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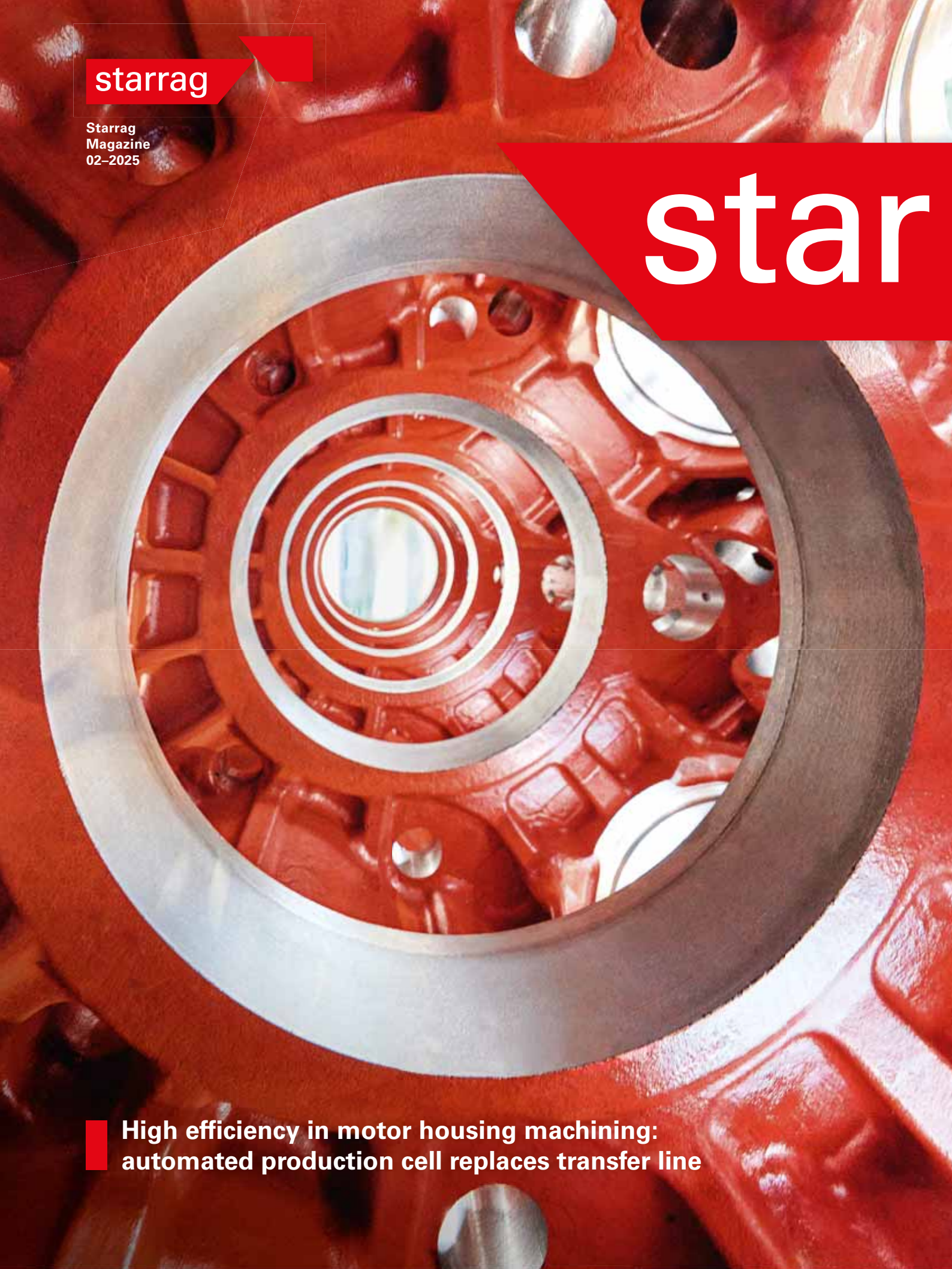
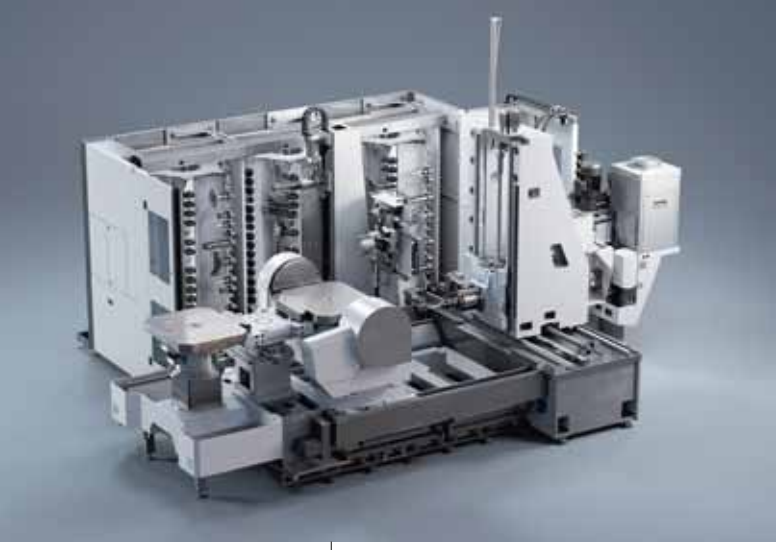


High efficiency in motor housing machining: automated production cell replaces transfer line



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LEGAL NOTICE

Star – The Starrag Division Magazine

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10 years

Martin Buyle
CEO, Division Starrag

Dear Readers,

In the summer of 1975, Paris was dreaming not only of love, but also of electronics: The first EMO at the Parc des Expositions marked the beginning of a new era in which numerical controls replaced mechanical systems. As early as 1973, Starrag introduced the NB 125 D, one of the first 5-axis NC milling machines with magnetic band control – a bold step for this technology, which was still rare at the time.

50 years later, we are not only showing live and virtually at EMO, but also here in the magazine, in detail, how the technology and speed have changed, for example with the première of the new Heckert X70. This further development of the successful compact series is not only suitable for housings and structural components, but also for the precise machining of components in turbine construction.

Long-standing partnerships play an important role, and not only for Starrag – Liebherr-Aerospace Lindenberg ordered its first Droop+Rein FOGS machining centre for landing gear production over 20 years ago. This first purchase of the main plant in the Allgäu region led to an intensive partnership and the establishment of a world-wide landing gear production network, which now has 13 centres.

A German-American collaboration developed in a similar way within eight years, with Omni Aerospace ordering an ECOSPEED in Wichita, Kansas, and two more following. Precision components for aircraft structures are produced at these centres. The investment has paid off and Omni Aerospace has since doubled its turnover.

There are also many satisfied customers in the commercial vehicle sector – Starrag has been working with the Czech manufacturer Tatra at the Kopřivnice plant for 25 years. The entire manufacturing process takes centre stage here – from raw part processing to final assembly. The latest milestone is a new production cell with three Heckert HEC 800 machining centres, which significantly increase production efficiency and flexibility.

The new Bumotec 1000/C^{neo} has already proven its worth in the watchmaking industry thanks to its shorter cycles, lower energy consumption and improved handling. A watch strap manufacturer found that it not only increased productivity by up to 50% compared to the predecessor model Bumotec s1000/C, but also improved the surface quality by 30%.

Happy reading!

Yours, Martin Buyle
CEO, Division Starrag

CIMT 2025

One of the largest international machine tool trade fairs with Starrag innovations

CIMT 2025 came to a successful close in April. For the first time, all 17 halls of the Capital International Convention and Exhibition Center and the China International Exhibition Center (Shunyi Pavilion) were in use. With 310,000 square metres of exhibition space, CIMT is one of the most important international trade fairs for machine tools. In addition to the Sprint Z3 parallel kinematic machining head and the Bumotec 191^{neo}, Starrag also presented new products such as the Dörries VT 28 and the Heckert H100. All machines combine the highest quality with innovative technology to efficiently meet customer requirements in a way that is future-proof.

1884

Dörries, the second oldest product range of Starrag, is founded

The Dörries machine tools success story began in 1884, in the small village of Vussem in the beautiful Eifel region. Over the next 100 years, the company grew rapidly, gaining a global reputation in the field of machine tools and, in particular, vertical lathes. Dörries, the specialist for large vertical lathes with turning diameters of up to 12 metres, also offers complex turn-mill solutions for large applications. Dörries became a member of the Starrag Group in 2011, and the machines are built at the Starrag plant in Bielefeld.

The customer saves 50 to 60% on costs compared to a new purchase with a significantly shorter throughput time.

Headstock overhauled:

A large, old boring mill with new precision

Retrofits on large boring mills are one of the specialities of the Starrag Large Parts Machining Systems business unit. Sometimes a comprehensive technical cure is required, from complete replacement of the drive units to installation of new control technology. But, if the substance is right, the targeted overhaul of a single central component is often enough to significantly increase a machine's performance and efficiency.

The headstock of an old Scharmann Heavycut boring mill was mechanically overhauled. This component plays an important role in everyday work, as the heart of the boring mill carries the main spindle, transmits torque and speed to the tool, and ensures smooth running and precise machining, even for workpieces weighing several tonnes, such as turbine housings, ship components or wind power components.

The results of the overhaul are impressive: For the customer, it means working at a new machine level with higher availability, less downtime, improved precision, and repeat accuracy. This leads to greater planning security, as the machine is reliably back in operation. The customer saves 50 to 60% on costs compared to a new purchase with a significantly shorter throughput time.

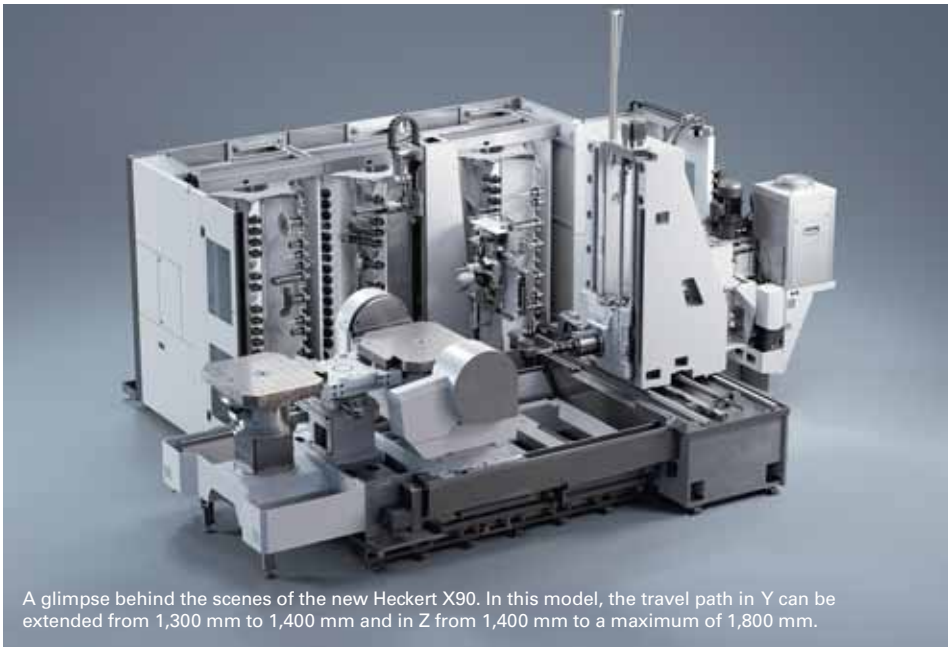
Headstock after retrofitting (left) and before (right).

Complete machining of large parts in small spaces

Starrag presents three new 5-axis Heckert machines

The 5-axis Heckert X compact series is now complete: To complement the Heckert X50 that has been available since April 2022, Starrag launched the larger Heckert X70, X80 and X90 versions in April 2025. These supersede the popular HEC 630 X5 and HEC 800 X5 models, adding to their already familiar range of applications. For instance, the Heckert X90 can be used to machine larger workpieces. The new Heckert X70 will be on show at EMO 2025 in Hanover – on the Starrag stand in Hall 12, C35.

With pallet sizes of 630 × 800 mm (Heckert X70) and 800 × 1,000 mm (Heckert X80 and X90), the new 5-axis horizontal machining centres are suitable for the complete machining of large components, including those that may be quite heavy. This is because the loading weight of the "newbies" ranges from 1,000 kg (Heckert X70) to 2,000 kg in the case of the Heckert X90. As such, these models are focused on the 5-axis heavy-duty machining of gearbox housings and cylinder heads, axles, valve and pump housings, planetary gear carriers and high precision machine components, including pallets, headstocks and spindle frames.



A glimpse behind the scenes of the new Heckert X90. In this model, the travel path in Y can be extended from 1,300 mm to 1,400 mm and in Z from 1,400 mm to a maximum of 1,800 mm.

The new machining centres require a smaller footprint due to their compact design. The Heckert X70 requires 18% less installation space than its predecessor, the Heckert HEC 630 X5. The other models of the X series also offer similar space savings. However, the machine's compact proportions do not mean the user has to compromise in terms of their workpieces. The working area and displacement circle remain unchanged, as do the permissible workpiece weight and workpiece height. Furthermore, turning as a technology is an integral part of the machine concept and can be configured as an option. Using specially developed assemblies and software modules, both classic and complex turning operations can be performed with the unrivalled productivity of a machining centre. Unlike a turning lathe, the machine benefits from a variety of setup options.

Not only can the workpieces be clamped vertically for added convenience, but they can in fact be clamped during the machining operation thanks to the pallet changer. In terms of tools, all versions of the large tool magazines can be used, and turning diameters in the working area can measure up to 1,400 mm (Heckert X90). Starrag has upheld the typical characteristics for which the

18% less installation space

On display at the Starrag stand at EMO 2025 in Hall 12, C35: the new Heckert X70, a 5-axis compact machining centre for highly dynamic complete machining. Like all machines in this series, it impresses with its efficient area utilisation and maximum long-term accuracy.

Heckert models are known. That's to say, these are robust, powerful and fast machines that offer exceptional accuracy and reliability over many years. Like all the new compact machining centres from the Chemnitz-based company, the new Heckert X70, X80 and X90 are built on a compact, low-vibration machine bed made of grey cast iron. This basis, combined with the thermo-symmetrically designed columns, ensures very high basic mechanical accuracy, thanks in part to trimmed guides. This means that the software compensation process needs only add the finishing touches.

The new Heckert X70, X80 and X90 are based on the 4-axis Heckert H-series. Instead of the NC rotary table installed in the earlier models, the X-series models feature a robust rotary/tilt table – an in-house development that is also manufactured at the Starrag plant in Chemnitz. Not only does the tilting unit have two equally sized bearings, but also a thermally stable design. This means that the machines are capable of complete five-sided, highly dynamic machining of complex components. Of particular importance to the developers was ensuring the compatibility of the pallets on the new Heckert X70, X80 and X90 models. The pallets are interchangeable with those of the H series. What's more, the pallets from the older Heckert HEC 630 / 800 X5 machines can still be used on the new X models. Another forward-thinking aspect: All machines in the 5-axis compact series are fitted with the SINUMERIK ONE control system, with new hardware and fast sensor technology. They are also easier to automate than their predecessors. This is thanks in part to the extended 13-channel clamping hydraulics and optimised standard interfaces to pallet storage systems and robot cells.

> The machines are robust, powerful, fast and exceptionally accurate and reliable.

“Within the Starrag Group, we have extensive technical expertise in the machining of aero-engine, gas and steam turbine housings, which we translate into advanced, turnkey solutions.”

Klaus Struebel, Segment Sales Manager Aerospace & Turbines

This expertise is unique!

State-of-the-art manufacturing solutions for turbine housings – including machines, tools and processes

In turbine construction for the aviation and energy sectors, manufacturing companies rely on Starrag machines – because they are among the most powerful and precise solutions the market has to offer. This applies not only to the manufacture of engine blades and blisks, but also to turbine housings. Decades of experience have gone into the wide range of Starrag machine tools for turning, milling, drilling and grinding. And that's not all: Starrag offers solutions for the entire manufacturing process. In-house, individually developed devices, special tools, angle heads and spindles through to fully automated production systems ensure maximum productivity.

The housings for aircraft engines, steam, and gas turbines – also known as casings – are available in small and large sizes. They are becoming ever more complex and are increasingly made from materials that are difficult to machine. This usually requires several processing technologies, ideally combined in one machine or in flexible manufacturing systems. Thanks to its wide range of machines, Starrag can meet all requirements.

The Starrag STC series covers a large area of turbine casing machining, with its various sizes and designs capable of handling casing diameters up to 3,300 mm. The machines are predestined for economical 5-axis heavy-duty machining of sophisticated casings made of titanium and Inconel. For machining smaller casings, Starrag can offer the Heckert X series in MT design. They allow high-precision turning and milling on one machine.

The 5-axis X variants of this compact series add another option: The positioning axis in the rotary swivelling table is ideal for angled holes, as are often required in casings. If the huge steam and gas turbine housings with diameters of up to 12 metres need to be machined, Starrag can rely on correspondingly large Droop+Rein portal machining centres, which are built at Starrag Technology GmbH in Bielefeld. The large vertical Dörries lathes, which are also used for steam and gas turbine housings, are also produced there. Vertical turning and grinding is also the speciality of the Berthiez machines from the Starrag plant in St. Etienne, France, which are mainly used in aircraft construction.

For ultra-precision machining on casings, for fine boring and milling as well as precision grinding, Starrag has the SIP jig boring machines – horizontal or vertical – in its range, which are produced in Vuadens in Switzerland. The Bumotec CNC turning/milling centres, which produce small, high-precision, and complex parts in five axes and with accuracies of just a few micrometres, also come from this plant. In the production process of casings, they are used for components to be mounted, such as injection nozzles.

The UK subsidiary TTL, which performs MRO (maintenance, repair, and overhaul) tasks, fulfils an important role in the turbine housing sector. Specialising in Siemens NX CAM, which is commonly used in the turbine environment, and as a process developer for adaptive milling, TTL is the ideal partner to take on maintenance and repair tasks on casings. After build-up welding and subsequent high-precision milling, the expensive housings are almost as good as new.

Alexander Fitz, Sales Director for Aerospace & Turbine at Starrag AG, explains: "Machine tools are one of our core competences, which no other company in the world can offer in terms of their technological breadth and varying sizes. We also have an in-depth technical understanding of the entire process chain required to manufacture ready-to-install turbine housings."

This expertise enables Starrag to combine various machining operations in one machine. Klaus Struebel is Segment Sales Manager Aerospace & Turbines at Starrag with decades of expertise in the field of turbines. He points out that the integration of milling, turning, and grinding with self-developed angle and other machining heads can reduce clamping positions and increase productivity. "If one machine is not sufficient for machining, we can combine our different product ranges in flexible manufacturing systems, for example a Starrag STC with a Berthiez vertical turning-grinding centre," says Struebel. "Standardised interfaces and pallets allow us to speed up the process and increase accuracy. If required, we integrate additional washing, drying, and measuring processes."

It is not only in such automation solutions that the process expertise gained over many years is reflected in numerous projects. "We have been involved in aero-engine casings since the 1980s and, in addition to processes, we also develop numerous components, from carbide tools, tool heads and spindles, through to devices," mentions Klaus Struebel.

Gaining a market advantage from tools adapted to the process

Starrag in Rorschacherberg has been developing and grinding carbide milling cutters for aircraft and turbine components made of difficult-to-cut materials such as titanium, Inconel, or high-alloy steels for many years. In most cases, these are customised products that are adapted to the respective machining process, i.e. to the component, the machine, the material and other concomitant circumstances. They ensure faster machining and have a longer service life than standard tools – an important contribution to a stable, repeatable process.

Machining expert Struebel cites the required bores, "especially the internal ones, as a major challenge in housing machining. We develop special interchangeable angle heads for this purpose, and these also have to be able to cope with the limited space available." This requires a great deal of experience – as does deep-hole drilling with very small diameters in titanium or Inconel. Tight tolerances must be maintained for the drill holes so that add-on parts – such as blades – can be fitted precisely.

Another of Starrag's strengths is the gear spindle manufactured in Rorschacherberg, which remains thermally and mechanically stable and is extremely durable even when processes are running for 80 hours. It is used on STC machining centres and

"Standardised interfaces and pallets allow us to speed up the process and increase accuracy."

Klaus Struebel,
Segment Sales Manager
Aerospace & Turbines

> “We provide our customers with higher productivity by looking at the entire process.”
>
> Klaus Struebel, Segment Sales Manager Aerospace & Turbines

Droop+Rein gantry machines. For the latter, different special heads are available, including angle heads in various lengths, with different torques and speeds.

Another advantage mentioned by Klaus Struebel is “that we can balance on almost all machines. Because the roundness of the casings is extremely important.” Once the fixture and workpiece have been mounted on the pallet, an optimisation process takes place in which the imbalance is determined and corrected. Klaus Struebel summarises: “We provide our customers with higher productivity by looking at the entire process. We don’t just sell a product, we make sure that the machine fits the machining application in terms of size, technology, axis configuration and kinematics, and then optimise the process with the appropriate peripherals.”

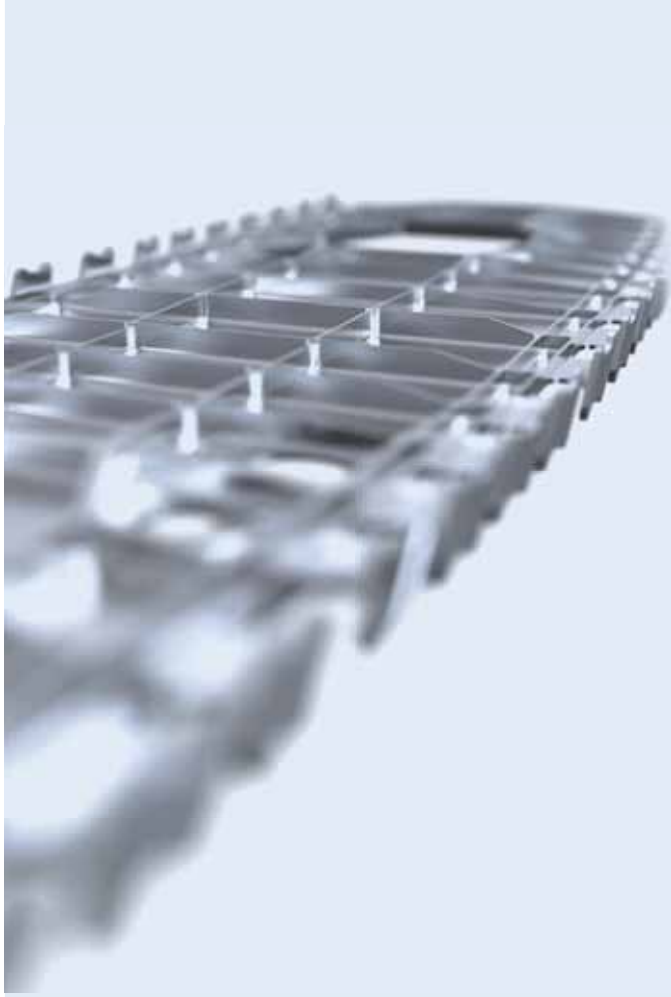
This usually takes place at the ATCC (Aerospace Turbine Competence Center), in Rorschacherberg, which offers the best conditions for this. Covering an area of around 2,000 m^2, it is equipped with the latest 4- and 5-axis Starrag machining centres. Developers and application specialists are also on call. The ATCC is also able to produce test and small series for customers.

Omni Aerospace and Starrag: **precision at altitude**

A story of partnership, performance, and progress

With the bright glint of the sun ricocheting off the wide expanse of an aircraft's wing, it's easy to marvel at modern aerospace engineering. But behind every flawless component that keeps a jet aloft lies a world of dedication, innovation, and precision-driven partnerships. Nowhere is this truer than at Omni Aerospace, nestled in the aerospace capital of the United States, in Wichita, Kansas.

Founded over 25 years ago by CEO John J. O'Neill, Omni Aerospace has built its reputation on producing complex structural metal components for some of the world's leading aerospace OEMs like Boeing, Bombardier, Gulfstream, Lockheed Martin, Textron Aviation, and the Department of Defence, to name a few. But as the demands for tighter tolerances, lighter materials, and faster turnaround times grew more intense, Omni faced a critical decision: either evolve, or fall behind. And evolve they did with the help of Starrag's ECOSPEED F 1540 machining technology.



Omni Aerospace has doubled its revenue since installing its first ECOSPEED.

An old leap: the first Starrag ECOSPEED changes the game

In 2017, Omni Aerospace made a strategic investment in its first Starrag ECOSPEED F 1540, a high-speed, high-precision machining centre engineered specifically for large aluminium structural aerospace parts. It wasn't just a new machine; it was the beginning of a new chapter. "We took our company to the next level by investing in technology that can do things other people can't do with their equipment," said CEO John J. O'Neill. "The ECOSPEED was a game changer. It's a unique piece of machinery that is unmatched for speed and accuracy." That machine didn't just meet expectations, it exceeded them. It enabled Omni to cut more precisely, reduce setup times, and eliminate costly match drilling on final assembly components. And most importantly, it unlocked the ability to consistently deliver close-tolerance, true-position fastener holes, a non-negotiable requirement for determinant assembly parts in commercial, business, and military aviation. Omni's first ECOSPEED marked a turning point. Not long after installation, revenue doubled. New customers arrived. Production expanded. A new plateau was reached.

Scaling up: from a single machine to a smart manufacturing cell

Riding the momentum of this success, Omni soon invested in a second ECOSPEED F 1540, integrating both machines into a palletised automated Flexible Manufacturing System (FMS). This smart system enabled continuous, around-the-clock operation, even with Omni's high-mix, low-volume manufacturing model. The ECOSPEEDs took on highly demanding parts such as wing ribs, machined from aluminium or aluminium-lithium billets weighing up to 2,700 kg, with dimensions approaching

4,000 mm × 1,500 mm × 152 mm. Some components required up to 95% material removal, a level of material transformation that demands not only brute speed but surgical precision.

"While roughing, we can fill a 250-litre drum with chips in less than a minute," one Omni technician noted. "Yet the tolerances remain perfectly tight. That's the ECOSPEED difference."

At the heart of this performance lies Starrag's Sprint Z3 parallel kinematic machining head. Using three radially mounted linear drives, the head enables five-axis/five-sided machining, ±45° spindle articulation, and lightning-fast motion, allowing the spindle to move within a spherical cone at speeds of up to 80° per second. The result? Precision cuts, complex geometries, and faster part completion, even with small batch sizes.

And through it all, the ECOSPEEDs never slowed down. In fact, they became more reliable with age." I'm almost embarrassed to admit how many spindle hours we have on our first ECOSPEED without a spindle replacement," one engineer said. "We run them at 30,000 rpm every day, over multiple shifts, and they just keep humming."

A new expansion: the third ECOSPEED and beyond

In 2025, Omni Aerospace is once again charting a bold new course. Rearranging their existing production floor to accommodate its third Starrag ECOSPEED F 1540, a clear signal of continued trust and a growing partnership.

This third machine will further boost capacity for aluminium parts while allowing the company to reconfigure its existing layout for more efficient workflows. But Omni's ambitions don't stop with aluminium. The team is also preparing to expand into hard metal machining, a move that will open the door to an even broader range of

> "The ECOSPEED was a game changer. It's a unique piece of machinery that is unmatched for speed and accuracy."
>
> **John J. O'Neill,** CEO Omni Aerospace

Johnny O'Neill (Complex 6 Axis Machining Supervisor), Gretchen O'Neill (President), John J. O'Neill (CEO)

> "Starrag has helped us not just meet expectations, but exceed them for ourselves and for our customers."
>
> **John J. O'Neill,** CEO Omni Aerospace

aerospace components and deeper vertical integration. "As a fast-growing company, we're always looking to take the next step. We required a new paradigm for high-speed, medium-to-large, six-axis machining. Starrag's solution checked every single box."

Starrag's philosophy in action: "Engineering precisely what you value"

The guiding philosophy "Engineering precisely what you value" is more than just a motto. It's a reality lived every day at Omni. By offering exactly what the customer needs and nothing superfluous Starrag has helped Omni unlock new levels of efficiency, growth, and competitive advantage.

And the numbers tell the story: Omni Aerospace has doubled its revenue since installing its first ECOSPEED. And if not for the pandemic freezing capital investment for a time, the company would be even further ahead today. "No matter what the challenge. No matter the part. No matter the complexity," O'Neill concludes, "Starrag has helped us not just meet expectations, but exceed them for ourselves and for our customers."

A partnership built to soar

The relationship between Omni Aerospace and Starrag is more than transactional: it's transformational. It's a case study in what happens when a manufacturer with a clear vision partner with a machine builder that understands both the technical demands and the strategic ambitions of its customer. Together, they've not only built aircraft components, but they've also built a path to sustainable growth, unmatched capability, and enduring innovation. Omni Aerospace and Starrag: A partnership with precision. A future with no limits.

Machining takes place in up to 40 steps, and comprises complex external contours, multiple drill holes with close tolerances, and heat treatment.

Learning from the eagle

Over a period of 20 years, Liebherr-Aerospace has built up a worldwide network for manufacturing precision landing gear that includes 13 Starrag machines, with the aim of mimicking the accuracy of the eagle. In a short YouTube video clip from Liebherr-Aerospace, viewed 7,300 times, an eagle lands calmly and precisely on rocky ground, accompanied by the slogan: "The best landing gears are built by nature. But we are working on it."

A harmonious image, however, the requirements in aviation are far more complex. The eagle weighs barely five kilograms, reaches 160 km/h in a dive, and carries only itself. A modern landing gear, on the other hand, must be able to reliably handle over 300 tonnes of flying weight, regardless of the weather, surface, or time of day. The film nevertheless underlines the important point: safe landing under almost all conditions. Together with Starrag, Liebherr is striving to manufacture landing gear systems that function safely, precisely, and reliably over time, even under extreme conditions.

The nucleus of this philosophy lies in Lindenberg in the Allgäu region, around 20 kilometres east of Lake Constance. The site has been a centre for aviation technology and precision metalworking for decades. Liebherr founded a repair company here in 1960, which has developed into today's Liebherr-Aerospace Lindenberg GmbH, a leading global system supplier for flight control systems and landing gear.

High loads on the "legs" of the aircraft

Landing gear components are among the most heavily stressed parts of an aircraft, even though they are hardly noticeable compared to the engine or wings. Their job is to safely support the full weight of the aircraft, including passengers, luggage, and fuel, when it touches down. On every landing, in any weather, and on any surface. The requirements in terms of material, geometry and production quality were

high from the outset: over 80% of parts requiring machine cutting, complex component geometries, machining strategies with µm tolerances, supplemented by process-reliable automation. This is also reflected in the production process. New landing gears are made of high-strength titanium or steel alloys. In the future, stainless steel alloys could also be introduced, and Liebherr is ideally prepared for their demanding machining properties with its powerful and stable Droop+Rein machines. Production takes place in up to 40 steps, and comprises complex external contours, multiple drill holes with close tolerances, and heat treatment.

A special feature is the design of the landing gear. "As soon as a machining feature protrudes from the cylinder housing, it is no longer possible to rotate in on a turning machine – it has to be milled", explained Lee Scott, Director Sales and Applications for Starrag UK. "And it's almost like mould construction: complex external contours, tight tolerances, lots of drill holes – all in one clamping operation."

© Foto: Liebherr

Landing gear components are among the most heavily stressed parts of an aircraft, even though they are hardly noticeable compared to the engine or wings.

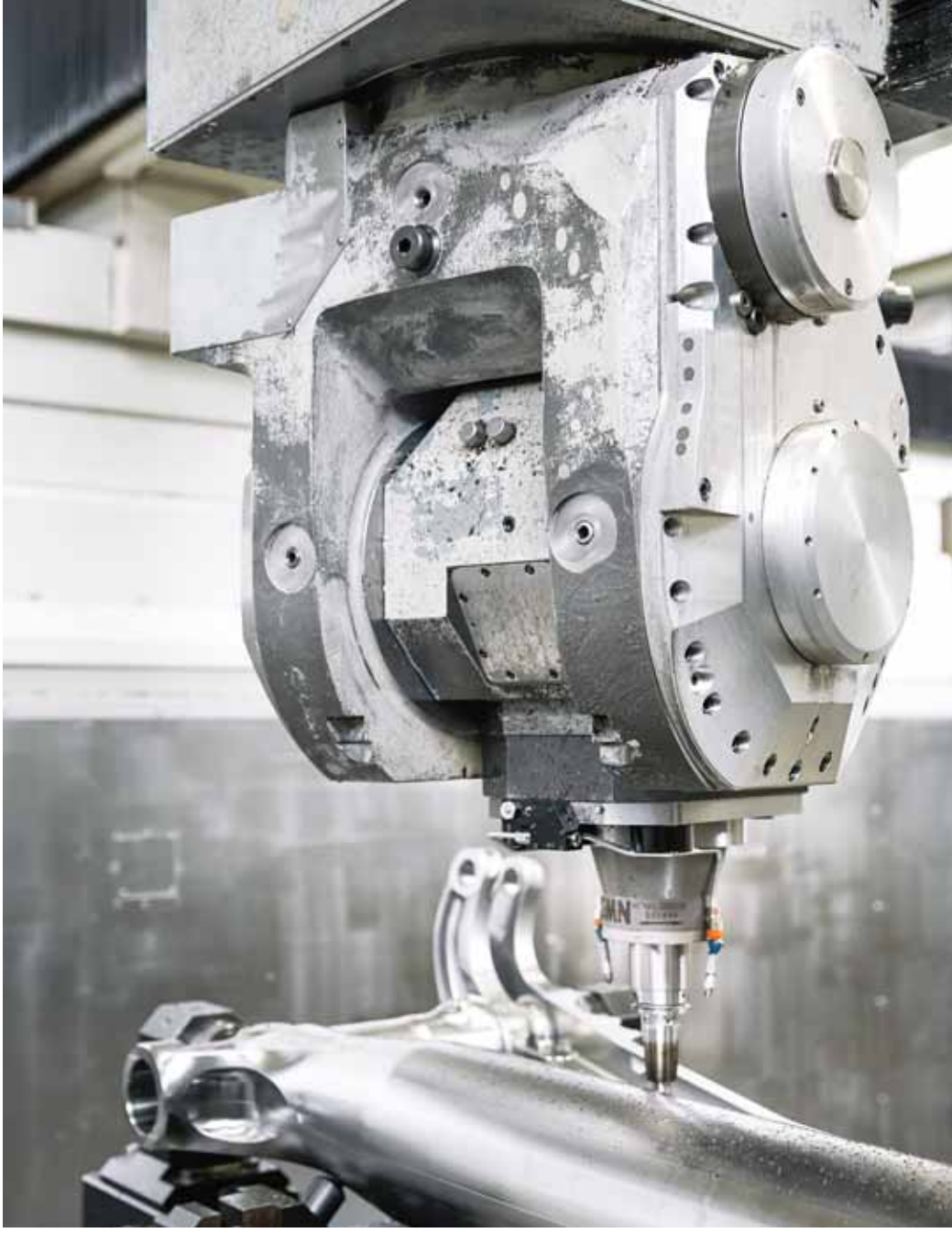
High level of vertical integration with machining in a single clamping operation

In order to be able to manufacture components of this complexity in-house, Liebherr-Aerospace Lindenberg GmbH relies on a high level of vertical integration. "We attach great importance to quality and availability. That's why we manufacture the main components of our landing gear ourselves", says Bernd Molinari, Group Leader in landing gear manufacturing.

In 2004, the decision was made to opt for the first Droop+Rein FOGS M40, a machine which offers impressive stability, precision, and flexibility. One of the decisive factors was the similarity of the

In 2004, the decision was made to opt for the first Droop+Rein FOGS M40, a machine which offers impressive stability, precision, and flexibility.

> Support covers the entire life cycle from development to maintenance.



component geometries to tool and mould construction. The complex contours and drill holes of the landing gear could be machined economically and precisely on the Droop+Rein FOGS in a single clamping operation, thereby forming the foundations of a long-term partnership.

Between 2004 and 2014, Liebherr-Aerospace built up a dynamic production network in Lindenberg, centred on four Droop+Rein FOGS machines. The machines were gradually expanded, modernised and specifically automated to include robot-supported tool handling, laser measuring systems and tool magazines for up to 250 tools.

At least 95% availability guaranteed

This network was not only designed for productivity, but also for maximum availability. "Since the first installations, we have been working with a contractually guaranteed technical availability of over 95%", explains Heiko Quack, Sales Director for Large Projects at Starrag's product range Droop+Rein in Bielefeld. "In addition to Starrag's renowned high-quality mechanical engineering with modern and proven technology, we also achieve this through close cooperation: maintenance contracts, regular service workshops, coordinated maintenance. Partnership and advanced planning are key to how Liebherr operates the machines." And successfully so: the machines from the first few years are still in use, and still providing technical availability of over 95%. The production structure at the site thus became a blueprint for other partner plants worldwide. Standardised processes and reliable machines form the foundation. The period up to 2014 marked not only the expansion of the in-house machinery, but also the start of a strategic network with a high degree of automation, which forms the basis for today's global production strategy. After the pandemic-related slump and the subsequent market ramp-up, Liebherr-Aerospace has been focussing on the targeted expansion of its global network. In addition to the four Droop+Rein FOGS machines in Lindenberg, a further nine machines were installed at partner sites in China, India, France and – until 2022 – also in Russia. "Liebherr has carefully selected its partners worldwide", explains Quack. "Together with Liebherr, we have transferred our technology to these locations – wherever new plants have been built or existing production facilities have been made suitable for landing gear manufacturing, we have been involved right from the start." Another Droop+Rein FOGS machine is currently on its way to Liebherr-

Aerospace's latest manufacturing partner and is scheduled to start production in the course of 2025.

Cooperation on an equal footing: partnership between two market leaders

This close co-operation takes place on an equal footing – not least because Starrag is regarded as the world's leading machine supplier in the field of landing gear manufacturing. Today, around 60 Droop+Rein machining centres are being used for this task. Around one in seven of them work directly or indirectly in the Liebherr-Aerospace production network. Quack emphasises: "We are the manufacturer of choice in this market segment, not only because of the technology, but also because of our reliable, global partnership and position in this demanding segment."

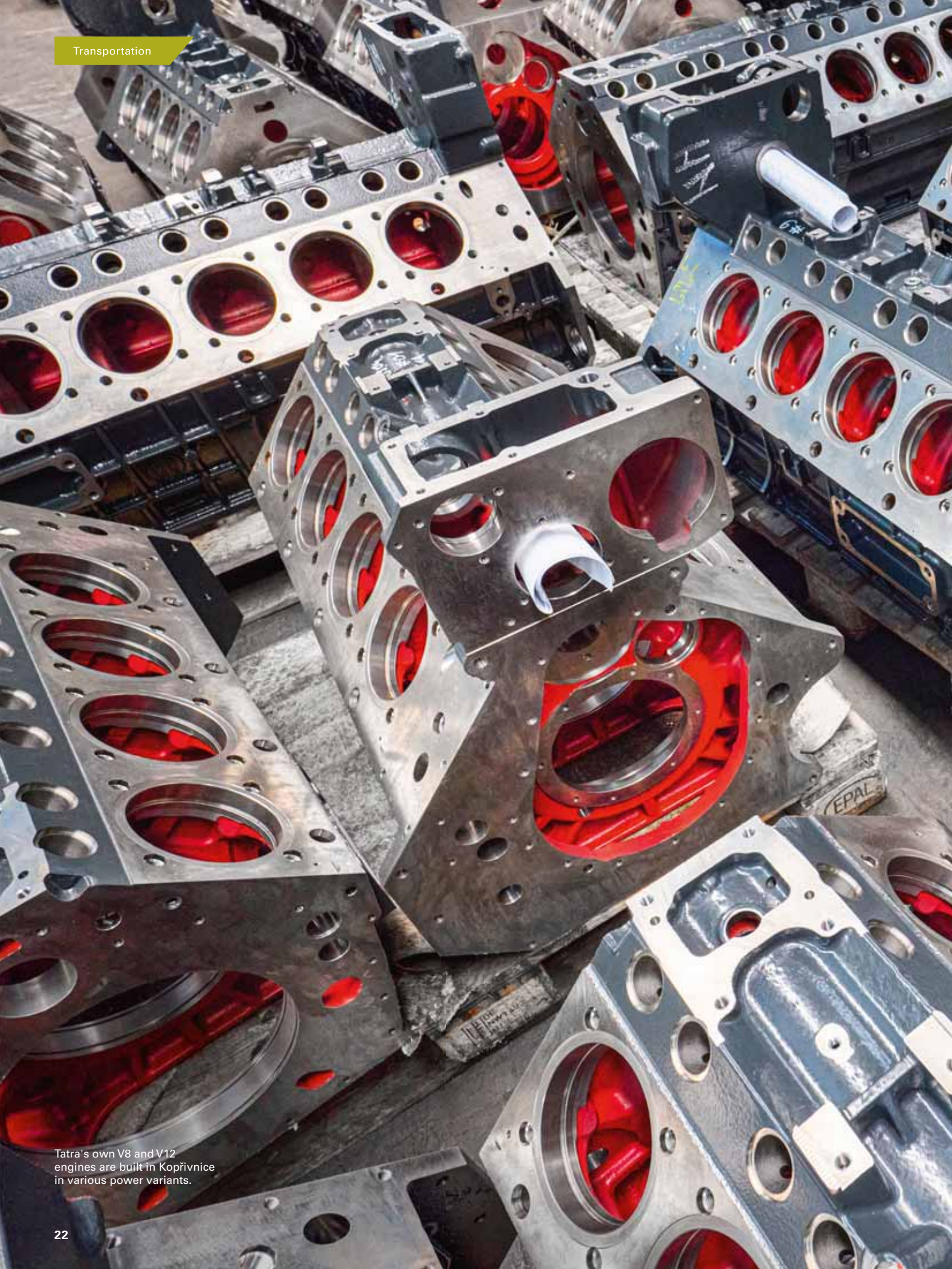
Starrag will be putting the spotlight on the resulting product for the first time at EMO 2025: a fully assembled nose landing gear (NLG) for the Airbus A350, manufactured at Liebherr-Aerospace in Lindenberg. This component not only features eye-catching technology, it is also the largest landing gear Liebherr has developed until now. Since the Airbus A350-900 entered service in 2016, Liebherr has supplied the system for all A350 variants. The nose landing gear of the Airbus A350-1000, which completed its maiden flight on 24 November 2016, has been redesigned – partly due to the higher maximum take-off weight of 308 tonnes. Liebherr was able to contribute its highly specific experience gained from the A350-900 programme.

In addition to the nose landing gear, Liebherr-Aerospace also supplies other systems for the Airbus A350, such as components for controlling slats and landing flaps, load measurement and damping. Support covers the entire life cycle from development to maintenance.

> Since the first installations, we have been working with a technical availability of over 95%.

The housing of the landing gear on display is produced on a Droop+Rein FOGS machine in Lindenberg. Unlike the much larger main landing gear, the nose landing gear accounts for only a small proportion of the aircraft's weight but is just as critical to safety. It is subjected to heavy loads during take-off and landing and must be able to absorb extreme shocks and cope with changes of direction. A high-precision landing gear, such as that exhibited, therefore not only ensures safe operation, but also reduces maintenance costs over the life cycle.

The A350 landing gear, exhibited for the first time, completes the circle: what began symbolically in Liebherr's YouTube clip – the flight and precision landing of an eagle – can be experienced in technical form at EMO 2025. Because although nature still designs the best landing gear, technology is getting amazingly close.



Tatra's own V8 and V12 engines are built in Kopřivnice in various power variants.

Efficient and flexible complete machining of V8 and V12 diesel engines

Automated production cell with Heckert HEC 800 machining centres replaces transfer line

Tatra Trucks, the oldest manufacturer of road and off-road vehicles and the second oldest manufacturer of lorries with internal combustion engines in the world, is bringing its engine production up to the latest standards. A production cell with three Heckert HEC 800 machining centres, automated by a pallet system, increases efficiency, and reduces the space requirement to almost a quarter.

Tatra trucks impress with their off-road performance, high reliability, and outstanding utility properties.

"We manufacture almost all components for our Force series vehicles ourselves: the complete chassis, cabin, engine and gearbox."

Martin Kappler, Technology and Process Manager

Tatra, an automotive manufacturer from Kopřivnice, Czech Republic, started producing carriages as early as 1850 and has been making cars since the end of the 19th century. Today, it is mainly the heavy Tatra trucks that impress with their off-road performance, high reliability, and outstanding utility properties – even in extreme weather conditions such as frost and desert temperatures.

One of the special features of the vehicles is the Tatra concept, a chassis with a central support tube and individually suspended semi-axles, which makes it possible to mount a chassis with any number of axles, from 4 × 4 to 12 × 12 and more. The direct air-cooled V8 and V12 diesel engines of the Tatra T3 series with supercharging and intake air cooler are also among the USPs. Production takes place at the company's headquarters in Kopřivnice, Czech Republic. The complete chassis for the T158 Phoenix vehicles, which are available with various superstructures such as containers, concrete mixers, tanks, and special superstructures, is produced there. In addition, vehicles from the T815-7 Force series are produced, which are available in both civilian versions (e.g. as fire engines, etc.) and military versions. Technology and Process Manager Martin Kappler explains: "We manufacture almost all components for our Force series vehicles ourselves: the complete chassis, cabin, engine, and gearbox." Tatra's production portfolio also includes the Tactic series of medium-sized vehicles, which are designed exclusively for military purposes.

Automated production cell replaces transfer line

As far as the engine equipment is concerned, Tatra Trucks lets its customers choose from several options. Liquid-cooled engines from proven manufacturers and Tatra's own V8 and V12 engines in various power variants are available. The latter have been manufactured on a transfer line in Kopřivnice since 1980. "Despite its age, the technical condition of this plant is still good," says Martin Kappler, "but the energy costs are extremely high, as is the consumption of coolants. That's why we decided to switch engine housing production to a cell with automated machining centres."

He also argues that the changeover from V8 to V12 on the transfer line takes a long time, usually several production shifts: "In view of the flexibility required today, the new production cell also impresses in this respect. With our universal fixture, we are quick to retool and can customise any motor housing. This means that we are much more efficient with the machining centres, even if the pure machining time of a motor housing on the transfer line is shorter." As a result, in 2024 the production managers at Tatra

Trucks decided to order a Heckert HEC 800 from Starrag as the basis for the planned production cell – supplemented by an automation solution in the form of a Fastems FPC3000 system.

25 years' experience with Heckert machines

A decision with a history: Tatra replaced an ageing machining centre back in 2017. Its original tasks were cutting base surfaces and machining index holes, which are required for clamping and positioning the cast parts in the transfer line. Purchaser Libor Kalíšek recalls: "After comparing several suppliers at the time, we decided in favour of a Heckert HEC 800, as it seemed the most suitable and offered a wider range of machining applications." Since then, Tatra has been using the Heckert HEC 800 to pre-machine 8- and 12-cylinder motor housings. The lower housing section is completely machined in a single operation, including the index holes and all holes for attaching the oil basin. Technologist Dušan Kelnar adds: "We also rough machine the motor housing surfaces on the Heckert HEC 800 and drill holes that cannot be machined on the line. Before we send the pre-machined housing to the transfer line, the motor housing is completely reworked, including the various covers, the pump seat, etc." Dušan Kelnar points out that he and his colleagues have been familiar with the machine manufacturer Starrag and the Heckert centres for a long time: "We bought the first Heckert CWK 630 for machining gearbox housings 25 years ago." In the years that followed, Tatra regularly invested in further Heckert machines: two CWK 630s for machining axle housings, three CWK 500s for swing arms and wheel reduction housings and two

Tatra chose a pallet system as the automation solution, which initially contains twelve pallet spaces, and in a later stage 18 pallet spaces and a linear conveyor.

"We bought the first Heckert CWK 630 for machining gearbox housings 25 years ago."

Dušan Kelnar, Technologist

CWK 500s for components in the Tatra Tactic series. By 2017, three HEC 630 and two HEC 500 machining centres had also replaced other old machines. "That's why we have extensive experience with Heckert machines," emphasises Kelnar. "These machines have proven themselves thanks to their design, reliability and long-term accuracy."

Production cell is expanded step by step

The new Heckert HEC 800, which was delivered at the beginning of 2025, is the basis for the production cell that has now been put into operation.

The machine has special equipment, including, for example, a travel path extended to 2,050 mm in the Z-axis, an NC axis in the spindle for controlling special tools and a magazine for long tools up to 1,250 mm. Process Manager Kappler explains: "The cell takes over the complete machining of our 8- and 12-cylinder motor housings and is increasingly replacing the transfer line." The blanks are cast parts made of copper-alloyed GG20 cast iron with dimensions of around 1,200 × 600 × 700 mm and a weight of around 400 kg. Complete machining is carried out in four clamping processes with special hydraulic clamping devices developed and manufactured by Starrag.

In a second step, the production cell will soon be expanded to include an identical Heckert HEC 800 machine. And in a third expansion stage, Starrag is integrating the Heckert HEC 800, which is currently still responsible for the external pre-machining of the cast blanks.

A flexible pallet storage system, which consists of a shelf with twelve pallet spaces and a linear conveyor, automates the production cell. The latter handles the pallet transfer between the machines and the machine setup stations. The pallet storage system will also be further expanded as the number of machines grows.

"Heckert machines have proven themselves thanks to their design, reliability and long-term accuracy."

Dušan Kelnar, Technologist

The Heckert HEC 800 machining centre guarantees optimum results in the economical machining of large and heavy motor housings.

Special tool for in-line machining of the crankshaft bearing seats of the Tatra V12 engine.

"Compared to the previous transfer line, the operating costs are considerably lower and the space requirement of the production cell is just over a quarter at 570 m².”

Martin Kappler, Technology and Process Manager

Enormous increase in space productivity

Martin Kappler compares the two production systems: “Our transfer line recently had a capacity of around 1,600 units per year, which we are currently only utilising half of. Our production cell will also reach this quantity in the final expansion stage in two-shift operation, which is important for us. Because we expect demand to grow strongly. We can cover any further increase in demand with a third shift if necessary.”

His enthusiasm for the new production solution is primarily due to its high level of efficiency. There are several reasons for this, as Kappler emphasises: “Thanks to the automation, our new production cell can be operated by a single employee. Compared to the previous transfer line, the operating costs are considerably lower, and the space requirement of the production cell is just over a quarter at 570 m².” Purchaser Libor Kalíšek, who initiated the purchase of the Heckert HEC 800, has since retired. His successor Tomáš Holčák also praises the cooperation with Starrag: “All offers and negotiations were at a high technical and commercial level. We greatly appreciate the fact that Starrag supplies us with turnkey machines, as a fully functional unit comprising machine, tools, fixtures, technologies, testing and handover. The technical support, service and maintenance are also excellent.” Based on the positive experience, further projects to modernise and rationalise production are already being planned.

Bumotec 1000/C^{neo}
Produce more and consume less energy

The new Bumotec 1000/C^{neo} horizontal transfer centre was developed on the basis of feedback from the field and optimises every step of the process: shorter cycles, lower energy consumption and easier handling. With its 32 motor spindles at 25,000 rpm and the new touchscreen interface, this Bumotec machine enables industrial companies to produce more while keeping energy costs under control.

The developers of the new Bumotec 1000/C^{neo} transfer centre did not start with a blank sheet of paper, but built on the practical experience gained from the previous model. "We wanted to know what factors were limiting the customer on their Bumotec s1000/C and what would allow them to increase the production speed," explains Sylvain Bapst, who is responsible for the development and design of the machines at Bumotec. "We first drew up a specification sheet and then developed a new machine on this basis."

First improvement: the interaction between man and machine. A human-machine interface (HMI) from Fanuc was chosen. In combination with the 24-inch touchscreen, this allows Bumotec to display more information for the operator. By integrating the WattPilote graphics application, the operator can continue to operate their machine while monitoring the consumption of the spindles on the same screen. The operator can even add virtual buttons, e.g., a button for selecting the stations or shortcuts for the most frequently used M-codes. "We have thoroughly revised our HMI so that the operator can control their machine ergonomically and intuitively," assures Cédric Berger, Head of the Software Department. And he emphasises: "Our aim for our HMI was to make it easier to train new colleagues on a complex machine with 32 motor spindles and nine machining stations." Here, too, the company listened carefully to what customers needed: "In view of the shortage of skilled labour, companies often employ people who were not trained as precision mechanics in machining technology and who previously worked in other professions. For this reason, it is all the more important that the HMI is designed to be extremely user-friendly. That's why we put so much effort into its development."

The machine has its own OPC UA server

Bumotec's software department has also been working on an OPC UA server on which all the machine's information can be consolidated. "We have gone even further because instead of using Fanuc's OPC UA server, we have developed our own server to give users more flexibility so that they can decide for themselves what information they want to transmit at factory level," emphasises Cédric Berger.

New motor spindles

Now let's take a closer look at the mechanics. Here, too, we have hit the mark with several improvements. Up to 40% shorter cycle times. It should be noted that Bumotec has replaced its 8,000 rpm motor spindles with 25,000 rpm models. "We developed the new motor spindles internally at a Starrag Group site," emphasises Sylvain Bapst. What's more, these new motor spindles with direct drive

Bumotec has successfully optimised all aspects of the energy required to operate the Bumotec 1000/C^{neo}. Total consumption has been reduced by 30%, compressed air consumption by 52%, saving up to 2 kWh of electricity.

Up to 40% shorter cycle times

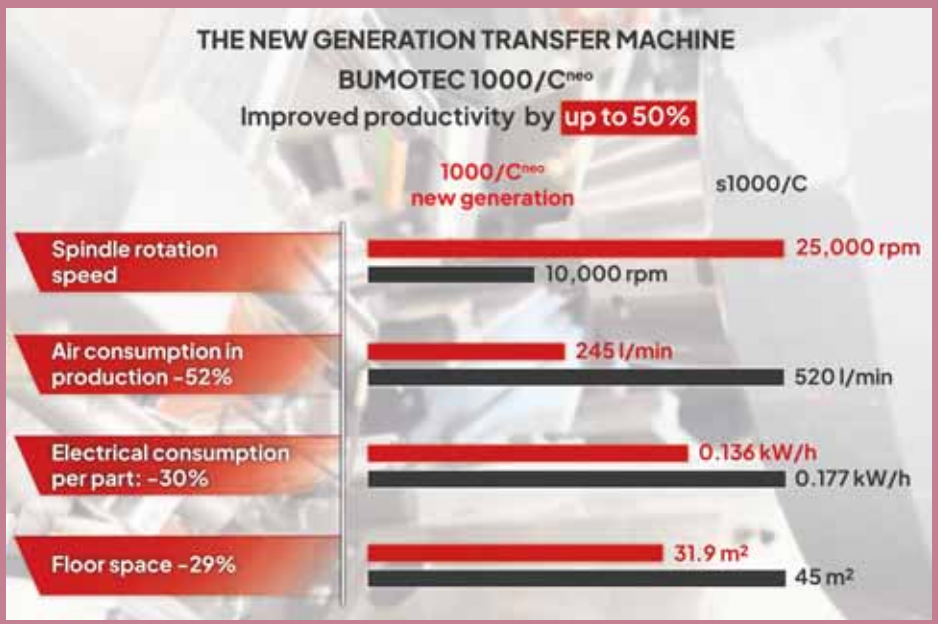
require less maintenance thanks to the high-pressure internal cooling of the tool, which operates at 70 bar. The motor spindles are equipped with acceleration sensors to monitor their vibration patterns. This allows the user of the Bumotec 1000/C^{neo} to check the condition of the spindles and also enables the control system (NC) to optimise the cutting conditions. To shorten the cycle times, a pick-up arm was added that has vices with a shorter stroke. The time for a parting-off sequence is now specified as 7 seconds – a reduction of 30% – and the machining time is 10 seconds – 51% less compared to the Bumotec s1000/C model. Tool rupture can now also be detected via the machine's software. For this purpose, a so-called "learning curve" for the current consumption of the spindle was created using a machining sequence. If there is a deviation, a "tool rupture" warning is issued.

Linear guides in the X, Y and Z axes

To improve the accuracy of the new horizontal transfer machine from Bumotec, the rigidity of the machining stations has been increased in the X, Y and Z directions. To achieve this, the manufacturer from Vuadens (canton of Fribourg in Switzerland) no longer works with dovetail joints, but instead uses linear guides with slides, as Sylvain Bapst emphasises, "with the aim of maintaining the same rigidity." "We carried out simulations in the workshop and confirmed them with measurements. As a result, we realised that we had not only increased the rigidity, but also reduced the friction so that we could move faster on the axes. So you could say that we have managed to achieve the same precision as a machine with just one rod."

4 milling spindles per workstation for machining at 25,000 rpm

Total consumption has been reduced by 30%, compressed air consumption by 52%, saving up to 2 kWh of electricity.



Bumotec has opted for a semi-autonomous cutting oil filter system. As Sylvain Bapst explains, "thanks to a new concept in which filtration takes place through filter bags on the outside, the machine no longer needs to be stopped."

To unload the finished parts, Bumotec has opted for a blowing system with which the part is conveyed into a plastic cup without being knocked. The cup, which is mounted on a linear arm, then places it on a belt.

Reduction of the energy footprint

Another highlight of the Bumotec 1000/C^{neo} is the monitoring of energy consumption. Thanks to the integrated sensors, the Bumotec 1000/C^{neo} can display relevant values for compressed air and power consumption on its 24-inch screen. And the temperature conditions too. Cédric Berger explains: "To cool the cutting oil, cold water is fed into the machine, which is then heated and flows back into the company's ice water network. So we installed sensors at the inlet and outlet to obtain information about the machine's heat consumption, i.e. the energy required to keep the machine at the right temperature." The WattPilote system also plays a role in the quality of the parts produced. "By gaining a better understanding of certain machine phenomena, we were not only able to increase production (see box), but also improve the surface quality of the workpiece," explains Sébastien Campalto, application engineer at Bumotec. He continues: "WattPilote is a small oscilloscope that measures the power consumption and creates a curve while the tool is machining the workpiece. This means the operator knows in real time whether the machine is working properly or not."

Costs in watt hours per workpiece reduced by 30%

The new HMI also offers various operating modes in accordance with ISO 14955: "OFF", "STANDBY", "READY", "HEATING" and "PRODUCTION". "In particular, the operator can switch more easily from

one operating mode to another. When production is finished, for example, the operator can choose whether their machine returns to Standby mode, i.e. practically everything is switched off. Or the machine returns to Heating mode because a new production run is about to follow. If production has still not started after one hour in Heating mode, the machine switches back to Standby. Everything is well thought-out and designed so that the customer can save on the energy bill for their machine," says Cédric Berger.

Bumotec has successfully optimised all aspects of the energy required to operate the Bumotec 1000/C^{neo}. Total consumption has been reduced by 30%, compressed air consumption by 52%, saving up to 2 kWh of electricity. The machine now requires only 245 litres of air, just 6 litres of hydraulic oil and 600 litres of cutting oil to operate. Depending on the workpiece and production conditions, the costs in watt hours per workpiece were reduced by 30%. This corresponds to a production efficiency of over 98.3% and a reduction from 0.177 kWh to 0.136 kWh. Sylvain Bapst explains how such results were achieved. "The machine was perfectly tailored to the customer's needs. Take the motor spindles, for example. They have been specially dimensioned for the customer's production, and as there are 32 spindles, this also results in a factor of 32 in terms of savings. We have also selected the latest generation of components in each case. All axes are equipped with new, less energy-intensive electric motors, and the high-pressure cooling system is also more favourable in terms of consumption. We have reduced the inlet pressure of the compressed air unit. It is a mosaic of many small pieces that have enabled us to achieve such values." Bumotec worked together with the company SIGMATools on this project. The company developed a multi-channel measurement technology that can be used to carry out detailed analyses of all components and operating states of a machine and then generate reports for optimisation measures.

Sylvain Bapst
Head of Mechanical Design
Starrag Vuadens

"The machine was perfectly tailored to the customer's needs."

Finally, and this should not be underestimated, the footprint of the Bumotec 1000/C^{neo} has been reduced by 29%. The various functions and peripherals have been developed to minimise the space required. With a length of 6,445 mm, a width of 4,950 mm and a height of 3,251 mm, the new Bumotec transfer centre takes up less than 32 m² in the workshop.

Watchstraps: Bumotec cuts times in half

The new Bumotec 1000/C^{neo} has now been in operation for several months at a company that manufactures elements for watchstraps. According to initial feedback, the manufacturer's expectations were even exceeded. "The increase in productivity is between 40 and 50% compared to the same workpiece machined on the Bumotec s1000/C. The customer was able to go from one minute to 30 seconds," confirms Sébastien Campalto, application engineer at Bumotec. He emphasises that the customer has also noticed a "better end result" for their workpieces, which is also "achieved in less time", with a 30% improvement in surface quality. "That is simply enormous," says Sébastien Campalto. "The simultaneous increase in productivity and surface quality is incredible." This machine, which he describes as a "great success" in this respect, could open the doors to new markets for the customer: Sébastien Campalto is thinking of medical technology and general mechanical engineering.

Easy access to the parts conveyor belt for quality control and unloading

Exakt Fijnmechanika from the Netherlands focuses on

complex precision mechanical long turning work with Tornos

No fewer than eight Tornos long-turning machines are currently operating nonstop at Exakt Fijnmechanika in Drachten. The facility, which resembles a clean room, is fully dedicated to the stable production of high-precision turned parts for the medical industry and other sectors.

In 2010, Exakt Fijnmechanika acquired its very first long-turning machine, a Tornos Micro 7, to produce 500,000 cannulas each year for ophthalmology. This product is a hollow tube – similar in size to a needle – used in eye surgery to penetrate the eye and remove fluid or treat certain conditions.

"These types of products must meet the highest standards in terms of dimensions and surface finish. A defect in such a product can result in irreparable damage. That is why we set very high standards for our machinery, and since 2010, Tornos has consistently proven that it can more than meet these requirements," Exakt Fijnmechanika Director Arnold Douma said enthusiastically.

Swiss quality

The reason Exakt Fijnmechanika chose Tornos has everything to do with the quality and accuracy of the machines. In long turning, it is essential that the process runs stably to ensure high precision and repeatability. "At the time, Tornos was one of the few machine builders that could meet our requirements. The Micro 7 was perfect for our starting material with a diameter of 4 mm and was developed in collaboration with leaders in the watchmaking industry," Douma explained. "Given the similar demands for precision manufacturing, we were simply charmed by Swiss precision, making Tornos the logical choice."

Overview of the machine park

> "These types of products must meet the highest standards in terms of dimensions and surface finish."
>
> **Arnold Douma,** Director Exakt Fijnmechanika

Pushing the boundaries

Today, Exakt Fijnmechanika still produces cannulas in large quantities, but other long-turning projects have been added over the past decade. For the medical industry, the company also manufacture small parts for insulin pumps and sharp needles with a radius of less than 5 micrometres. For the defence industry, Exakt Fijnmechanika produces components with very low Rz values used in night vision goggles.

"These are just a few examples," said Douma, showcasing a wide range of precision mechanical turned parts. "We specialise in high-tech turning. When you are pushing the boundaries of what is feasible, you have to be willing to make mistakes. That's the only way to progress."

Eight Tornos long-turning machines

Due to increasing demand and positive experiences with both Tornos and Gibas – Tornos' official distributor in the Netherlands – Exakt Fijnmechanika added a SwissNano 4 to its equipment lineup in 2015. This model succeeded the Micro 7 and features improved user-friendliness in terms of both control and accessibility to the machining space.

"We program directly on the machine to maintain optimal control over the process. With the SwissNano 4, this has become much easier due to the user-friendly interface. Another great feature is the construction of the machine. The glass dome,

which can be fully opened, provides complete access to the machining area. Despite the 14-year difference between the Micro 7 and the newer models, the performance, accuracy, and cycle time remain very consistent. That is a testament to Tornos' quality," Douma noted.

Leaving nothing to chance

Between 2015 and today, six additional SwissNano 4 long-turning machines have been added to Exakt Fijnmechanika's workshop, bringing the total to eight. All machines have a maximum bar capacity of 4 mm, which is also the diameter of most starting materials. However, Exakt Fijnmechanika also processes smaller diameters down to 1 mm. The compact long-turning machines have six linear axes, two C axes, and 13 tools, four of which are driven. Each machine is equipped with a high-frequency spindle capable of speeds up to 16,000 rpm on both the main and subspindles. "We sometimes drill holes of just 0.2 mm in diameter. In such cases, 16,000 rpm isn't enough, so it takes a bit of magic to successfully complete these types of operations," Douma explained. "Everything has to be perfect, from the alignment of the machine to the quality of the cutting oil, temperature control, and tooling – especially for unmanned production."

Reliable and unmanned production

Because Exakt Fijnmechanika produces large series ranging from 1,000 to a million pieces, all Tornos long-turning machines are equipped with LNS Tryton bar feeders. According to Douma, this

> "We drill holes of just 0.2 mm in diameter."
>
> **Arnold Douma,** Director Exakt Fijnmechanika

Thanks to a bar loader, Exakt Fijnmechanika can produce large series efficiently.

Long-turning specialists Mihai Mihaltan (left) and Ranjdar Junaid Ismael are satisfied with the SwissNano 4.

The paper belt filter system is one of the solutions that guarantees high process reliability.

A variety of precision mechanical turning parts produced with Tornos machines.

bar loader is ideal for automated production of small-diameter workpieces. "Even with small diameters, there are no vibrations, which allows us to produce all night long with process reliability," he said.

While Tornos machines are known for their thermal stability, Exakt Fijnmechanika leaves nothing to chance. Seven employees dedicated solely to quality control are proof of that commitment.

> "All in all, we are extremely satisfied with Tornos' long-turning machines and the support from Gibas."
>
> **Arnold Douma,** Director Exakt Fijnmechanika

To ensure maximum process reliability, all long-turning machines are housed in a temperature-controlled room. "At a constant temperature, there's no need for compensation, which greatly enhances process stability," Douma said. Furthermore, Gibas has equipped several machines with a paper belt filter to maintain optimal cutting oil quality, preventing small chips from damaging the tool or workpiece. "All in all, we are extremely satisfied with Tornos' long-turning machines and the support from Gibas. We still have some space available in our long turning department, and we will undoubtedly fill it with more Tornos machines," Douma said.

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