the system is 4 mm (0.157") with a groove width (w) of 0.5 mm to 2.5 mm (0.019" to 0.099"). For grooving operations, the inserts are available with both straight and full radius cutting edges. HORN offers the indexable insert with a 15-degree chamfer for parting off. A cylindrically ground chipbreaker geometry ensures reliable chip removal. The tool holder is designed as a square shank measuring 10 x 10 mm (0.394 x 0.394") , 12 x 12 mm (0.472 x 0.472") or 16 x 16 mm (0.629 x 0.629"). All versions feature an internal coolant supply and are available in both left-hand and right-hand designs. For the coated grades, users can choose between EG35 (material groups P and M) or EG55 (material group P).

THE 32T SYSTEM COMPLETES HORN'S PORTFOLIO OF TRIPLE-EDGED INSERTS BY OFFERING A SOLUTION FOR SMALLER-SCALE APPLICATIONS.



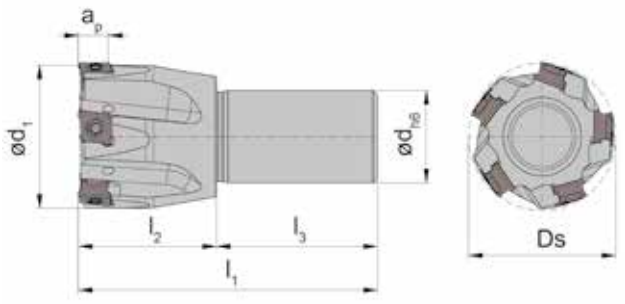
406 SYSTEM

Milling system 406 with wiper geometry

HORN has extended the 406 tangential milling cutter system to include an insert with wiper geometry for finishing. The new insert has been developed in response to demand from HORN's customers, reflecting the fact that surface quality requirements are constantly increasing. The new geometry produces very high surface quality, even at higher feed rates. This results in shorter cycle and machining times for each component. Moreover, the geometry makes it possible to reduce the need for subsequent grinding processes.

The single-edged finishing insert is used in the 90-degree shoulder mills of the 406 system. Only one insert with wiper geometry needs to be fitted to the tool body in each case. The remainder can be standard indexable inserts from the 406 system. The wide finishing insert is available in grade AS4B for the workpiece material groups P and M, and in grade AS46 for workpiece material group K.

THE SINGLE-EDGED, WIDE FINISHING INSERT IS USED IN THE 90-DEGREE SHOULDER MILLS OF THE 406 SYSTEM.



PRODUCTS

304 SYSTEM

The 304 circular milling system

HORN has extended its range of products for circular interpolation milling to enable the productive machining of holes with diameters of 8 mm (0.315") or more. With its triple-edged 304 milling system, the tool manufacturer is offering a versatile solution for groove milling, finish boring and chamfering.

The insert has a cutting circle of 7.7 mm (0.303"). In conjunction with the vibration-damping carbide shank, this makes it more flexible to use than solid carbide groove mills. The substrate and geometry can be easily matched to the machining process. The shanks feature internal coolant supply for targeted cooling of the contact zone.

The groove milling inserts are available with cutting widths (w) of 0.5 mm (0.019"), 1 mm (0.039"), 1.5 mm (0.059") and 2 mm (0.079"). For milling circlip grooves, HORN offers the system with cutting widths of 0.8 mm (0.031"), 0.9 mm (0.035"), 1.1 mm (0.043") 1 (0.039") and 1.3 mm (0.051"); and, in the case of the full radius version, offers radii of 0.4 mm (0.157"), 0.6 mm (0.023") and 0.8 mm (0.031"). To enable the milling of chamfers, angles of 45, 30 and 15 degrees are available. As regards the substrates, HORN relies on coated grade EG55 for general steel machining and IG35 for the machining of stainless steels and superalloys.

The HORN circular milling system offers users a host of process advantages: it is fast, reliable and achieves good surface finish. During the process, the tool plunges into the material either at an angle or horizontally, and is then interpolated on a helical path. This means that threads, for example, can be manufactured to a high level of reproducible quality. When compared to machining using indexable inserts for larger diameters or solid carbide milling cutters for smaller diameters, circular interpolation milling is generally more economical. Circular interpolation milling cutters have a wide range of applications: they are able to machine steel, special steels, titanium and superalloys. These precision tools are especially suited to groove milling, circular interpolation milling, thread milling, T-slot milling and profile milling processes.

THE SUBSTRATE AND GEOMETRY CAN BE EASILY MATCHED TO THE MACHINING PROCESS.

PRODUCTS

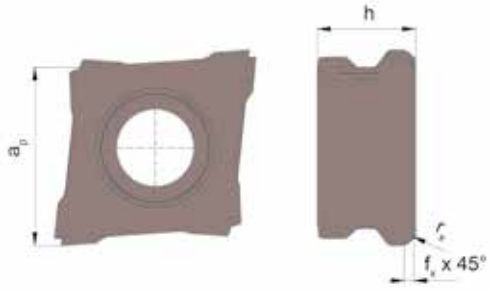
409 SYSTEM

409 tangential milling system

HORN has extended the 409 tangential milling cutter system to include a precision-sintered indexable insert. The sintered insert with roughing geometry offers a cost-effective alternative to the ground version. The geometry includes a circumferential protective chamfer to ensure long tool life. The stable wedge angle along with the incorporated flank chamfer create a smooth, low-vibration milling process. The positive radial and axial rake angles ensure a soft cut, with the closed chip groove resulting in reliable chip formation. The indexable inserts are compatible with all milling body types.

To cope with the time and cost pressures that are increasing all the time, including in the area of milling, we need more efficient processes: faster cuttings speeds, higher feed rates, increased chip thickness, shorter cycle times, longer tool life – in short: low unit costs. Until now, the main technology for volume cutting has been conventional milling with radially arranged inserts, but this is about to be overtaken on the market by another process that has long been used for milling: tangential milling. Over recent years, tangential milling systems have become the workhorses of the machining industry. During tangential milling, the cutting forces act in the direction of the insert's greatest stability. As a result of the high infeed forces that are possible, this process achieves formidable material removal rates and high levels of productivity along with good surface finish.

AS A RESULT OF THE HIGH INFEED FORCES THAT ARE POSSIBLE, THIS PROCESS ACHIEVES FORMIDABLE MATERIAL REMOVAL RATES AND HIGH LEVELS OF PRODUCTIVITY ALONG WITH GOOD SURFACE FINISH.



PRODUCTS

BOEHLERIT MILLING

Boehlerit expands 3D milling system

HORN presents the Boehlerit 3D milling system expansion for the tool and mould making industries. The ISO 00P, RHOMBItec, BALLtec and TORROtec systems cover all relevant machining operations in the 3D milling market sector. The ISO 00P is a universal tool system for general mechanical engineering and mould making. As the inserts are mounted in a neutral position in the tool holder, they ensure a high level of contouring accuracy. Despite the neutral position, the insert geometry enables a soft cut to be achieved. With the RHOMBItec system, Boehlerit is presenting a universal finishing tool for all standard materials and applications. The indexable inserts demonstrate high manufacturing precision and long tool life. The axial and radial wiper geometry ensures high productivity, outstanding surface quality and vibration-free finishing, even at high depths of cut.

The BALLtec and TORROtec milling systems are multifunctional tools for achieving high productivity. The system allows users to save on tool holders, as the ball nose copy milling cutters are suitable for semi-finishing and finishing. In addition, Boehlerit offers a wide variety of indexable inserts and tool holders. The solid carbide shank with brazed insert seat ensures excellent vibration damping, resulting in outstanding surface quality on the workpiece. The use of ultrafine carbides for the inserts ensures high wear resistance combined with high resistance to breakage, which increases process reliability. All variants feature an internal coolant supply.

THE ISO 00P IS A UNIVERSAL TOOL SYSTEM FOR GENERAL MECHANICAL ENGINEERING AND MOULD MAKING.

EUROSKILLS 2020: THE COMPETITION FOR THE TRADES

EuroSkills is a vocational skills contest staged every two years at European championships. The event revolves around the amazing abilities of a group of young and highly talented specialists who compete in around 45 different skills and trades. These competitors must be aged 25 or under and can either be skilled junior employees who have finished their training or young people who have successfully completed a course at a secondary or tertiary vocational training establishment. Around 650 competitors will battle it out in the contests, which cover vocational fields drawn from industry, the skilled trades and the services sector. These European championships will take place in the Austrian city of Graz from 16th to 20st September 2020.

euroskills Graz 2020

We are Skills

#WE ARE SKILLS

HORN IS HELPING TO SUPPORT THE SKILLS OF CNC TURNING AND CNC MILLING IN ITS CAPACITY AS A SILVER SPONSOR.

The EuroSkills European championships are the flagship event of the "WorldSkills Europe" association – whose stated aims are to enhance the status of vocational training and draw attention to the importance of having really well trained specialists. The "WorldSkills Europe" organisation was established in 2007 and now has a total of 30 member countries, which regularly send competitors to the European skills championships. The EuroSkills event itself is held in one of the 30 member countries every two years – which is why the young and talented "vocational elite" will be coming together in Austria in 2020 to turn Graz into a hotspot of young talent for four days. In addition to the 650 or so competitors, the city also expects to receive visitors in the tens of thousands. The event revolves around the amazing abilities that a group of young and highly talented specialists aged 25 or under are required to demonstrate in around 45 European trades/professions.

What will happen at EuroSkills 2020?

Over three days of competition, the contestants will showcase their skills and knowledge in practical working situations associated with their specialist fields. The tasks will be devised and the results subsequently assessed by a panel of experts. Visitors can watch the contestants live as they work, find out about the respective specialist fields and get to know the companies from which the contestants come – all completely free of charge. On top of that, there are exciting conferences and congresses to attend as well as other side events. On the final day, all the tasks will be assessed and the winners of the individual specialisms will be announced at the award ceremony, along with the winners of the "Best of Europe" title.

HORN is a silver sponsor

Paul Horn GmbH is helping to support CNC turning and CNC milling skills at EuroSkills 2020 in its capacity as a silver sponsor. As a result, contestants who intend to compete in these two skills can look forward, in particular, to receiving support in the form of tools and materials provided by HORN. Christian Thiele, Press Officer at Paul Horn GmbH, explains why HORN is so keen to back the young

specialists and the EuroSkills 2020 event: "Here at HORN, we are convinced that by sponsoring EuroSkills 2020 we can play a part in making young people aware of the skilled jobs and possibilities that exist in our field and encouraging their enthusiasm. The event shows that professions in this sector are interesting and challenging, and offer a great deal of variety."

The "Try a Skill" show

Discover your talent and become a hero! That is the motto of the "Try a Skill" vocational orientation campaign. This campaign is aimed at school students, as well as their parents and teachers, with the aim of helping the young people to choose a career – all in an exciting and informative setting. As part of EuroSkills 2020, the interactive "Try-a-Skill" stations will be directly integrated into the competition area to encourage young people to try out the various jobs for themselves there and then, with options ranging from concrete finisher and CNC miller right through to baker.

One of the declared aims of the project is to make school students understand what their own strengths are and encourage them to choose a profession based on their gifts and talents.

Christian Thiele, Press Officer at HORN, and Josef Herk, Chairman of the Supervisory Board of EuroSkills 2020 GmbH, signing the silver sponsorship certificate.

COMPOSITES

INTERVIEW WITH MARKUS KANNWISCHER

What are the challenges when machining composites?
Composites generally consist of heavy-duty fibres made from carbon, aramid or glass that are bonded with elastomers, thermoplastics or thermosets. Extremely hard and abrasive fibres are combined with softer plastics, especially heat-sensitive ones.

DIFFERENT TYPES OF NON-CRIMP FABRIC.

Depending on the position of the fibres, composites have either isotropic or anisotropic properties. In addition, there is the huge range of materials that comes from the different orientations of non-crimp fabrics, different percentages of plastics used and – often – from combining composites with metal sheets. The requirements imposed on the machining process are that the resulting surfaces must be clean and free from tears, without any protruding threads or delamination. This leads to conflicting requirements for the tool cutting edge: light and cool cutting coupled with highly stable cutting edges, long tool life and smooth tool surfaces that prevent adhesion of the material.

How are you tackling the challenges associated with the tool?
When designing tools for composite machining, the key is to combine the different tool design options in a smart way. Just a few of the parameters that can be used to define the optimum tool are: the axis intersection angle of the cutting edges on the top layers for compression cuts, cut divisions to reduce the cutting pressure, the use of nicked cutting tools to score the top fibres and matched rake and clearance angles. Once you have set the macro-geometrical parameters, you can select the appropriate grade. Certain options have to be discounted on the basis of the macro-geometry: in the case of very small tools, solid carbide tools offer considerably more design freedom than PCD-tipped or CVD-tipped milling cutters, for example. The substrate should be tough enough to cope well with the dynamic cutting forces generated when cutting through the fibres. To improve tool life, these cutters are often provided with a diamond coating. This makes it possible to create a tough cutting edge with an extremely hard boundary layer as well as a good level of sharpness. This ensures process reliability and long tool life. However, the process of seeding the diamond grains will only work if the cobalt content of the carbide is below a certain level.

When it comes to the key topic of cutting materials, what distinguishes PCD from CVD?
In the case of PCD, hard individual diamond grains are bonded together using cobalt or other elements as a catalyst. The composite is electrically conductive and can be machined and shaped using eroding technology. CVD is made entirely from diamond and is mainly laser cut or ground. This makes CVD much harder than PCD. Conversely, PCD is tougher than CVD, which means it is better protected against breakouts. As PCD is made from individual diamond grains, the properties of the PCD can be more finely matched to the individual application by using different grain sizes on one cutting edge. Consequently,

there is a much smaller window of parameters within which CVD will work compared to PCD. But, if the right parameters are selected, CVD tools have a significantly longer life than PCD-tipped tools.

How do you test the relevant tool solutions?
The top priority during machining tests is safety. In addition to the standard safety precautions that apply during such tests, attention must be paid to dust extraction. The maximum allowable concentrations (MAC) must be observed in this regard. When carrying out machining trials at our test centre, we rely on special extraction equipment. We use all kinds of measuring systems, such as cutting force measuring instruments, a high-speed camera and surface measurement systems.
The customers' workpieces often take the form of flat parts that require a corresponding clamping device. In such cases, we do the functional testing in-house first and then perform the final tool life tests in conjunction with customers on their machines. In order to carry out fundamental studies and further test series, we collaborate with institutes. The results are always evaluated by the customer because everyone assesses the requirements for a cutting edge or for a milled surface differently.

How do you see things developing? Is the use of composites likely to increase in the future? And if so, in what areas?
The proportion of composites is going to continue increasing across all sectors. Studies are predicting an overall annual growth rate of 10 to 15 per cent. However, the extent to which different sectors will make use of composites is expected to vary. In the aerospace industry, CFRP materials are already being used in large quantities, with the proportion of these set to continue increasing in the future. In addition to composite housings, even engines are going to have fan blades containing carbon. As things currently stand, we are fairly unlikely to see widespread use within the passenger car sector because of the considerable gains that have been made by hot-worked steel materials. However, flat CFRP components are increasingly playing a role in commercial vehicles and motor homes. One very interesting area is that of carbon concrete, which offers a range of key benefits: thinner design, less expensive assembly and no corrosion. However, there are not many long-term studies concerning its durability. If the costs of carbon concrete can be further reduced, it will unlock a huge market.

Where do you see future potential for tools with regard to composites?
In the field of cutting tools, drilling is the biggest market. Here at HORN, we focus predominantly on the trimming and production of pockets and cut-outs, in other words: on milling tool production.

When it comes to diamond coatings for solid carbide tools, new multilayer diamond coatings are ensuring a high level of wear resistance while at the same time providing a sharp cutting edge. The combination of tougher carbides and good layer adhesion is increasing the range of applications for diamond-coated solid carbide tools. In the area of CVD cutting edges, knowledge has increased considerably over recent years as far as the correct application parameters are concerned, with the result that huge leaps in performance have been achieved here as well. In conjunction with the latest laser technology for producing sharp and precise cutting edges, this has broadened the range of CVD applications significantly.

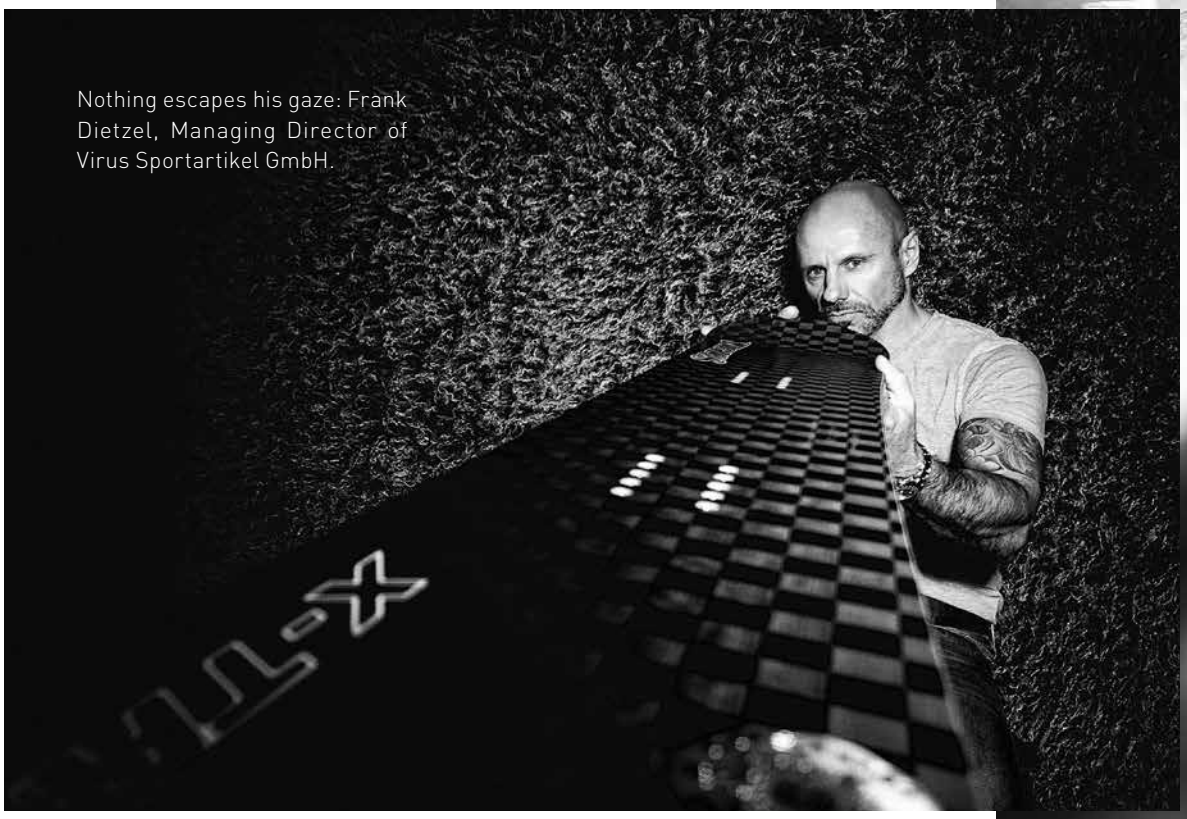
CUTTING FORCE MEASUREMENT, A HIGH-SPEED CAMERA AND SURFACE MEASUREMENT.

The DA arbour milling cutter with CVD-D-tipped inserts is ideal for machining composites.

COMPOSITES

DIAMOND TOOLS CUT CFRP CLEANLY AND EFFICIENTLY

“Once you’ve stood on a virus board, you will realise that these boards are addictive”, jokes Frank Dietzel. The Managing Director of Virus Sportartikel GmbH has been producing high-end snowboards and skis for highly discerning winter sports enthusiasts at his workshop for more than 30 years. Together with his team, Dietzel relies on high-tech fibre composite materials and native timber to manufacture these products. “Each of our boards contains a flexible wood core”, explains Dietzel. As well as requiring lots of manual work, the processes of cutting the CFRP mats and milling the wood cores also involve using a CNC milling machine. For this, the company’s specialists rely on diamond tools from Tübingen-based Paul Horn GmbH.



Nothing escapes his gaze: Frank Dietzel, Managing Director of Virus Sportartikel GmbH.

“ONCE YOU HAVE CAUGHT THE BUG, YOU WILL REALISE THAT THESE BOARDS ARE ADDICTIVE.”

Back in 1984 when the sport of snowboarding was still very much in its infancy, Dietzel started professionally producing this new type of winter sports equipment in Großwallstadt, Bavaria. Since then, the Virus brand has become a stalwart of the industry. Professionals and discerning winter sports enthusiasts count on the performance of its skis and snowboards. Virus boards are made by sandwiching together high-tech materials and solid wood cores. The wood cores are made completely by hand and, depending on the model, reinforced with two or three carbon fibre inserts. For his top models, Dietzel also uses a material called Zylon, which is the strongest man-made fibre ever produced. “Zylon is like a synthetic spider thread that is much more resistant to tearing than carbon. Processing this material is very complex and you need special tools and technologies just to be able to cut the fibres”, says Dietzel.

The individual layers of the sandwich structure are responsible for different tasks. The core determines most of the properties exhibited by the finished board. Wood is a good choice of core material because of its all-round characteristics. Each wood core is made from several strips of laminated hardwood that are stuck together. These provide the board with natural flexibility and have good vibration-damping properties. To reinforce specific areas of the board, carbon and fibreglass inserts are placed inside the laminate. The equipment has to adapt to the ground during rapid turns (carving), but must also quickly bend back into its original shape when the load changes. The important thing here is that the material must not behave like a coiled spring, as this would have a major impact on board control. Dietzel laminates CFRP mats into the core and the outer layer, which boosts board handling and performance even further.

Milling the CFRP mats. The frayed edges originate from the protective fabric.

CVD diamond

For cutting the CFRP mats and milling the wood cores, Dietzel relies on CVD diamond-tipped and CVD diamond-coated milling tools from HORN as well as on a CNC portal milling machine. "The materials are very abrasive. Carbide would wear away too quickly during machining", explains HORN field sales representative Stefan Bachmann. The CFRP mats and the 3D shapes of the wood cores are milled using DSS diamond-coated end mills. The edges are trimmed with a CVD-D-tipped milling cutter with five cutting edges.

"The edges of the CFRP mats are very important. If any parts are frayed or delaminated, they are useless. We are completely satisfied with the performance of HORN milling tools, because rejects are very costly when you are using CFRP", explains Dietzel. Prior to milling, an additional fabric is stuck onto the CFRP mats to protect the edges. This fabric is removed after machining. For the milling operations, Dietzel uses a CNC portal milling machine, which would normally be used in the woodworking industry to produce furniture parts. "With its vacuum clamping table, the machine provides us with all the features and machining options that we need for our products", clarifies the Managing Director.

"THE MATERIALS ARE VERY ABRASIVE. CARBIDE WOULD WEAR AWAY TOO QUICKLY DURING MACHINING."

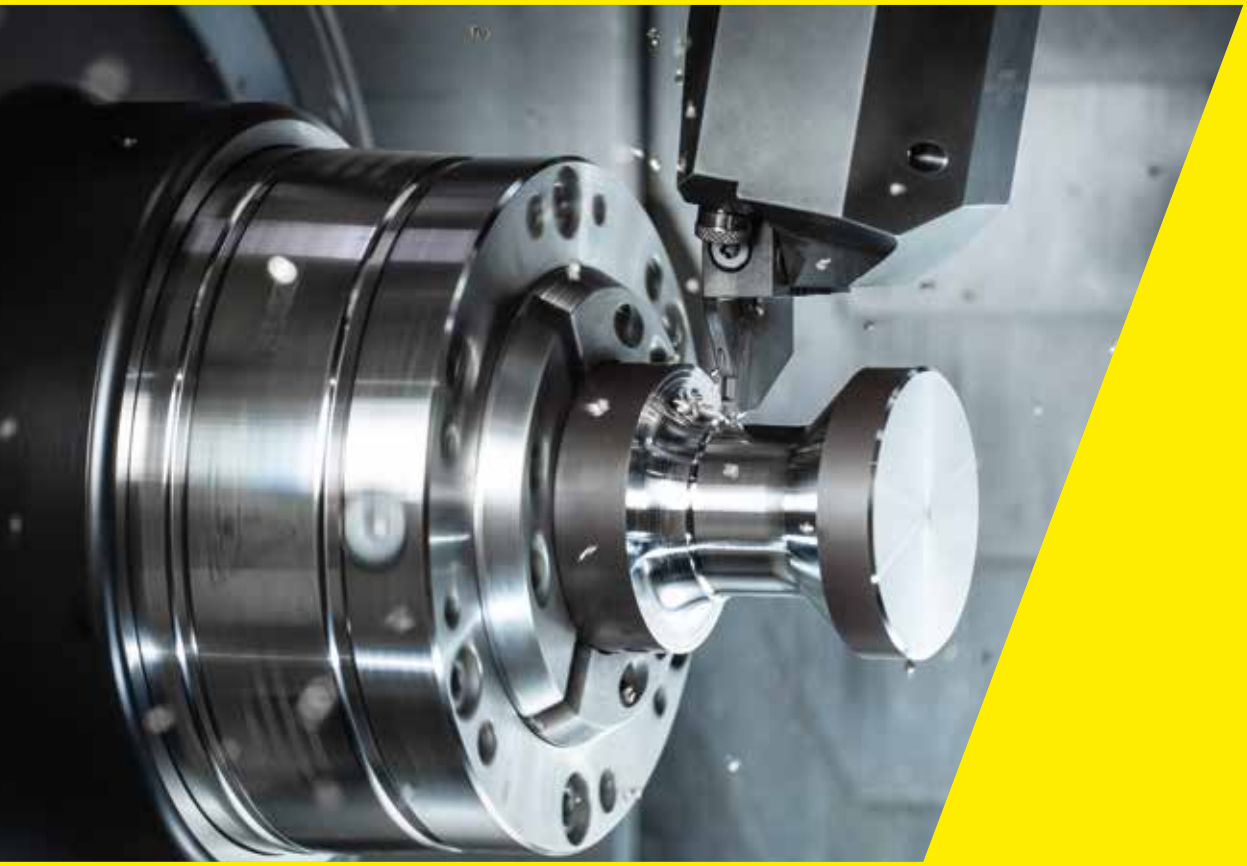
An overview of the individual production stages: On the left is the laminated and trimmed blank. On the right is the finished and coated snowboard.

Cutting rather than crushing
CVD diamond differs from PCD diamond cutting edges in several ways. CVD diamond is 99.99 per cent pure diamond – in contrast to PCD, which is mixed with a binder that makes up 10 to 20 per cent. Although both cutting materials are polycrystalline, CVD diamond has a more homogeneous structure that is almost as hard and wear-resistant as natural monocrystalline diamond. Whereas PCD cutting edges are usually ground or eroded, CVD cutting edges are precision-lasered. As a result, the cutting edge roundness of between one and two microns makes them at least ten times as sharp. During PCD grinding, boundary crystals at the cutting edge are knocked out but during CVD diamond laser cutting, the beam slices through them. This also explains the long tool life that is achieved when machining carbon-fibre and glass-fibre reinforced plastics. With their sharpness of 1 to 2 µm, CVD diamond cutting edges slice through thin fibres measuring 5 to 8 µm in thickness whereas PCD cutting edges are ten times blunter meaning that they merely crush the fibres and wear away more quickly due to friction.

CVD DIAMOND CUTTING EDGES DIFFER FROM PCD DIAMOND CUTTING EDGES IN SEVERAL WAYS.

Once the protective fabric has been removed, there is no damage or delamination to be seen on the workpiece edges.

Frank Dietzel (centre) talking to HORN engineers Robert Braun (left) and Stefan Bachmann (right).



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