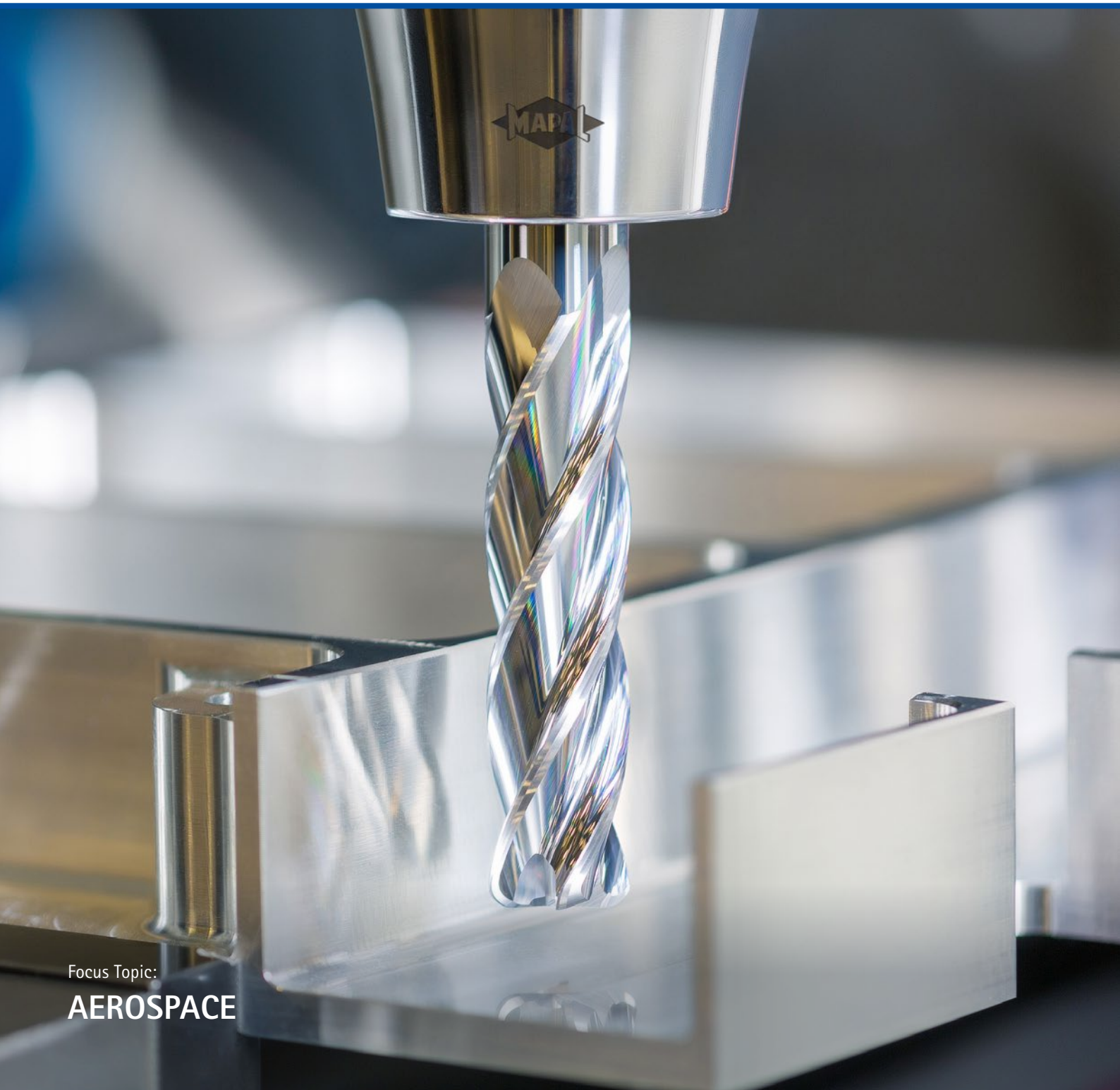
IMPULSE

MAPAL TECHNOLOGY MAGAZINE | EDITION 82



Focus Topic:

AEROSPACE

Dear Business Partners,
and Readers,

as our customers and partners, you challenge us to serve your needs even better, through new solutions, better processes or more targeted support. This drives us to continuously expand our expertise. In our technology magazine IMPULSE, we regularly report on what we've achieved to turn YOU and US into MORE.

One example is the aerospace industry which is experiencing rapid growth. This also raises customers' expectations of us in terms of technologies and solutions. At MAPAL, we have been active in this market for 15 years, focusing on the challenges of machining and the product portfolio. We have analysed demanding components in terms of machining technology, developed economical and reliable processes for them, and can therefore provide our customers with quick and targeted solutions. We offer a comprehensive product range for titanium, CFRP, CFRP material combinations and aluminium. Our in-house expertise in coating technology enables us to meet tool requirements even better. We've shared our expertise in materials, processes and economic efficiency parameters throughout our organisation, enabling us to support our customers worldwide with the same level of expertise.

While lightweight construction has always been important for the aerospace industry, which consequently relies on aluminium among other materials, the trend towards weight reduction and thus the use of aluminium in vehicle construction has received a boost with e-mobility. The increasing importance of the workpiece material goes hand in hand with a number of developments, which in turn place specific demands on machining. The trend towards mega- or gigacasting is a prime example. Here, the size and instability of the components call for special tool geometries for low-vibration machining with high precision. Chip formation is becoming increasingly important with the use of long-chipping grades of aluminium. In high-volume machining of aluminium, more than 90 per cent of a raw part is removed, which means powerful tools are required. Due to these market developments and the challenges you face as a result, solutions and support are in demand. Our Centres of Competence for PCD and solid carbide tools and our wealth of experience in aluminium machining enable us to develop innovative and cost-effective processes, to deliver these from a single source and to provide you with sound and comprehensive support from the start of your project to the end of the product life cycle.

The markets are changing, machining is changing – and at MAPAL, we are changing too because we want to remain a great partner for you in the future. That's why we've taken the last two years to become even more reliable and faster. For example, we have increased the availability of many standard tools and the level of delivery reliability. I hope you've noticed these changes. Try us out!

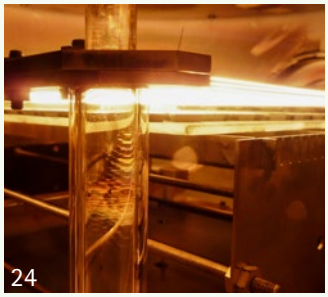
For now, I hope you enjoy reading the 82nd issue of IMPULSE and gain exciting insights into developments in the aerospace industry and beyond.

Yours,

Dr Jochen Kress

FROM THE COMPANY

FOCUS TOPIC **AEROSPACE**



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MAPAL GROUP MOURNS DR DIETER KRESS

Dr Dieter Kress passed away on December 27, 2023 at the age of 81 after a long illness. He was a passionate entrepreneur and an impressive personality. Dr Dieter Kress was at the helm of the MAPAL Group for almost five decades and shaped the once small company into an international company group. He retired from active management in 2018 but continued to take a lively interest in the company's developments. "MAPAL is my baby and that's why I will never let it out of my sight completely," he once said. The entire workforce joins the Kress family in mourning the passing of Dr Dieter Kress.

Dr Dieter Kress joined MAPAL Dr Kress KG in 1969 after graduating with degrees in mechanical engineering and business administration. His father, Dr Georg Kress, had founded the company in 1950. While working at the company, Dr Dieter Kress completed his doctorate on the subject of reaming, which was the basis for the success story of MAPAL: Dr Dieter Kress developed high-performance special tools from the standard reamer. This became the essence of MAPAL - always close to the customer to find the best solution for him and his machining task.

With great vision and personal commitment, Dr Dieter Kress managed the company for 49 years as President. The product portfolio was continuously expanded under his leadership and MAPAL established itself on the market as a full-range supplier. Tools for drilling, countersinking, milling, hard turning and actuating were added to the reaming range. Chucks and devices for setting, measuring and dispensing as well as numerous tool-related services further expanded the portfolio.

In addition, company acquisitions and foundations were responsible for MAPAL's enormous growth. Dr Dieter Kress followed his very own strategy. For him, it was important to respect and preserve the respective culture of the acquired companies. In his 49 years at the helm, Dr Dieter Kress transformed a regionally active manufacturer of taps into an internationally active, broadly positioned company group.

In addition to his entrepreneurial activities, Dr Dieter Kress was also involved in a number of honorary positions. The region and the training of young people were particularly close to his heart. He attached great importance to training junior staff directly at MAPAL and invested in the corresponding infrastructure. Today, MAPAL is one of the largest training companies in the East Württemberg region. There are as many as 300 apprentices at MAPAL worldwide, with around 130 learning different professions at MAPAL in Aalen - from cutting machine operators to warehouse logistics specialists and IT specialists. Dr Dieter Kress also supported research and education at Aalen University - among other things by setting up an endowed chair in cooperation with other companies and as a member of the university council. He was active in committees, initiatives and associations, including as Chairman of the VDMA Precision Tools Association and as a founding member of the P.E.G.A.S.U.S. association, which supports company founders.

Dr Dieter Kress has received numerous awards for his services, including the Cross of the Order of Merit of the Federal Republic of Germany and the Golden Staufer Medal of the State of Baden-Württemberg. He was also one of the first recipients of the German Mechanical Engineering Prize. Aalen University conferred him the dignity of Honorary Senator.

Today, MAPAL is represented in 44 countries and employs around 5,000 people worldwide, including around 1,700 at the headquarters in Aalen. In 2018, Dr Dieter Kress handed over responsibility to his son Dr Jochen Kress, who is now the third generation to head the precision tool manufacturer. "My father entrusted me with his life's work with MAPAL, which he has made into what it is today over almost fifty years of activity," says Dr Jochen Kress. "I approach this task with the greatest possible commitment, continue to run the company in the spirit of my father and stand for continuity in the collaboration with our customers and partners."

The MAPAL Group and its employees owe a great deal to Dr Dieter Kress. He has shaped, developed and promoted the company and its employees as the driving force and motor. ■

Dr Dieter Kress, former President of MAPAL Dr. Kress KG, passed away in December 2023.

PARTICULARS

DR MICHAEL FRIED

CHIEF HUMAN RESOURCES OFFICER (CHRO) | MAPAL GROUP

Dr Michael Fried is Chief Human Resources Officer (CHRO) at MAPAL and is responsible for the important area of employee recruitment and retention, the development of agile work structures and employer branding. The experienced manager has been a member of the MAPAL management board since 2015 and previously held the position of Chief Operating Officer (COO).

ROGER STEINER

CHIEF OPERATING OFFICER (COO) | MAPAL GROUP

The position of Chief Operating Officer (COO) was taken over by Roger Steiner. He now manages all operations tasks and responsibilities worldwide. He will hold his previous position as Managing Director of the MAPAL Centre of Competence Meiningen until further notice.

MICHAEL LÖFFLAD

MANAGING DIRECTOR | MAPAL KK | JAPAN

Michael Löfflad has headed the MAPAL KK subsidiary in Japan since 1 January 2024. The manager has been working in Japan for more than 20 years and brings extensive expertise and industry knowledge from various management positions to the company. Löfflad started his professional career with a law study at the Ludwig Maximilian University in Munich and a European Commission qualification programme for managers in Japan. As Managing Director of MAPAL KK, Michael Löfflad will now utilise his wide-ranging experience and contacts to drive forward the further development of the site and the expansion of the market position in Japan. He succeeds Koichi Matsuda, who wants to take on new challenges.

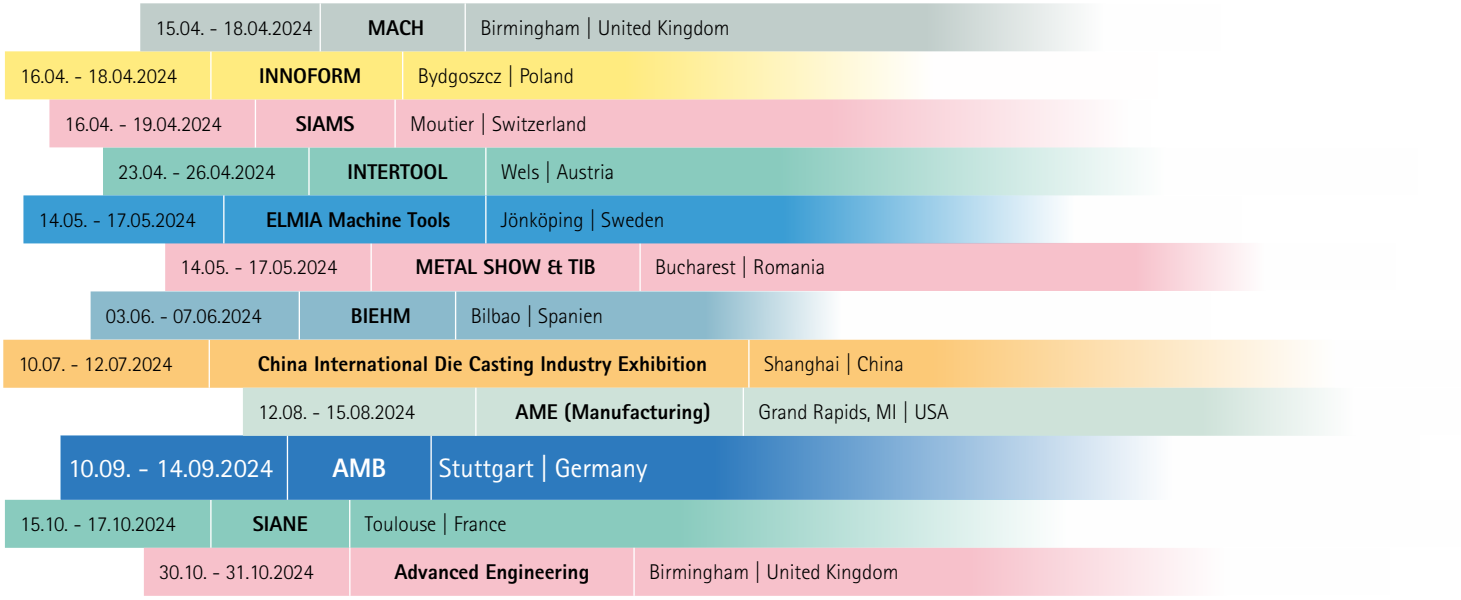
ALEXANDER KOSCHEWSKI

EXECUTIVE VICE PRESIDENT STRATEGY AND BUSINESS DEVELOPMENT | MAPAL GROUP

The "Strategy and Business Development" division headed by Executive Vice President Alexander Koschewski was anchored at the top management level. This is how MAPAL ensures that the strategic change processes are being implemented sustainably within the company group. Koschewski is a proven specialist in business process management. He was previously responsible for the Project Management Office and is in charge of the transformation process of the MAPAL Group.

MAPAL AT TRADE FAIRS AND EVENTS 2024

Whether in large exhibition halls, at open house events or at specialist conferences – direct discussions and close contacts are at the heart of MAPAL's activities. The following events are firmly planned for 2024. The MAPAL team is looking forward to presenting products and solutions relating to the machining process and to sounding out specific customer requirements. The event calendar is constantly updated and can be found on the MAPAL website in the mapal.com/events section.



In-house exhibitions, customer events, conferences and symposia

10.04.2024	**MAV Innovation Forum**	Leinfelden | Germany
10.04. - 12.04.2024	**Wappler Open House**	Coswig | Germany
16.04. - 19.04.2024	**GROB In-house exhibition**	Mindelhein | Germany
17.04.2024	**Technology day "Die and mould" at GFE**	Schmalkalden | Germany
23.04. - 24.04.2024	**MAPAL Technology Day at MAZAK**	Düsseldorf | Germany
23.04. - 26.04.2024	**HELLER Open House**	Nürtingen | Germany
24.04. - 26.04.2024	**CHIRON Open House**	Tuttlingen | Germany
04.06.2024	**OPS Technology day "Die and mould"**	Burbach | Germany
11.06.2024	**MAPAL Technology Day at bavius**	Baienfurt | Germany
04.07. - 05.07.2024	**Dieter Schätzle in-house exhibition**	Tuttlingen | Germany
26.09. - 28.09.2024	**Fritz Weg industrial fair**	Eschenburg-Wissenbach | Germany
26.11. - 27.12.2024	**Avitation Forum**	Munich | Germany

MAPAL Inc. is represented with two locations in the USA: In Port Huron, Michigan (right), and in Fountain Inn, South Carolina (below).

INNOVATIVE SOLUTIONS AND COMPREHENSIVE TECHNICAL SUPPORT

The US subsidiary MAPAL Inc. was founded in 1977 as the first location outside Germany. Local presence, high-precision and customised machining solutions and a clear commitment to the fulfilment of customer requirements are at the centre of the activities of the US team.

The United States is a continental size country and developing business in one of the largest markets in the world demands that you are present to support your product. This was realised early by the MAPAL Group when in 1977 the first subsidiary outside of Germany was established there: High-precision reamers with guide pad technology were manufactured and reconditioned in New Jersey from then on.

Over the following years, with the expansion in the automotive sector, from this hub the business grew, and it became clear that a small operation would not be enough. The next step was to manufacture near the automotive customer base in Detroit. Consequently in 1995, MAPAL opened the production facility in Port Huron to focus on reconditioning PCD tooling, giving the customers a faster response time and close technical support.

With the expertise of the global centres of competence, the manufacturing knowledge and capabilities have grown. In 2019, MAPAL opened up its second plant, this time in the south of the country. Fountain Inn, South Carolina, provided additional capacity for sales, service and manufacturing, and a new test centre for the aerospace industry.

Today, MAPAL Inc. manufactures and reconditions solid carbide and PCD tooling, such as single diameter to multi-step drills, form tools, reamers and composite machining tools, with equipment and technology corresponding to the uniform global standards of the MAPAL Group.

1 – 3 *MAPAL Inc. manufactures new tools and carries out reconditioning services at both locations using the equipment and technologies of the global MAPAL standards.*

4 *Dan Shelton, CEO MAPAL Inc., is focussing on the aviation industry and fluid technology for 2024.*

BUILDING A BROAD BASE FOR CONTINUED GROWTH

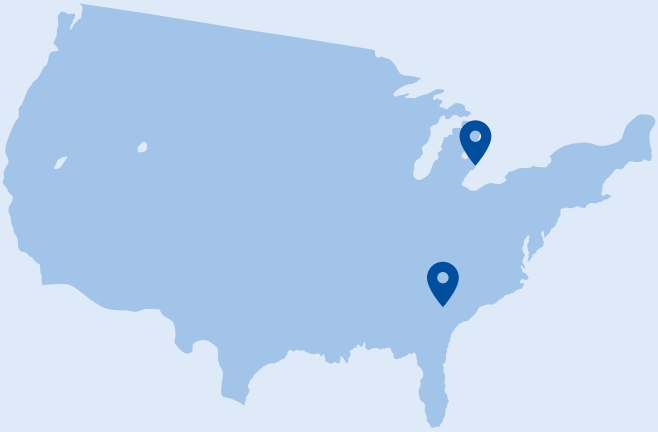
While automotive is the largest market in the US and one that MAPAL will continue to serve at the highest levels, customers also come from the aerospace, fluid power, oil and gas and e-mobility markets, as well as from various machine tool builders. In 2022, MAPAL Inc. put a big effort into intensive sales training on opening new doors and selling MAPAL values and succeeded in considerably growing its customer base.

In 2024 one focus will be on developing the aerospace business with proven solutions and comprehensive technical support: "We focus on a needs-based approach where our precision products and solutions help our customers increase their productivity and keep them competitive in the marketplace" states CEO Dan Shelton.

In recent years, MAPAL Inc. has identified certain areas of aircraft manufacturing that lend themselves nicely to MAPAL's technical expertise and engineered solution portfolio. One of those focuses are hinge lines.

MAPAL works closely with the end-users' supply chain stakeholders to create engineered solutions specifically for the customer. In this way, MAPAL Inc. has become an integral partner to achieve customer requirements with regard to quality, schedule, and productivity needs. ■

MAPAL in the USA



Port Huron, Michigan
Fountain Inn, South Carolina

Founded: 1977 / 2019

Number of employees: 175

Production scope:

- Production of solid carbide and PCD tools
- Reconditioning, regrinding, servicing

MAPAL is investing in sustainability

THE OBJECTIVE IS CARBON-NEUTRAL PRODUCTION

Protecting the environment, using resources responsibly and keeping CO_2 emissions to a minimum – MAPAL regards this as an essential task and a core element in its strategic orientation. Sustainability plays an important role in every product and company division.

"We have a duty here to future generations, and as a family business we consider this to be particularly important. We've set ourselves clear and measurable sustainability goals and are working wholeheartedly to achieve them."

Dr Jochen Kress, President of the MAPAL Group

As part of the certification for environmental standard DIN EN ISO 14001:2015, a management system was implemented which takes into account all aspects of the sustainable use of resources.

The international MAPAL Group's environmental and climate action concept is holistic and is based on several pillars:

UTILISATION AND SELF-GENERATION OF ENERGY FROM RENEWABLE SOURCES

MAPAL is continuously expanding the carbon-neutral energy supply at its production sites. From 2024, MAPAL's main plant in Aalen will produce around one megawatt peak of solar power each year by operating its own photovoltaic systems. The subsidiaries in the United Kingdom, Italy, Poland, India, Australia and South Korea already cover a substantial proportion of their electricity demand using solar energy or are completely self-sufficient in electricity.

The MAPAL plants in Germany source environmentally friendly green electricity for their additional electricity requirements.

State-of-the-art heating concepts contribute to a sustainable energy supply and improved energy efficiency at the individual locations. MAPAL is continuously investing in the use of combined heat and power units, the use of waste heat from machines, heat recovery systems, efficient heat pumps and environmentally friendly LED technology in the companies.

SUSTAINABILITY AND DURABILITY OF THE PRODUCTS

As a technology partner, MAPAL helps customers to make their machining processes sustainable. Smart combination tools, minimum quantity lubrication technology and hydraulic clamping technology all help achieve this. Replaceable head solutions or the streamlining of tool circulation through smart and reliable tool management solutions also address the issue of sustainability. MAPAL ensures that valuable resources are used sustainably by reconditioning, maintaining or reworking tools.

PROMOTION OF CIRCULAR ECONOMY

Conscious use of recyclable materials and their recycling as part of a sustainable closed-loop system are part of the company's environmental management. In the area of packaging, MAPAL uses protective covers made from recycled materials. They keep environmentally harmful emissions and the use of plastic to a minimum without compromising on the requirements of high packaging quality for optimum protection of the tools.

MAPAL also endeavours to procure paper and cardboard material from sources of sustainable and certified forestry. To protect forests, the climate and biodiversity, all paper-based processes are also being reviewed and gradually replaced by modern, digital data management systems.

OCCUPATIONAL SAFETY AND HEALTH PROTECTION

The introduction of a management system for occupational safety in accordance with ISO 45001 includes measures for the safe handling, disposal and substitution of working materials and hazardous substances. This is done to protect the environment and ensure the health of employees.

ENVIRONMENTALLY FRIENDLY TRANSPORT

MAPAL is also committed to a green future in the field of transport. New company vehicles only include electric or hybrid models. E-charging points are available at many sites for visitor, employee and company vehicles, and their roll-out is continually being expanded. MAPAL also encourages its employees to opt for environmentally friendly transport and provides incentives at its sites in Germany, for example, with a bike-to-work programme, subsidised rail and local transport and remote working options. ■

Protective covers made from recycled materials minimise plastic consumption.

Precision tools from MAPAL for Argentina

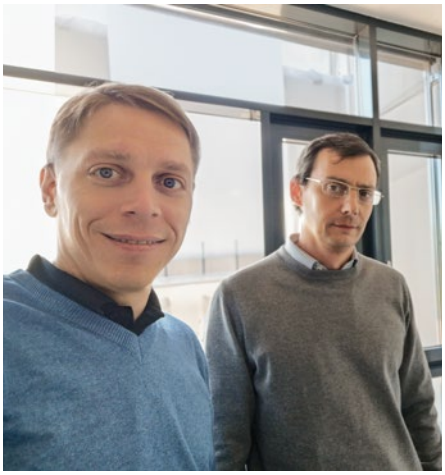
NO DISTANCE IS TOO FAR FOR THE SPECIALISTS AT WSM HERRAMIENTAS

EXCLUSIVE REPRESENTATIVE FOR MAPAL PRODUCTS

WSM Herramientas based in Buenos Aires is a young, dynamic company that has been the exclusive representative for MAPAL products in Argentina since 2015. The owners Daniel Stephan and Javier F. Molina have worked for the MAPAL Group for a long time and have over 25 years of experience in the precision tool industry. They are both technically minded and highly familiar with the production processes of Argentinian customers. WSM Herramientas takes care of MAPAL's direct customers, mostly automotive and commercial vehicle manufacturers and their suppliers, as well as local customers from the fields of machine engineering, aerospace, agriculture, and the hydraulics and pharmaceutical industry. For smaller requirements, the commercial agency keeps a range of the most common MAPAL tools in stock and can serve customers at short notice. When it comes to special projects or commissioning, WSM Herramientas and the experts at MAPAL work closely together.

PERSONALISED CUSTOMER CARE

Daniel Stephan is the first port of call for customers in the industrial regions of Buenos Aires, Santa Fe and Mendoza, while Javier F. Molina takes care of customers in the Córdoba and Tucumán provinces. Both attach great importance to providing users with expert support when designing machining processes and commissioning tools. As a result of the geographical size of Argentina, the specialists are often on the road, even driving long distances to provide users with on-site support. They also offer user training and after-sales support. Another service provided is support with the procurement and supply processes for MAPAL products and with imports. Despite their extensive travelling, Daniel Stephan and Javier F. Molina are always available to customers. ■



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Argentina is one of the largest economies in South America and is a promising future market for international industry. Numerous vehicle and machine engineering manufacturers with global success operate their own production plants in Argentina. For 40 years , MAPAL has collaborated with expert local partners to support them and local companies.

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MAPAL takes on apprentices from Alfing Kessler Sondermaschinen

NEW FUTURE FOR EIGHT ASPIRING MECHATRONIC ENGINEERS

MAPAL is significantly expanding its training capacities. The company is strengthening the area of mechatronics by taking on eight trainee mechatronics engineers from the company AKS (Alfing Kessler Sondermaschinen) in Aalen-Wasseralfingen. With this strategic decision, MAPAL is not only securing the future of the young people, but also enabling them to continue their training under optimum conditions. AKS and MAPAL have been working together in the field of training for many years. In order to secure the existing training contracts in the long term, the two companies have decided to transfer the entire training contracts to MAPAL. The previous trainer and the complete training equipment from AKS will also move to MAPAL, which will ensure the continuity and quality of the training.

The new trainees and their trainer Henrik Konrad (3rd from right) together with the MAPAL HR managers.

MAPAL Chief Human Resources Officer Dr Michael Fried emphasizes the mutual benefit of the takeover: "In the course of our previous cooperation, the trainees from AKS have already completed parts of their practical training at MAPAL and can now continue this in an environment they are already familiar with." At the same time, MAPAL is expanding its expertise in the field of mechatronics and consolidating its position as a trainer that covers the entire range of mechatronics training.

The importance of the mechatronics profession is increasing, driven by the introduction of new technologies and the need for automation in production. In view of demographic trends and the acute shortage of skilled labour, adjustments to manufacturing processes are a decisive factor in enabling production in Germany in the long term.

MAPAL began training mechatronics engineers in 2018 and has already achieved considerable success. Two graduates won the World Championship of Robotics Professions in 2022. While AKS took over the teaching of electrical engineering training content in individual practical phases as part of the training cooperation, MAPAL focused on the acquisition of mechanical skills. Now all skills can be combined under one roof, making the training even more effective.

With the current expansion of training capacities, MAPAL is underlining its commitment as one of the largest training companies in Aalen. The headquarter is now training a total of 115 apprentices, including 15 mechatronics engineers. ■

POOLING KNOWLEDGE FOR AIRCRAFT ASSEMBLY

The MAPAL Group is pooling its global activities in aircraft assembly in the newly founded "Global Organisation for Assembly (GOA)" department, thereby reflecting the great importance and special requirements of the final assembly sector in aviation. The GOA is based in France and has a team of qualified staff as well as production and testing capabilities.

Dr Piotr Tyczynski, Global Head of Segment Management Aerospace, and Christophe Potier, CEO MAPAL France, have restructured and concentrated processes in the aircraft assembly field with the establishment of the Global Organisation for Assembly.

In Vigneux-de-Bretagne on the outskirts of Nantes, one of MAPAL's four sites in France, a dozen employees have been permanent members of the GOA since January 2024. If they need support, they can rely on the complete organisation of MAPAL France with a total of 120 employees. Laurent Benezech, Business Development Manager Aerospace, is responsible for the GOA and works closely together with plant manager Thomas Dauteuille.

The GOA is MAPAL's first Centre of Competence outside Germany. "It is very important for the development of the MAPAL Group to pool our expertise close to our strategic customers", explains Christophe Potier, CEO of MAPAL France. He himself has played a major role in the company's success in the final assembly sector. During the 2009 financial crisis, he searched for new markets and was given the opportunity to find out about the requirements of aircraft assembly at Airbus. After visiting the site, he concluded that although there was great potential here, MAPAL didn't yet have the right products for it. Adapted tools were developed within one month and successfully tested on site, putting MAPAL in business. With the additional takeover of a small French tool manufacturer, the company also became a strategic supplier.

Around a million bores have to be drilled to assemble the parts of an aeroplane. The challenge is that the components are made up of layers of different materials such as titanium, aluminium and CFRP in various combinations. As a result, there is no standard range for machining rivet bores. MAPAL primarily provides solid carbide

Boring and reaming tools for through bores with special cutting edges and guide elements for the reliable production of precise bores with high surface quality and exact concentricity.

Producing precise, circular countersinks and flat surfaces on pre-drilled bores.

Tools for drilling from the solid in multi-layer composites (stacks) made of CFRP, aluminium, high-alloy steels or titanium with a hand drill.

tools for this: step drills with sharp cutting edges and multi-bladed reamers. Great importance is attached to suitable coatings, which MAPAL is constantly further developing.

MAPAL is highly successful with its assembly tool technologies and now boasts a large number of customers in the aviation industry. The new structure is heavily tailored to the requirements of the sector. "We have to be able to react very quickly. This has been a major challenge for MAPAL so far and the reason for our new organisational unit", explains Piotr Tyczynski, Global Head of Segment Management Aerospace at MAPAL. "And just as important as having the right solutions is a good, tightly-knit network to get the tools to our customers quickly and to support them in using them."

DEVELOPMENT, PRODUCTION AND CUSTOMER SERVICE

The required capabilities were concentrated and expanded in France. The GOA not only acts as a sales organisation that centrally handles all quotation processing worldwide for the final assembly division. In Vigneux-de-Bretagne, a development department has also been set up for testing customised tools. In addition to measuring all parameters, it is also possible to adjust the tools to the customer's individual machining conditions. This is important because the many bores on the aircraft are drilled using semi-automatic or manual machines. Production is only a few metres away from the development department. If modifications need to be made to a tool, this is done within a few minutes and the tests can continue. Solutions can thus be developed in a very short amount of time. In addition, the GOA's manufacturing unit also produces the first tool series and standardises their production to ensure reproducibility in the Centre of Competence Altenstadt and in Toulouse as well as at all MAPAL production sites.

Experience and findings from France are shared with other MAPAL Group sites through the GOA. MAPAL appoints a process expert in each country because on-site support for customers is so important in the assembly field. These experts already exist in the key focus markets and form a network under the leadership of Thomas Dauteuille. Where the relevant knowledge still needs to be built up locally, customers receive centralised support from the GOA. ■

The GOA in Vigneux-de-Bretagne has a development department for quick and targeted tool design and optimisation...

... which is located in the immediate vicinity of the production unit. All prototype tools for customers in the aviation assembly sector are produced here.

COMPLETE KNOW-HOW IN ONE PART

MAPAL has developed two sample components for the aerospace sector. These so-called "generic components" cover all the demanding machining steps that may be involved in the production of hydraulic valve housings made of aluminium or torsion links for landing legs milled from titanium.

Wherever something needs to be moved on an aircraft, there is a valve housing. Flaps, rudders, landing gear, engines and other components are controlled by hydraulics. Every plane has a large number of valve housings with different designs. They range from small boxes to blocks measuring half a meter. The machining requirements, however, are similar.

The generic component created by MAPAL measures around 30 x 30 x 30 centimetres and contains all machining steps that may be involved in manufacturing a valve housing, from pre-machining to finishing. It is deliberately not a replica of a customer component but was designed instead based on the machining requirements of various real-life components. Within the group of companies, MAPAL has compiled experience gained worldwide in the machining of such components. All of this knowledge has been incorporated into a single sample component.

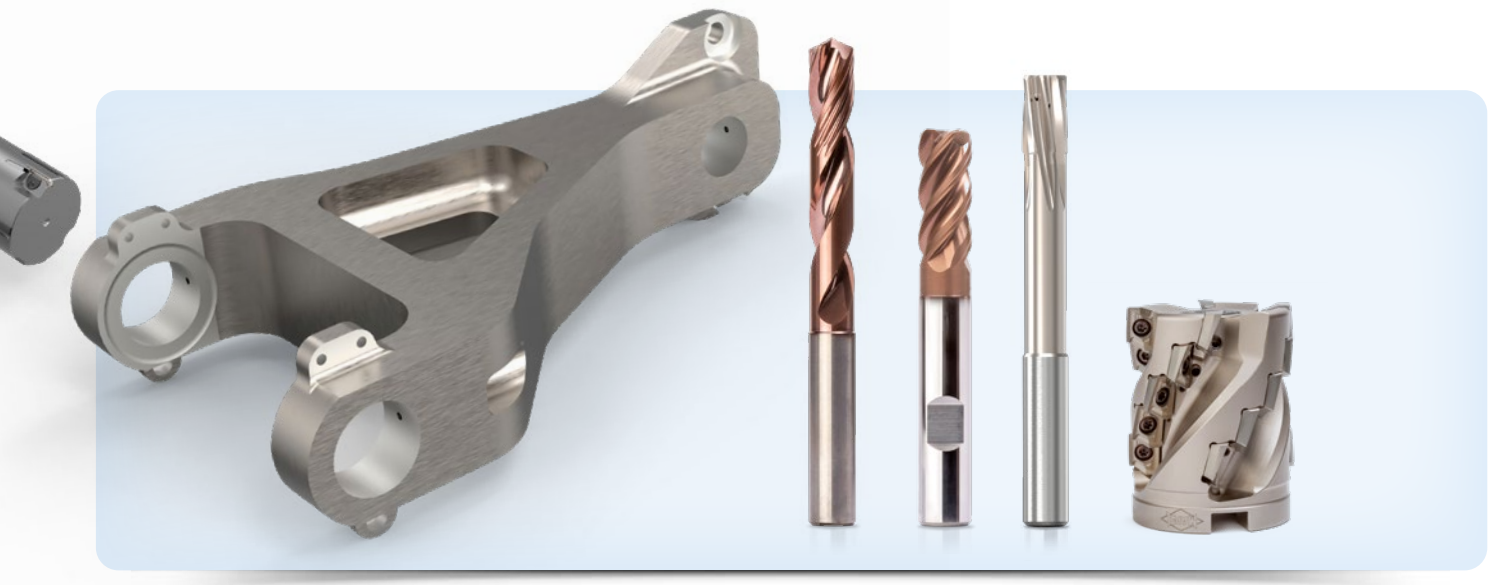
This involves recommendations from the tool manufacturer for the appropriate machining strategies and cutting data. Several different options are often available to solve a particular problem. Piotr Tyczynski, Global Head of Segment Management Aerospace at MAPAL, gives an example: "To ream a bore, we can use either a PCD tool or a fine boring tool, or multi-bladed reamers". "Each solution has its advantages. The deciding factor is always which advantages best meet the customer's requirements."

Valve housings for aerospace are more complicated components than those used in other areas, such as hydraulics for construction machinery. MAPAL used over 130 different custom tools for a single housing type in the most complex customer project to date. Manufacturing often involves very thin-walled parts as it is important to minimise weight in the aviation industry. Other challenges include deep bores with cross bores or slots that create interrupted cuts. In addition, the machining of the aluminium used, with its low silicon content, produces very long chips that are difficult to break.

Another generic component that MAPAL has developed for the aerospace market segment is a torsion link for the main landing gear on the aircraft. It connects the two cylindrical parts of the landing leg. This design allows the damper cylinder to retract and extend without twisting. This part is also available in various designs.

MAPAL uses its medium-sized sample part to model all real requirements. Due to the resulting high loads, torsion links are made of titanium. The low thermal conductivity of the material results in high temperatures during machining, which have a negative impact on tool life. In addition to optimised coating and cutting edge preparation, the right machining strategy is essential here.

With the generic components for aerospace, MAPAL is pursuing a concept that has already proven its worth in the automotive sector. Here too, demanding components were identified which can be machined using the company's tools. A large part of automotive technology is now covered by the appropriate generic components. "We can now also use the generic components to demonstrate what MAPAL is technologically capable of in the aerospace sector", explains Piotr Tyczynski. ■



The sample process for torsion links maps all real requirements.

High production repeat accuracy and reliable processes are the focus of the process design of hydraulic valve housings for aircraft. The generic component is not a replica of a customer component, but a design based on real machining requirements.

The process sequences in detail are available at:

Efficient machining of workpiece materials with poor thermal conductivity

TROCHOIDAL MILLING USING INDEXABLE INSERTS

Solid carbide tools were chiefly used for trochoidal milling in the past. Together with SolidCAM and its iMachining software, MAPAL has now demonstrated that the highly efficient machining technology also offers advantages for milling with indexable inserts. An aeroplane part made of titanium was used as a demo object.

The torsion link is a component of the main landing gear of aeroplanes and is made up of two parts. It connects the two cylindrical parts of the landing leg. This design allows the damper cylinders to retract and extend without twisting. The torsion link thus maintains correct positioning of the wheels and ensures the directional stability of the aeroplane when the landing gear is extended.

Due to the resulting high loads, torsion links are made of titanium. Other than parts for a few mass-produced aeroplanes where production of forged blanks is worthwhile, both parts for the torsion link are usually milled from solid. Because titanium is a poor thermal conductor, trochoidal milling is a suitable machining strategy as the tool only briefly comes into contact with the workpiece. Part characteristics like constrictions that have to be machined, deep cavities and grooves all speak for this method.

THE BETTER MACHINING STRATEGY

For conventional roughing (groove milling), a wrapping angle of 180° is stipulated for the milling cutter. This has various disadvantages: long chips, high thermal loads, big machining forces. This limits infeed depths, feed rates and cutting speeds. By superimposing a circular movement of the tool over the feed movement, the contact conditions can be positively influenced with trochoidal milling.

Next to classic trochoidal paths, iMachining by the software provider SolidCAM has been making increasing use of morphed spiral paths to achieve higher removal rates. The contact angle constantly shifts between minimum and maximum values, while the feed is adapted dynamically. The mechanical and thermal loads on the milling cutter stay constant in this way. This ensures the longest possible tool life. The cutting forces remain constant at all times, producing chips with uniform thickness that can be reliably removed. Recordings with infrared cameras by SolidCAM prove this. When machining, iMachining uses the maximum cutting depth of the tool and automatically implements strategies to reduce vibrations. This prevents excessive tool wear.

The shell end face milling cutter NeoMill-Titan-2-Shell performs trochoidal milling convincingly with maximum machining rates, very quiet running and optimal chip removal.

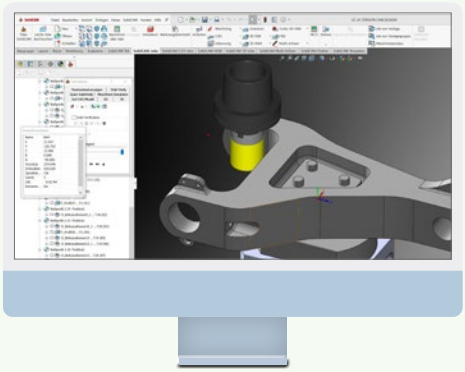
TOOLS WITH INDEXABLE INSERTS FOR LARGER DIAMETERS

Trochoidal milling with solid carbide tools for smaller diameters is well established on the market. Tool manufacturer MAPAL has optimised tools with indexable inserts for this field of application in order to be able to economically implement this machining strategy even with larger tools.

The shell end face milling cutter NeoMill-Titan-2-Shell is equipped with a sophisticated cooling system for targeted heat removal. The interior of the tool is hollow and acts as a buffer for the coolant. This tank is tapped through various screws that distribute the coolant to the individual blades. The selection of the screws is decisive here. They can have small or large bores, or no hole at all to completely stop the coolant flow to the respective area. The tool can thus be perfectly adapted to the particular machine and application.

In this way, titanium can also be milled using machines with pumps with lower pressure and volume when the screw with smaller openings is used, creating coolant pressure that is high enough. New machines that have a lot of pressure and volume might only need to use the first two cutting rows of the milling cutter during machining. To get the full cooling pressure to these cutting edges, the openings at rear cutting edges are closed. The coolant tank in the tool also cools the tool body. The constantly circulating coolant carries away the heat and the temperature of the part is lowered.

MAPAL offers the NeoMill-Titan-2-Shell as a standard tool in the diameter range of 32 to 80 mm. Larger diameters do not make sense in MAPAL's opinion as there is no machine on the market that could mill titanium at those sizes. Besides the required spindle power, the clamping setup would also have to be able to absorb the resulting forces. MAPAL offers coated carbide inserts in three different designs for the milling cutter. The non-alloy standard substrate is conceived for contract manufacturers who only machine with titanium or stainless steel occasionally. Two high-alloyed versions enable the highest cutting data.



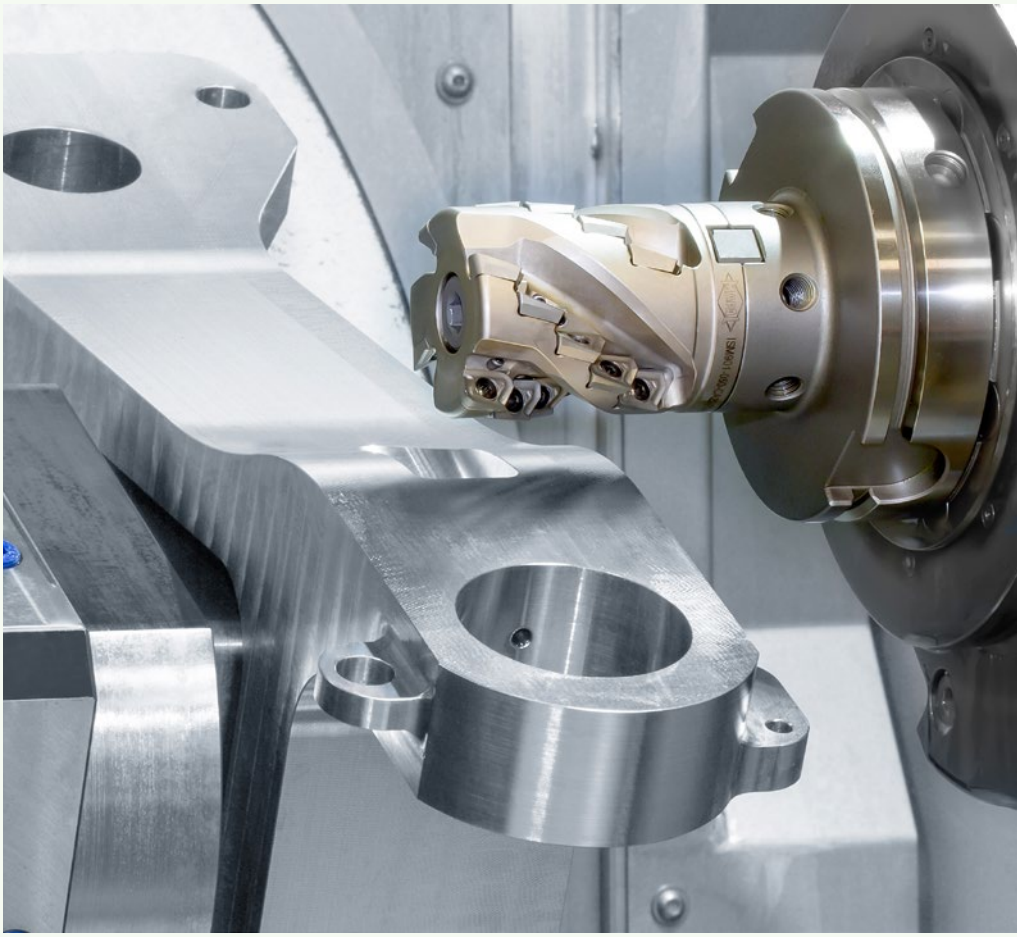
When machining, iMachining uses the maximum cutting depth of the tool and automatically implements strategies to reduce vibrations. This prevents excessive tool wear.

MAPAL AND SOLIDCAM AS A DUO

When it comes to trochoidal milling, SolidCAM has been an important partner for MAPAL for many years. Together, both companies have subjected the new indexable insert milling cutters to a variety of tests with various materials. Their expectations have been met: the technology works with indexable inserts just as well as with solid carbide. Users can also manufacture more affordably using indexable insert tools with diameters starting at 45 mm as only the inserts have to be replaced in case of wear. In tests with iMachining, much longer tool lives have been achieved than with conventional milling.

MAPAL is one of the first tool manufacturers SolidCAM added to their tool catalogue. When selecting the tool, the iMachining's Technology Wizard immediately provides the optimal cutting data. MAPAL is responsible for direct customer contact. Their trained application engineers are instructed in the use of iMachining and can process most project directly. For more complex parts, MAPAL is supported by SolidCAM if necessary.

Beside the torsion link, parts for the aerospace industry being focussed on include further structural parts in the landing gear, like wing box, fuselage and empennage. In automobile manufacturing, control arms are a candidate for trochoidal milling. As the tool allows a long projection length, deep cavities in aluminium could also be interesting. MAPAL and SolidCAM are planning to test this as well. ■



MAPAL deploys the NeoMill-Titan-2-Shell for the trochoidal milling of a torsion link.

The torsion link is part of the main landing gear of aeroplanes. It is made of titanium due to the high loads it is exposed to. Generally, torsion links are milled from solid.

Holistic process understanding for optimum machining results

MACHINING TITANIUM ECONOMICALLY

Machining titanium is fundamentally different from machining cast iron or steel. For economic results, tool technology and the process must be optimally designed. With its holistic understanding of the overall interrelationships in the machining of titanium, MAPAL is able to identify this optimum combination of precision and cost-effectiveness.

The material properties of titanium are valued in many fields such as aerospace, the automotive industry and medical technology. However, the material is notoriously difficult to machine. This is because of its extremely low thermal conductivity. By way of comparison, with steel machining, ten percent of the temperature remains in the workpiece, 15 percent causes stress on the cutting tool and by far the largest proportion, 75 percent of the heat, is transferred into the chips and removed with them. Titanium is completely different. In this case, the chips only absorb 25 percent of the heat. The lion's share of 60 percent goes into the tool and causes a high thermal load on the cutting edge or the cutting material. This leads to considerably shorter tool lives. In this way, the cutting material costs become the focus of attention.

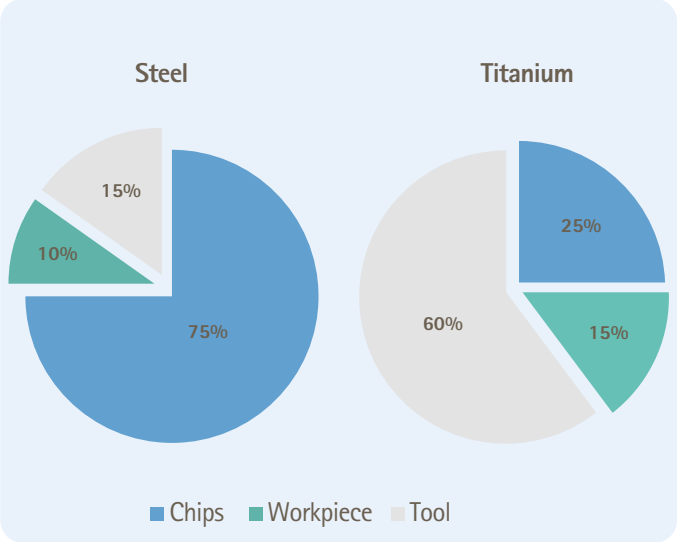
INFLUENCE OF THE CUTTING SPEED ON WEAR AND TEAR

If the cutting speed is too low, this can lead to adhesion, i.e. the material sticking. If the cutting speed is too high, the risk of abrasion and tribochemical wear increase sharply and the cutting material is burnt. One way to ascertain the condition of the cutting edge is to look at the width of the wear mark. In a stationary range, it grows slowly and continuously. If this range is exceeded and the machining enters the transient range, a rapid and incalculable failure of the tool cutting edge occurs. This happens when the selected cutting speed or feed is too high. There is a difference of up to 100 percent in tool life between the stationary and the transient range.

It is very important for MAPAL's area field service to help run in processes, to check the width of the wear mark and to show the customer when the end of the stationary range has been reached, for reliable and optimum machine running times. As a general rule, MAPAL recommends replacing the tool when wear is approximately 0.2 mm. A carbide milling cutter can still be reground then, but not at higher levels of wear.

Comprehensive expertise in titanium machining

Workpiece material + Tools



Heat dissipation during milling – comparison of steel and titanium.

The machining specialists at MAPAL provide support with innovative tool technology and optimum process design.

MAPAL has incorporated process knowledge of titanium machining into the development of its tool technology. The focus is on wear and tear criteria and their influence even beyond the most suitable cutting material. To ensure optimum heat resistance, MAPAL uses innovative cutting materials, i.e. selected carbide grades and matching coatings that produce as little friction as possible. The micro and macro geometry with extremely positive tool geometries, polished rake faces and measures for efficient cooling pave the way for cost-efficient machining. However, careful balancing of the cutting data is essential for the cost of titanium machining.

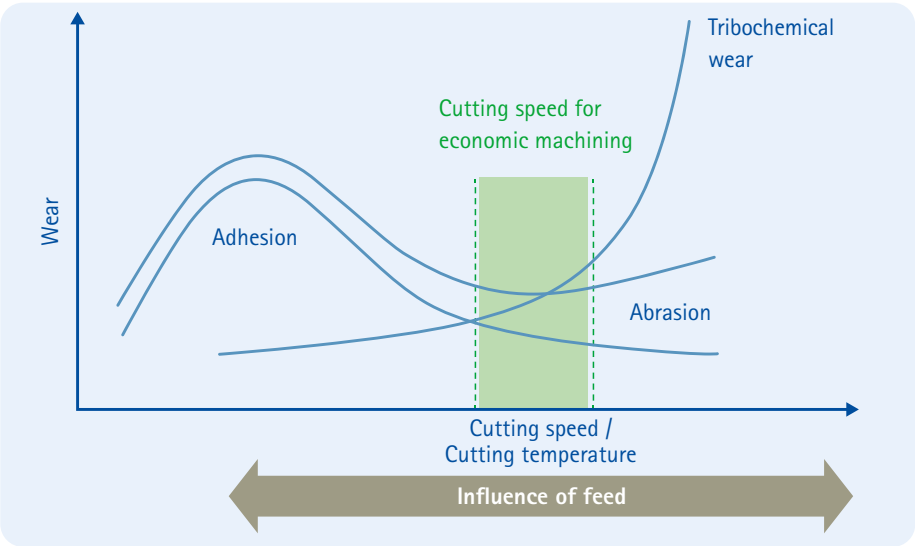
FASTER DOES NOT MEAN LOWER COSTS PER PART

When machining steel and cast iron, higher cutting speeds often mean higher productivity and lower overall costs, which are made up of machine costs and cutting material costs. The machine costs get lower the quicker and more efficiently the machine operates. Although the cutting material costs increase in this case, an optimum in terms of overall costs is nevertheless achieved at a relatively high cutting speed. Conversely, when it comes to titanium, higher cutting speeds are not expedient. Tobias Gräupel, Technical Expert Indexable Tools at MAPAL, proves this with an economic efficiency calculation that optimises the cutting data of titanium machining from a cost point of view. A milling operation with a NeoMill-Titan-2-Corner with four cutting edges that machines TiAl6V4 with a cutting depth of 4 mm and a cutting width of 24 mm is considered. An examination of different combinations of feed rates and cutting speeds leads to a clear recommendation in terms of the machining values for titanium machining.

By way of comparison, when machining a steel part, doubling the cutting speed from 200 m/min to 400 m/min resulted in an overall cost saving of 24 percent per part. When machining a titanium workpiece, increasing the cutting speed from 32 m/min to 50 m/min results in a cost increase of 259 percent. "An increase in the cutting speed is clearly reflected in the overall costs. They skyrocket", comments Gräupel. The optimum cost is achieved with a machining operation with high feed rates and low cutting speeds. If, on the other hand, the cutting speeds were maximised in addition to the high feed rates, the costs would be more than four times as high.

"These economic efficiency calculations are vital especially for larger lot sizes", highlights Gräupel. After all, when producing large quantities, the overall costs play a major role when it comes to making investment decisions. Inefficient cutting parameters cause the total costs in titanium to shoot up; only the combination of innovative tool technology and optimum process design leads to a perfect result. The technical consultants at MAPAL harness this expertise to help production managers achieve optimum results regardless of machining and production batch sizes. ■

\+ Economic correlations of the cutting values = **Optimum machining results**



Phases of tool wear.

DEVELOPMENT OF CUSTOMISED DIAMOND COATINGS

With its in-depth knowledge in the field of coating technology, MAPAL also develops extremely hard and wear-resistant diamond coatings for machining materials such as CFRP, ceramics, graphite and aluminium alloys. MAPAL's machining solutions thus achieve longer tool lives and more process reliability especially for applications in the automotive and aerospace industry, in the die & mould sector and in medical technology.

The tool manufacturer has coating technologies at its site in Aalen and in its centres of competence to coat indexable inserts and solid carbide tools using PVD or CVD processes. The choice of process depends on the relevant application parameters. For dry machining and high cutting speeds, CVD is usually chosen; in the case of unstable machining situations or difficult machining conditions, the tougher PVD coatings are applied.

If adhesive wear processes occur frequently when machining, the use of diamond-like carbon coatings (DLC) is advisable. DLC coatings are also deposited using PVD or a plasma-enhanced CVD process. These coatings are formed by a mixture of sp^2 hybridised carbon atom bonds (graphite) and those with sp^3 hybridisation (diamond). The mixing ratio determines the physical and mechanical properties of the coatings. The more sp^3 atomic bonds there are, the harder the coating.

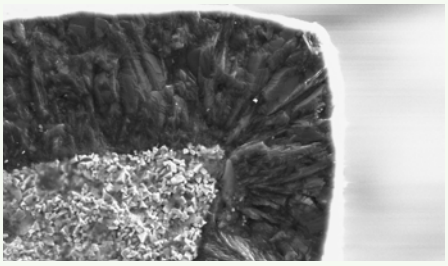
NEW COATING PROCESSES THANKS TO CVD DIAMOND REACTORS

Pure diamond coatings are required for milling or drilling highly abrasive materials. The process used in the MAPAL Group for the synthesis of diamond coatings is a modification of purely thermal CVD and is called hot filament CVD, or HF-CVD for short. In HF-CVD, wires made of refractory metals heat up a mixture of hydrogen and methane to temperatures of up to 2,500 degrees. In the process, very reactive methyl radicals are formed, which are gradually deposited on the seeded carbide surface as a diamond layer. MAPAL has own CVD diamond reactors at its disposal for this.

"In recent years, we have worked extensively on improving the diamond coating process and have created new possibilities for MAPAL in tool production", explains Dr Martin Kommer, Team Leader R&D Cutting Material / Coating at MAPAL. The tool manufacturer now has the complete tool design under its own control, from the appropriate geometry to the selection of a suitable carbide to the coating. This means that tools can be designed even more precisely to meet customers' requirements. The development department in Aalen has its own centre for machining, which tests new tools for tool life and wear behaviour, among other things.

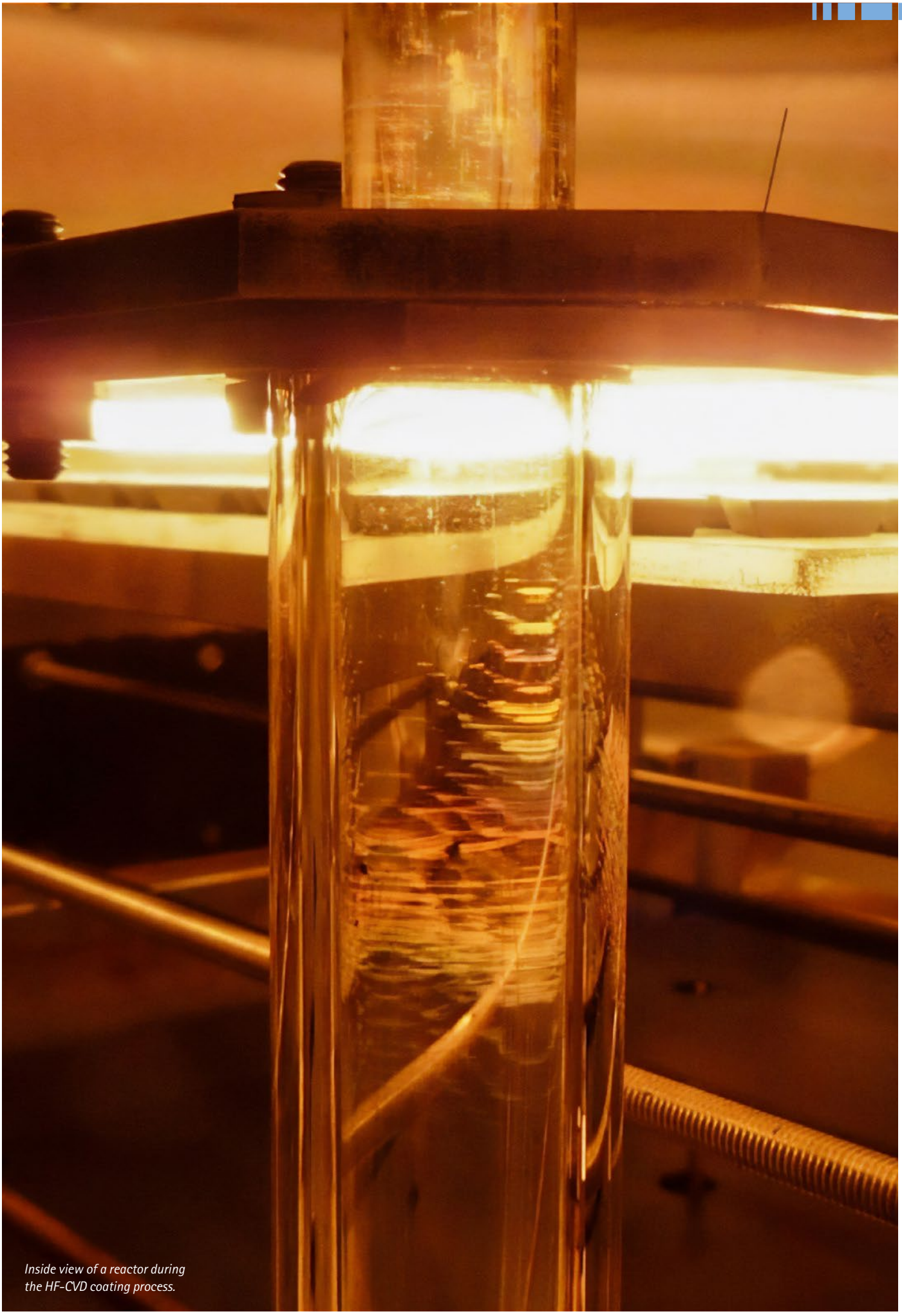
Since the coating process functions via a chemical reaction combined with mechanical clamping, defined etching of the carbide surface and seeding are important during pre-treatment. As not every carbide is suitable for this, MAPAL evaluates appropriate substrates. Whether fine-grained microcrystalline or nanocrystalline layers are produced during coating is determined by the temperature, pressure and flow of the respective reactive gases during the process. Theoretically, layers up to a thickness of 50 µm can be produced by HF-CVD. For coating its tools, MAPAL currently focuses on the range between 3 µm and 15 µm, depending on the respective application.

The optimised HF-CVD process produces layers with almost uniform thickness, which MAPAL used when developing its OptiMill-Composite-Speed-Plus (see page 26). In the respective machining application, the entire cutting edge length can thus be reliably used regardless of the cutting depth. ■



REM image of the break edge of a diamond-coated solid carbide tool. Enlarged: 3,000x.

The homogeneous CVD diamond coating from MAPAL ensures long tool lives and a high level of process reliability, for example with the OptiMill-Composite-Speed-Plus solid carbide milling cutter for CFRP workpiece materials.



Inside view of a reactor during the HF-CVD coating process.

CFRP MACHINING OPTIMISED

High process reliability with the OptiMill-Composite-Speed-Plus

Improved clamping technology for large carbon-fibre parts enables the aerospace industry to machine more quickly. MAPAL supports this development with innovative tools. With its diamond coating and optimised geometry, the OptiMill-Composite-Speed-Plus guarantees process reliability.

The aerospace industry is reluctant to change functioning processes that have already been audited due to the large effort involved. However, growing cost pressures are also forcing this sector to make its production as efficient as possible. Aircraft manufacturers have so far identified the clamping technology as an obstacle on the path to higher performance. Large CFRP parts are usually fixed using vacuum clamping technology. The limited holding forces of the suction cups require relatively low cutting speeds in order to prevent rising vibration. This can lead to a loss of quality and deviations in shape and position tolerances.

New clamping technologies now enable manufacturers to increase the cutting values. But with this came a new problem: under the changed process conditions, there was an increased risk of breakage of the milling cutters that had previously worked perfectly due to the increased load. "Even very large manufacturers were affected by tool breakages after using the tools to their limits", explains Tim Rohmer, Product Manager for solid carbide milling tools at MAPAL. The tool manufacturer saw a need to act and developed the OptiMill-Composite-Speed-Plus as a response to market demands.

MEASURES TO REDUCE THE RISK OF BREAKAGE

In order to enhance the flexural strength, MAPAL increased the core diameter of its solid carbide shoulder milling cutter. Although this is at the expense of chip space, it does not have any negative effects because CFRP machining does not produce chips, but a fine dust. During tool tests with differently dimensioned diameters, no differences were found in terms of removing dust and process heat. MAPAL noticeably increases the flexural strength with the larger core diameter.

The requirements for the groove profile also differ from the machining of metal, where feed, infeed depth and cutting width influence the chip thickness. Since the rake angle for CFRP is only slightly engaged due to a low feed per tooth, MAPAL has designed the cutting wedge for maximum stability.

The new OptiMill-Composite-Speed-Plus also has an optimised envelope contour to reduce leverage forces and thus for increased fracture resistance. It works well in practice, as Rohmer explains: "Typical parts in the aerospace industry consist of stacks, i.e. composite panels, with five to 15 mm usually being machined. Shorter tools are perfectly adequate for this." While the predecessor tools were still longer than specified in DIN6527, the new tool series largely complies with the standard. MAPAL provides the tools with diameters of 4 to 20 mm.

EVEN DIAMOND LAYER

The OptiMill-Composite-Speed-Plus also ensures high tool lives for machining abrasive carbon fibres with an innovative diamond coating. The uniform layer thickness distribution and the high repeatability with which MAPAL applies the diamond in the CVD process are exceptional. Conventional coating technologies often produce irregular layers that are thicker at the tip than further down on the cutting edge. This process ensures different edge rounding and thus fluctuating cutting pressure and wear and tear.

The homogeneous layer thickness over the cutting edge length contributes to process reliability. This enables consistent performance regardless of which part of the cutting edge is involved. This means that the tools can also be used for circumferential machining of a stack, regardless of height: users sometimes use the milling cutter until the end of of the tool life, ➔

With coated and uncoated variants, the OptiMill-Composite-Speed-Plus is ideally suited for CFRP composite materials as well as thermoplastics, thermosets and fibreglass materials.

The OptiMill-Composite-Speed-Plus ensures high process reliability with diamond coating and optimised geometry.

Its large core diameter is responsible for the enhanced flexural strength of the OptiMill-Composite-Speed-Plus.

then readjust it and continue working with a fresh part of the cutting edge. The shoulder milling cutter is suitable for a wide range of applications. In addition to circumferential machining, it is also used to produce grooves, edges and pockets.

Perfect cutting quality is very important in the aerospace industry. Once the fibres are no longer neatly separated and the part thus no longer achieves the desired quality, the tools are replaced, even if they only appear slightly worn. The OptiMill-Composite-Speed-Plus achieves its excellent cutting quality thanks to its specially arranged "fibre catchers" on the cutting edges, which cause a double compression and thus separate the fibre protrusions on the workpieces extremely precisely.

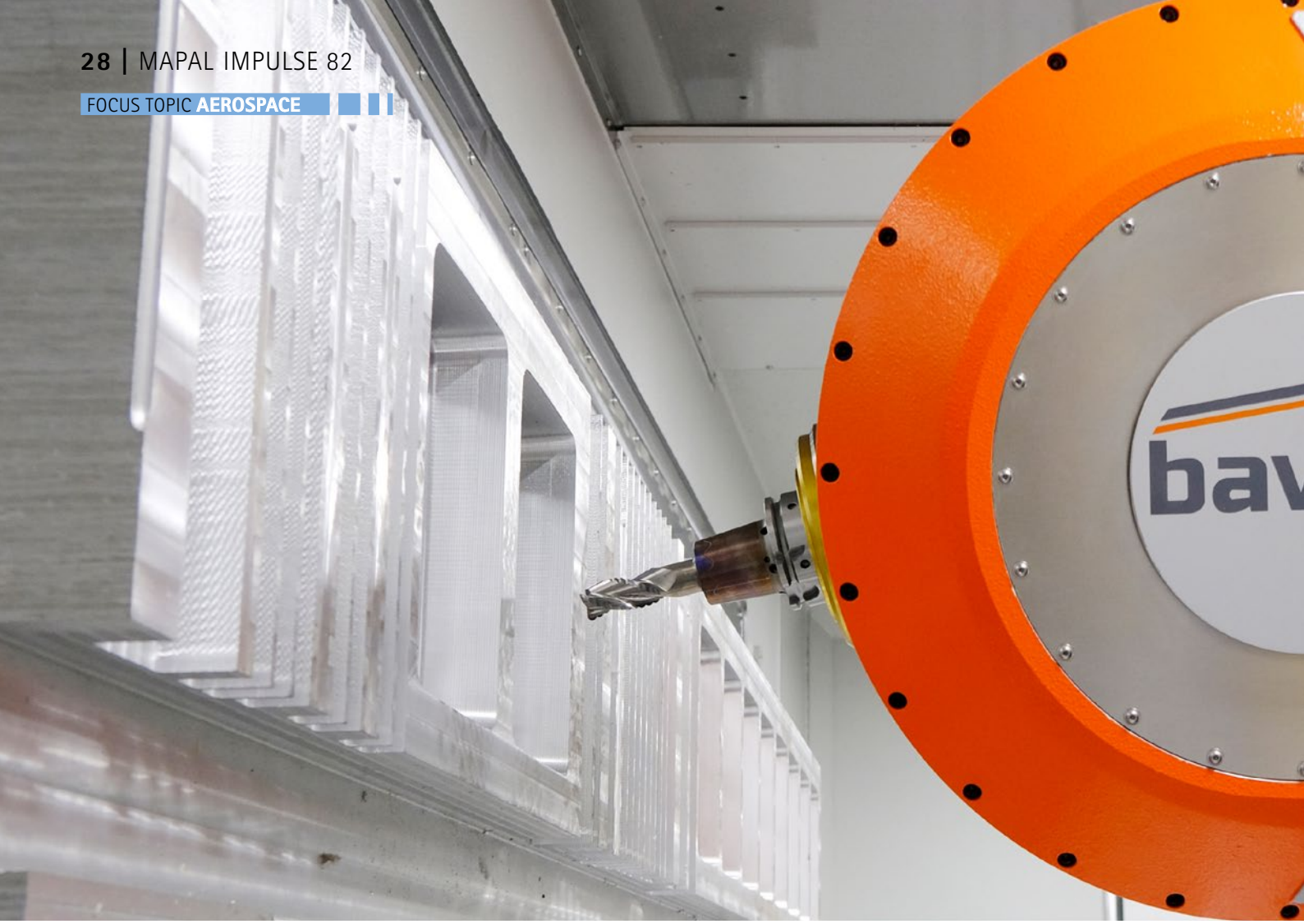
PULL OR PUSH: IMPROVEMENTS OF UP TO 30 PERCENT

One aspect of CFRP machining is that the tools available today produce different machining qualities on the workpieces. The user must decide which quality requirements are placed on the part according to the existing material composite and therefore make the ideal tool selection. It is often connection points for which particularly neat edges are required. MAPAL provides two different variants of its milling cutters. The right-hand spiral model produces a pulling effect and thus axial tensile forces, while the left-hand spiral variant has a pushing effect and thus forms compressive forces in the axial direction. The fibre catchers counteract the force created by the respective spiralisation.

The previous model had a third, neutral variant. With further development, this variant is no longer required as the new tools reduce the axial forces by up to 40 percent. As such, the two versions of the new product also assume all tasks for which the neutral variant was previously used. In terms of tool life, quiet running, productivity and cutting quality, the new tools are up to 30 percent better than their predecessors.

In addition to the aerospace industry, the use of CFRP is also growing rapidly in other areas. These include the automotive industry, racing and the consumer sector. Manufacturers of sports equipment such as bicycles, skis, snowboards or fishing rods increasingly use the modern material.

With its sharp cutting edges, the OptiMill-Composite-Speed-Plus can also be used to machine thermoplastics and thermosets. As these plastics are not abrasive, coating is not required here and sharp cutting edges are used. The uncoated milling tools replace the previous router tools as they are far superior, especially in terms of cutting quality. MAPAL also recommends the uncoated tools for machining fibreglass materials. ■



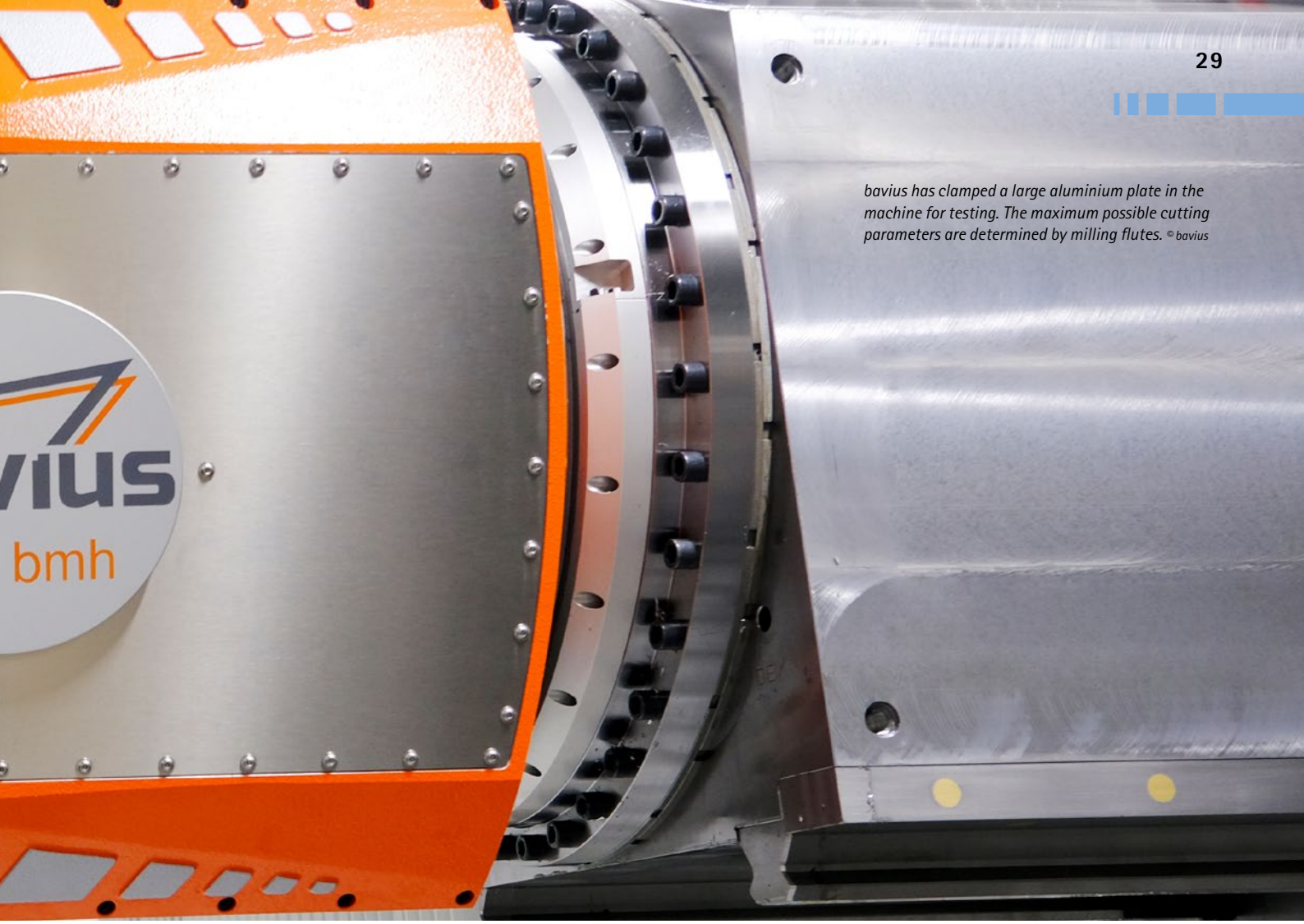
MAPAL high-volume milling cutters in use at bavius

ALUMINIUM MACHINING IN NEW DIMENSIONS

The machine tool manufacturer bavius technologie gmbh was able to achieve impressive material removal rates of over 20 litres per minute on its new high-end model HBZ AeroCell 160 with a new generation of aluminium high-volume milling cutters from MAPAL. The result of this successful collaboration comes at the right time for the aerospace industry, which is taking off again following the downturn caused by coronavirus.

The machine manufacturer, which emerged from the Handtmann Group, has been operating as an independent company under the name bavius technologie gmbh since a management buy-out in 2017 and has its headquarters in Baienfurt. Despite all the changes, the business area has remained the same for almost four decades. CNC machining centres are designed and built for the precise high-speed machining of large workpieces made of aluminium.

"Over 80 percent of our work is for the aerospace industry, where our AeroCell machines are used primarily to produce large structural parts", explains Amit Paranjape, Sales Manager at bavius. Customers are aircraft manufacturers and their first and second tier suppliers. Large volumes are required to make full use of the bavius systems. There are currently two different machine lines from Baienfurt. The PBZ profile machining centres are used, among other things, to machine seat tracks for aircraft. The HBZ horizontal ma-



bavius has clamped a large aluminium plate in the machine for testing. The maximum possible cutting parameters are determined by milling flutes. © bavius

chining centres are used to manufacture large structural parts from solid. "Everything long and wide is machined here", explains Paranjape. "Users can machine all the necessary parts for the airframe of an aircraft on our machines." The material removal rates are extreme, as one example from a bavius customer shows, who mills out finished parts weighing only 35 kilograms from blanks weighing 1.3 tonnes.

TREND TOWARDS HORIZONTAL MACHINING

The aerospace industry is undergoing a transformation in terms of machine concepts. After decades of preferring to work on gantry machines or vertical machining centres, horizontal machines are now preferred for new investments, where the components are clamped upright and the spindle is moved horizontally. The main advantage of the horizontal design is the easier removal of the large quantity of chips, which practically fall into the chip conveyor by themselves.

At bavius, it's clear that the aerospace industry has recovered from Covid. Passenger numbers have already returned to pre-pandemic levels and are continuing to rise. As a result, new planes are needed again, which keeps machine manufacturers busy. Demand in Germany, France, Spain and other countries reveals that there is a lot of investment in Europe again. Dynamic machines with high spindle power are particularly sought after.

bavius is currently expanding its high-end series HBZ AeroCell with the new AeroCell 160. With a range of mechanical changes, the manufacturer also achieves even greater dynamics with the new machine. Modifications in automation reduce non-productive times. Instead of functioning with hydraulic arms, it is now electrically powered. With the set-up station in front of the machine, a complete pallet change takes two to three minutes. If the pallet is already connected with the part, this takes less than a minute. Tool change has also been optimised with a chip-to-chip time now of 12 seconds.

TO THE LIMITS AND BEYOND

The AeroCell 160 is designed for maximum material removal rates in aluminium. A powerful jet of coolant and a widened chip conveyor ensure that no chip particles can build up anywhere. "Thanks to our concept, we avoid problems that occur with gantry machines. In this way, we can optimally deploy modern tools", explains Stefan Diem, Application Engineer at bavius. In order to test new machines and at the same time provide customers with references, bavius carries out milling tests that push them to their limits and beyond. "Lots of customers want to see evidence first before they buy a machine", admits Diem.

It is important for the machine manufacturer to use the most efficient tools currently available for the tests, which are then also available

for customer demonstrations. bavius regularly tests various manufacturers' tools. Due to the tight production deadlines, there are not many options. "To save time, it is important for us to have a good exchange with the tool manufacturer", says Stefan Diem. "We've had a good relationship with MAPAL for many years and have always been very pleased with the roughing and finishing tools. I appreciate our close collaboration with MAPAL. We receive excellent advice and are in good hands."

Because milling cutters from the OptiMill-SPM series had previously been used at bavius and performed very well, MAPAL was asked again. It was perfect timing: the tool manufacturer had just finished developing a new solid carbide roughing cutter, the OptiMill-Alu-Wave, and also offered the aluminium high-volume milling cutter NeoMill-Alu-QBig with indexable inserts for larger diameters.

The milling tests are kept simple in design but put the tools through their paces. bavius mills a series of flutes in a large aluminium plate for this. Stefan Diem takes a very pragmatic approach: "If the tool can do the flute, we can also use it to mill pockets and do any other machining." This means that the determined cutting data can be directly applied to customer parts.

THE TOOL COULD DO EVEN MORE

For the tests with the OptiMill-Alu-Wave, bavius chose the largest diameter of this three-fluted cutter at 25 mm. At a spindle speed of 25,465 rpm and a cutting speed of 2,000 m/min, the spindle power was gradually increased. Slot number 6 delivered the best material removal rate with a record-breaking 20 dm^3/min. This test run was performed with a spindle power of 175 kW, with a torque of 66 Nm, and a material removal rate of 30 mm. The machine stopped during tests at higher powers. "The tool could do even more, the limiting factor is the spindle", Diem comments on the result. "With the 25 mm OptiMill-Alu-Wave, we have achieved a new dimension in aluminium machining. The milling cutter is definitely better than anything we had previously used."

bavius used the Safe-Lock™ system as pull-out protection. "In this speed range, symmetrical pull-out protection is very important in order not to create imbalance", explains Tim Rohmer, Product Manager Solid Carbide Milling Tools at MAPAL. A Weldon flat, which is often attached to such tools as pull-out protection, is the wrong solution here. To guarantee the smooth running of the machine, there is no way around careful balancing, even with symmetrical tools.

The tests in Baienfurt were also met with a great deal of satisfaction in terms of surface quality. The cord geometry of the OptiMill-Alu-Wave ensures optimum chip formation. The polished groove profile ensures seamless chip removal, which is supported by the central cooling of the tool in cooperation with the external cooling in the machine.

In further tests, pockets were milled into the aluminium plate, with a material removal rate of 16 litres still being achieved with very good surfaces. For Application Engineer Thomas Jungbeck and Component Manager Alexander Follenweider, who monitored the tests for MAPAL, this is proof of the very good dynamics of the bavius machining centre: "Other machines often stop in the corners and cause high vibrations. This doesn't occur at all with the AeroCell, which goes round corners almost unrestrained."

Have achieved the best results in aluminium machining in close cooperation (from left): The team with Thomas Jungbeck (Technical Consultant, MAPAL), Tim Rohmer (Product Manager Solid Carbide Milling Tools, MAPAL) and Stefan Diem (Application Engineer, bavius). © bavius

The tests at bavius with the new indexable insert tool NeoMill-Alu-QBig from MAPAL, for which the 50 mm diameter was selected, were also extremely positive. The aluminium high-volume milling cutter achieved a material removal rate of 18.4 dm³/min. On the machine, the milling cutter stood out with its high level of stability, smooth running and low cutting forces. For use at spindle speeds up to 35,000 rpm, MAPAL fitted the tool body with four threaded bores for fine balancing. The high-precision peripherally ground indexable inserts achieve surface finishes of R_a 0.8 µm and R_z 4 µm during rough and fine machining. They are equipped with a polished chip guiding stage to reduce frictional resistance and heat release. Weight was also saved in order to reduce centrifugal forces. "For larger diameters, milling cutters with indexable inserts are the more economical solution", explains Heiko Pup, Product Manager for tools with indexable inserts, contrasting the NeoMill-Alu-QBig milling cutters with solid carbide milling cutters.

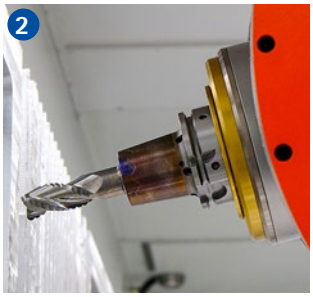
With a 25 mm diameter, the two systems merge. "Some of our customers always go for the more cost-efficient indexable inserts if possible, others prefer to save themselves an extra machining step and continue with the solid carbide milling cutter", explains Stefan Diem. With different possible radii for its tools, MAPAL provides users with flexibility.

With the horizontal machining centre AeroCell 160 and the aluminium high-volume tools, bavius and MAPAL provide users with a combination that takes machining structural parts to a whole new level. ■

With the OptiMill-Alu-Wave and the NeoMill-Alu-QBig, MAPAL showcased a complete range of products for high-volume machining of aluminium materials at EMO 2023.

2 *The OptiMill-Alu-Wave is a new and improved version of the solid carbide roughing cutter from MAPAL. For the tests, the milling cutter with the largest available diameter of 25 mm was used and ran with a spindle power of up to 175 kW. It achieved a material removal rate of 20 dm³/min.* © bavius

3 *As an indexable insert tool, the new aluminium high-volume milling cutter NeoMill-Alu-QBig from MAPAL is an economic solution for larger diameter ranges. In the tests, the 50-mm milling cutter stood out with a high degree of stability and smooth running. It achieved a material removal rate of 18.4 dm³/min.* © bavius



1 *The bavius horizontal machining centre AeroCell 160 for the high-speed machining of aluminium structural parts up to 1600 x 4000 mm.* © bavius

ALL-INCLUSIVE PACKAGE FOR END MACHINING

Regional roots, international success. This applies to the three companies GABO STAHL, Mössner and MAPAL equally. It is only logical that a cooperation benefits everyone: For the end machining of round steel, GABO STAHL now relies on an automated solution from Mössner, which in turn works with MAPAL tools.

Round steel bars with a diameter of 30 to 100 mm and a length of 300 to 2,000 mm are machined on the system from Mössner. A robot is in charge of loading and unloading the system.

GABO STAHL's portfolio includes round steel bars in different dimensions.

Sawn round steel bars with lengths of nine millimetres are just as much a part of GABO STAHL's portfolio as round steel bars with a length of six metres. There is a large customer base, and the products are used for a wide range of applications – from use in electrical and hydraulic parts production to large bolts for wind turbines. GABO STAHL is not only a steel trader, but also a steel processor. The company based in Essingen near Aalen was looking for the right system to machine the ends of all round steel bars with a diameter of 30 to 100 mm and a length of 300 to 2000 mm. As GABO STAHL CEO Thorsten Maier points out: "We like to supply our customers with the primary material ready for use and undertake as much preparatory work as possible."

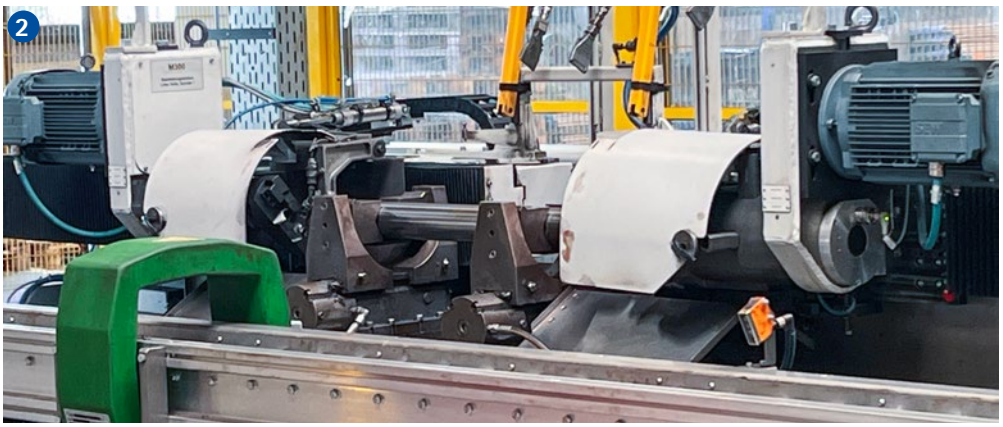
At GABO STAHL, these products are not usually manufactured in large series. Business is mainly dominated by small series. "Our production equipment has to be able to work just as flexibly as we do", explains Maier. The problem with this is that "Although we perform machining tasks for our customers, we don't have any trained machinists working for us." Therefore, in addition to the requirement for flexibility in terms of different dimensions and steel grades, there is also a need for the simplest possible operation.

"That's a typical case for us", says Markus Fuchs, Purchasing Manager at Mössner. The machine manufacturer is also based in the greater Aalen area. Mössner is a specialist in the field of automated special-purpose machinery. Customised solutions are an area that MAPAL is also familiar with. "MAPAL is our go-to partner, we work closely together and receive quick, straightforward support, also thanks to our geographic proximity", explains Fuchs. The machine experts at Mössner often get in touch with the specialists at MAPAL as early on as the concept creation phase for the customer.

MAPAL and Mössner worked together closely for around eight weeks on the system that is now installed at GABO STAHL. Marc Wagner, Technical Consultant at MAPAL, recalls: "The tool for facing, chamfering and centre drilling different types of steel and diameters was a major challenge." The various steel grades were the main source of development work. The engineering steels and tempering steels to be machined are usually specified by GABO STAHL's customers in terms of chemical composition and mechanical values.

"We get everyone round the table, work things out, think creatively and find joint solutions", Fuchs describes the development process. "Once the right tool has been found and designed, we build the rest of the machine around it." After all, the tool is at the centre of the system.

The team found the optimum solution with a milling tool with cartridges and a centre drill. "We are able to reliably machine the many different workpiece materials and workpieces with the same coated indexable insert", Alexander Schulze, Application Engineer at MAPAL, is pleased to report. The cartridges can be used to quickly and easily set different diameters for the chamfer on the workpiece. This requires no specialist knowledge and can be easily done after a short briefing. Different centre drills made of coated solid carbide in various diameters are clamped into the tool itself using easy-to-operate clamping sleeves. Here, the solution lay in the special geometry. "We've developed a tool that precisely performs both chamfering and facing as well as centring", says Schulze. And not just on one side of the round steel bar, but on the other side at the same time with a similar tool.



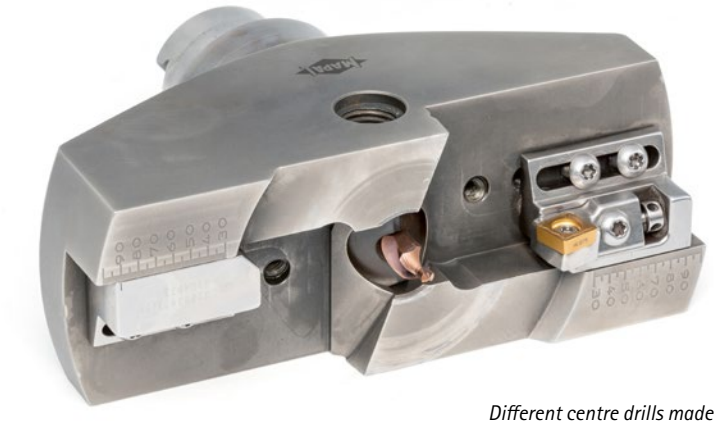
1 *Happy about the successful project (from left): Marc Wagner (Technical Consultant MAPAL), Thorsten Maier (CEO GABO STAHL), Alexander Schulze (Application Engineer MAPAL) and Markus Fuchs (Purchasing Manager Mössner).*

2 *The round steel bars are machined on both sides at the same time.*

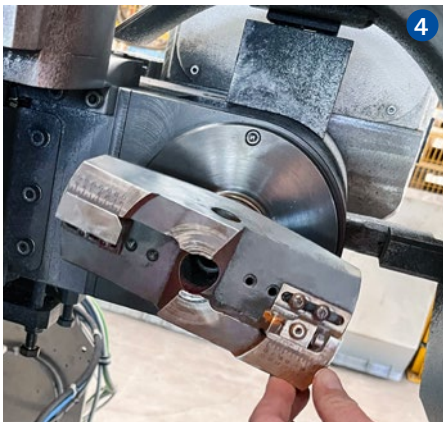
"The system from Mössner is a great asset for us", says Thorsten Maier. Before production started with the new machine, all machining operations were performed by hand. GABO STAHL thus not only saves a huge amount of time with machining, but also ensures the consistently high quality of the machined ends. And: "The system also saws, measures, marks, demagnetises and packs the workpieces", says Maier. An all-inclusive package supplied by Mössner and MAPAL. The staff who work with the machine every day are also impressed by how easy it is to use and by the ability to switch over to new components quickly and straightforwardly.

The smooth running of this joint project at GABO STAHL is no accident. "We work successfully with Mössner not only here in Baden-Württemberg, but all over the world", explains Marc Wagner. For example in Mexico, where many car manufacturers and suppliers operate plants and rely on the combined solutions of both companies. MAPAL has already designed a separate tool range for Mössner, which is specifically tailored to the manufacturer's machines. And so further joint projects are already in the pipeline including in sectors other than the automotive industry. ■

MAPAL has developed a milling tool with cartridges and a centre drill which reliably machines the many different workpiece materials and workpieces with the same coated indexable insert.



Different centre drills made of coated solid carbide in various diameters can be clamped using easy-to-operate clamping sleeves.



3 *Mössner developed the system for machining round steel bars specifically for the requirements of GABO STAHL.*

4 *Staff at GABO STAHL can use the cartridges on the tool to quickly and easily set different diameters for the chamfer on the workpiece.*

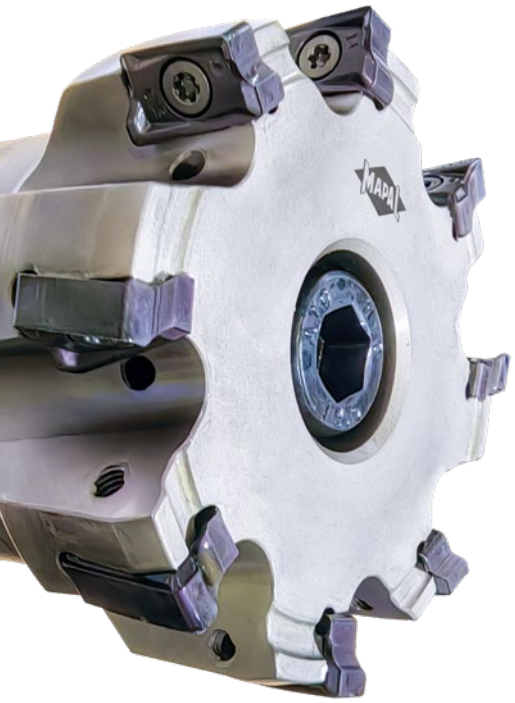
5 *GABO STAHL stocks various round steel bars at its plant in Essingen for its customers.* © GABO STAHL

6 *The system from Mössner is an all-inclusive package for GABO STAHL. In addition to machining, it also saws, measures, marks, demagnetises and packs the workpieces.*

Optimum machining of cast iron

TOOL AND PROCESS EXPERTISE AS DECISIVE SUCCESS FACTORS

GF Casting Solutions Leipzig produces large castings for various sectors. As a development partner for its customers, the company also produces numerous prototypes. In order to be able to machine these quickly, the company uses a large milling centre, which is also used to machine series parts. MAPAL not only develops the right tools for this but also supplies the complete machining process.



The indexable inserts of the NeoMill-4-Corner can be both rotated and turned, which significantly reduces cutting material costs.

"Our customers come from sectors such as commercial vehicle construction, the construction industry, agricultural machinery construction and machine engineering", says Lukas Blumenauer, Head of Additive Manufacturing / Machining at GF Casting Solutions Leipzig GmbH. However, the company also includes wind turbine manufacturers among its customers. GF Casting Solutions Leipzig GmbH produces cast components with a total volume of up to 60,000 tonnes every year. Most of these components are made of cast iron grades with spheroidal graphite (EN-GJS), which are characterised by high strength and ductility.

The company works closely with its customers as an innovation partner to develop new castings. State-of-the-art development methods are used, such as CAD design, finite element-based strength calculations and casting simulation. In order to provide initial prototypes as quickly as possible, GF Casting Solutions Leipzig 2017 set up its own department for the production of mould components and cores using the 3D printing method. The company uses these to cast prototypes or hydraulic parts in series.

SOPHISTICATED MACHINING ON A LARGE 5-AXIS MILLING CENTRE

In 2022, the casting manufacturer invested in its own machining department and installed a large MILL E 1900 U ST 5-axis machining centre from GF Machining Solutions with an interference circle diameter of 1,900 mm. The spindle with a hollow shank taper T100 connection achieves spindle speeds of up to 12,000 rpm. Pallets with a zero-point clamping system enable clamping in non-productive time. A modern coordinate measuring machine from Hexagon is used for quality assurance. "What matters to the customer is when they finally have the finished casting in their hands" explains Andreas Mielsch, CAM Programmer and machine operator.

ADDITIONAL SERIES MACHINING

"Of course, such powerful equipment cannot be fully utilised with prototypes alone", explains Gerd Nicolaus, who is also responsible for CAM programming and machine operation. That's why the managers were already considering using the system for machining series cast parts at the time of purchase. A key prerequisite is being able to offer this at standard market machining

The 5-axis milling centre MILL E 1900 U ST used for machining prototypes made of high-strength cast iron with spheroidal graphite.

Successful partners, from left to right: Lukas Blumenauer (Head of Additive Manufacturing GF), André Ranke (Regional Sales Manager MAPAL), Heiko Süß (Application Engineer MAPAL), Andreas Mielsch and Gerd Nicolaus (both CAM Programmers GF).

Pictures: Klaus Vollrath

times and costs. This is only possible with largely automated operation. And this involves complex parts and demanding, high-precision machining. In order to develop the right tools and process parameters for this, GF Casting Solutions Leipzig has been working very closely with MAPAL since the start of the first project.

MAPAL – YOUR PARTNER FOR TOOLS AND PROCESS DEVELOPMENT

"GF Casting Solutions Leipzig tasked us with developing a machining concept for the highly complex transmission housing of a combine harvester. The aim was to machine it in one clamping operation within two hours", MAPAL Regional Sales Manager André Ranke recalls. The transmission housing is made of high-strength cast iron with spheroidal graphite EN-GJS-600-3.

The project included solving all machining-related issues until market maturity was achieved. Particular challenges arose due to the unusual geometry of the component, which required the use of partially long overhanging tools, as well as demanding fits. Initially, GF planned to use 30 different tools for machining. The total machining time was three hours during initial tests. A lot of optimisation work was therefore required to achieve the target of four finished housings within one shift. The selection and design of the tools, the cutting material and the milling and drilling strategy provided potential.

EXCELLENT TOOL SOLUTIONS

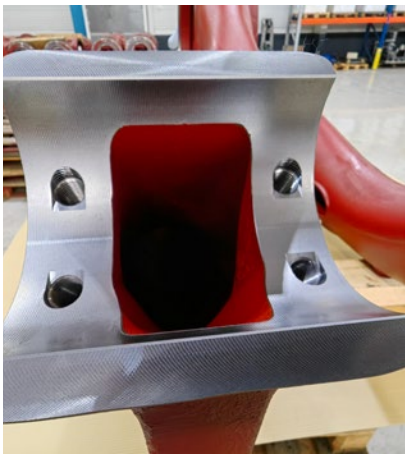
"We made an important improvement in terms of machining time and costs with the NeoMill-4-Corner milling cutter with eight indexable inserts, which is used for roughing all larger bores", says Heiko Süß, Application Engineer at MAPAL. The milling cutter is provided with an HSK extension in order to be able to reach deep into the part despite tool restrictions. The NeoMill-4-Corner with optimised machining values achieves a milling time of just 16 minutes while at the same time reducing the cutting material costs compared to the previously provided tool, which required 34 minutes for machining and displayed macroscopic flaws on the cutting edges. ➔

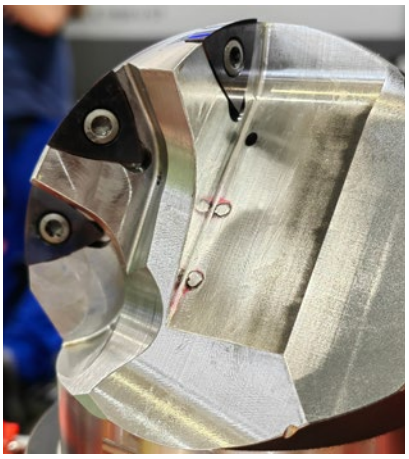
The NeoMill-4-Corner with an extension is used for roughing all larger bores. MAPAL was able to reduce the operating time from 34 to 16 minutes thanks to an optimised milling strategy.

Pictures: Klaus Vollrath

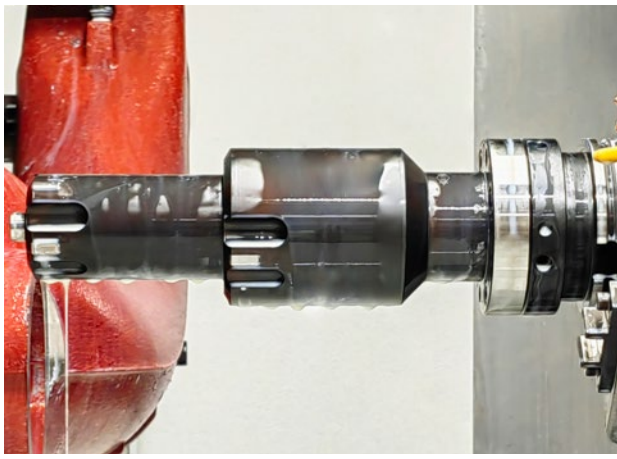
In addition to the step fine boring tool (right), two other fine boring tools (centre and left) that can be set with a high degree or precision are used.

In the slim, 300 mm long special adapter of the NeoMill-ISO-360 roughing cutter, dynamic balance compensation by means of a spring-mounted mass ensures smooth running.





The bearing area of the long, slim arm is precisely milled using a hemispherical milling cutter (right) manufactured for this application.



Step fine boring tool for machining bearing seats arranged one behind the other with a diameter of 60 and 90 mm and an accuracy of H7.

Another highlight includes a custom-designed fine boring tool with guide pads and several steps, which machines bearing seats arranged one behind the other with diameters of 60 and 90 mm. The tool can be set directly in the machine.

The indexable insert milling cutter NeoMill-ISO-360 with a 52 mm diameter is used for control cuts on the housing. Its very slim, 300 mm long connection with vibration damping is exceptional. The tool compensates for any vibrations by means of a spring-mounted equalising mass inside to ensure smooth running.

GOOD SUPPORT FROM MAPAL

"MAPAL has been a competent and efficient partner in this project, providing us with excellent support", Lukas Blumenauer sums up. The project started in December 2022 with a basic analysis of the tasks. This was followed by selecting the milling strategies and designing the tools. The first tests were then carried out on the machine, after which two of the 30 tools were reworked. Compared to other providers where up to a third of tools presented difficulties, this was a very good result. Optimisation of the established machining process began at the start of 2023, with the tools and application parameters being successively improved and refined. Machining currently takes 109 minutes. That's a whole 71 minutes less than during the initial tests. "We've reached the target of under two hours, but still see potential for improvement", André Ranke summarises. The teams are therefore working together on further improvements. ■

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