

The heart of machining

Starrag offers in-house spindle technology at its best

100 machines for the wind power world champion

Quill specially developed for the wind power industry

Precision check – The truth lies behind the measuring centre in Chemnitz

When it comes to high-precision parts, quality assurance is the moment of truth

Heckert NC quills

For higher cutting values and improved process reliability



160 years of SIP



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Starrag Group Holding AG
Seebleichstrasse 61
9404 Rorschacherberg
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Tel.: +41 71 858 81 11
Mail: info@starrag.com

Editorial staff:

Sabine Kerstan, Christian Queens,
Angela Richter, Michael Schedler,
Elena Schmidt-Schmiedebach,
Ralf Schneider, Stéphane Violante

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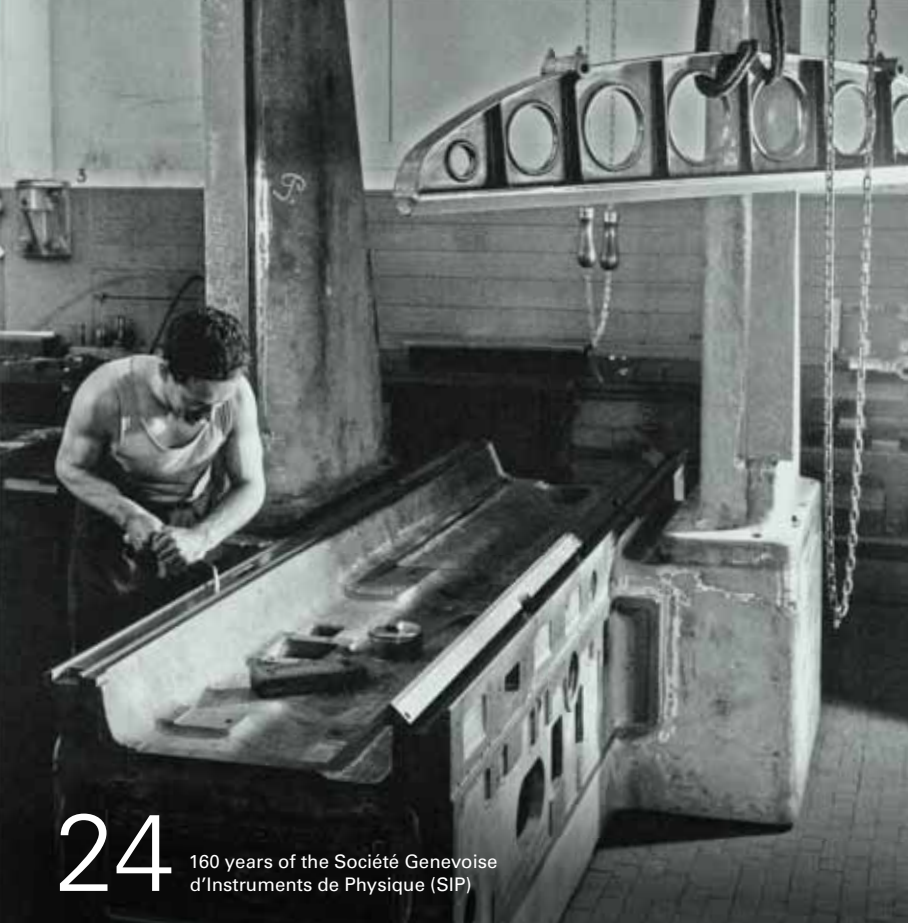
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CIMT
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06. – 09.06.2023
EPHJ
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(Switzerland)

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GTMA
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19. – 25.06.2023
Paris Airshow
Le Bourget
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EMO
Hanover
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Dubai Airshow
Dubai
(United Arab
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Alexander Attenberger,
CSO of the Starrag Group

Dear reader,

I am pleased to introduce to you Rainer Hansjürgens, a new member of the Executive Board. He has led the Large Parts Machining Systems (LPMS) business unit since November 2022 and has learned everything in the machine tool industry from the ground to the top – a characteristic that distinguishes many of the Starrag executives.

While reading our new customer magazine Star, I was struck by how often Starrag is about precision and tradition: One example of “lived precision” is today’s SIP product range, which recently celebrated its 160th anniversary and to which the Geneva Office for Cultural Heritage and Sites dedicated a special exhibition in the Museum of the History of Science.

High precision also shaped the machining centres from the 50-year-old Bumotec product range which, together with SIP, forms the Ultra Precision Machining Centers business unit. Initially, it was mainly the watchmaking and luxury industries that worked with the high-precision machines, but the Starrag product range now has also captured new markets such as medical technology.

The struggle for fractions of a millimetre is different in every product range: For 30 years, Heckert, for example, has been relying on a special form of work spindle: I refer to the NC quill, with which deeper surfaces and bores can be machined with high precision using short standard tools without vibration.

Heckert demonstrates how well this can be achieved at the Chemnitz measuring centre, which fulfils the strict specifications of German standard VDI 2627 and whose services can also be used by Starrag customers. The four ZEISS measuring machines and programming stations allow you to measure ghost layers for checking product lines – with an accuracy of up to 0.7 micrometres.

The Starrag headquarters in Rorschacherberg has been developing and manufacturing motor and gear spindles in-house since 1920. This traditional precision work is also impressive: According to current measurement results, the axial shaft displacement is less than ten micrometers over the entire speed range.

But where are these remarkable achievements currently in demand? In the Far East. One hundred Starrag machine tools have been received by wind turbine manufacturers in China since 2006. The two most important decision criterias being productivity and precision.

I hope you enjoy reading the Star 01–2023 issue and our “lived precision” in all areas.

Best wishes,
Alexander Attenberger

"Successful and quiet..."

...this is how the business magazine 'brand eins' very aptly describes the greater Bielefeld area, the home of Starrag's Droop+Rein product range. The region with the complicated German name of Ostwestfalen-Lippe also left its mark on Rainer Hansjürgens, the new Managing Director of Starrag's Large Parts Machining Systems (LPMS) business unit.

Learned from the ground to the top – this is how the vernacular describes managers who have worked their way up from skilled worker to being the boss. A typical example of this is Rainer Hansjürgens. The graduate engineer (born in 1970) grew up in the greater Bielefeld area, learned the trade of a machine fitter there, studied mechanical engineering at the Bielefeld University of Applied Sciences and worked in many traditional mechanical engineering companies in the region.

First a Design Engineer, then Operations Manager and Business Unit Manager

"In the beginning, I set up machines myself and put them into operation at the

customer's premises," says Rainer Hansjürgens, looking back. "After my mechanical engineering studies, I designed special machine tools, which then allowed me later to take over the entire department of special machine construction as Business Unit Manager." His decades of production knowledge eventually led him to Gildemeister Drehmaschinen GmbH, a subsidiary of DMG Mori AG in Bielefeld, as Managing Director.

At home in large-scale mechanical engineering

For years, however, he has been passionate about products in an XXL format, which he got to know in Starrag's

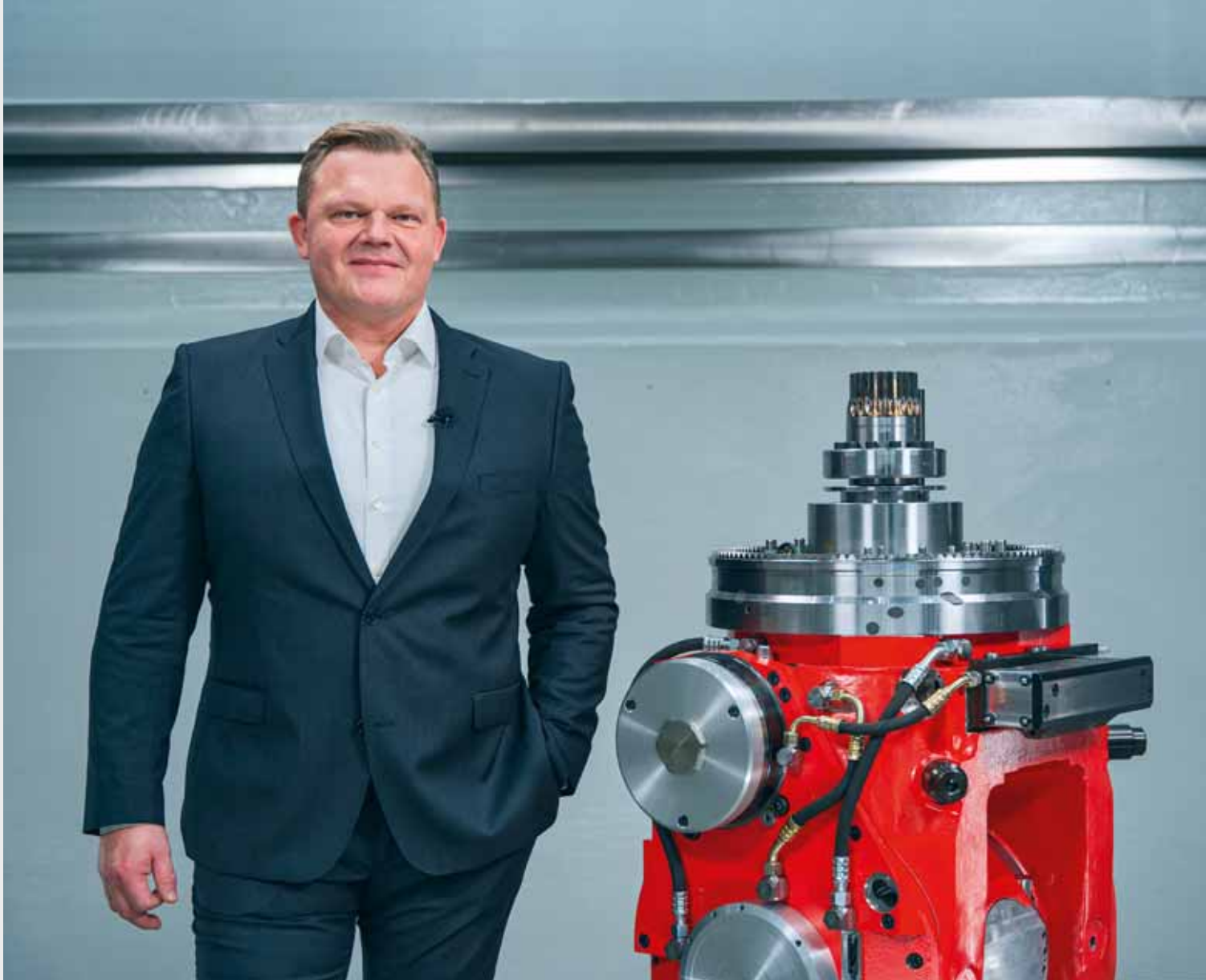
Droop+Rein product range. "I was responsible for the global project management as Head of Production in Bielefeld from 2002 to 2005. So I come from large-scale mechanical engineering and therefore feel at home here," says Rainer Hansjürgens happily.

The Westphalian has been in charge of the Large Parts Machining Systems (LPMS) business unit since November 2022. "In this area, everything revolves around Starrag's commitment to large and very large machines," explains the new LPMS head. "The business unit includes the Droop+Rein and Dörries product ranges in Bielefeld, Berthiez in St. Étienne, France, and the Large



We've got the goods that are right for you – LPMS products such as this gantry portal milling machine are the benchmark in large-scale mechanical engineering in terms of performance, accuracy and long-term stability.





Parts Machining Systems division in Mönchengladbach."

But how does the long-serving expert in large-scale mechanical engineering assess the business unit? "Within the LPMS business unit, we combine many years of expertise and comprehensive know-how in turning, milling and grinding to jointly develop new machine, automation and machining concepts for customers," says Rainer Hansjürgens. "LPMS products are the benchmark in large-scale mechanical engineering in terms of performance, accuracy and long-term stability. With our application engineers, we set standards in terms of turnkey applications with excellent 24/7 service. Integrated into the Starrag Group, we thus offer our customers maximum investment and future security."

"I come from large-scale mechanical engineering and therefore feel at home here."

Rainer Hansjürgens, Managing Director of Starrag's LPMS business unit

Sometimes, successful Westphalians quite right forget how quiet they really are.

A major order from the Droop+Rein product range in Bielefeld, for example, has been on a scale beyond anything they were used to before. Going with the trend of larger wind power plants, the Danish family-owned company HACO A/S from Jutland has ordered two gigantic Droop+Rein portal machines for complete machining of rotor housings and front and stator sheets, in addition

to its five Dörries vertical turning and boring mills. The gantry portal milling machine (100 kW milling head and 2 x 111 kW master/slave main drive), which weighs around 500 tons, offers a distance of 12,600 mm between the stands, and the gantry axis travels over 14,000 mm. Similar XXL dimensions also characterise the second Droop+Rein, a portal turning machine with a third linear axis. By adjusting the table, the turning diameter can be increased from 13,000 to 15,000 mm if required. ▀



The heart of machining

Starrag offers in-house spindle technology at its best

In-house development and production of motor and gear-driven spindles – which machine manufacturer can offer this? Starrag has built up unrivalled expertise in this field over several decades. Customers benefit from an application-specific spindle design, leading technology and the highest quality, as well as from very quick service in the event of any – although rare – malfunctions.

“The spindle is the heart of a milling machine. It makes a decisive contribution to ensuring that the machining results correspond to what the user expects,” emphasises Rainer Hungerbühler, Sales Director Aerospace and Turbines. “I am glad that we have our own spindle production here in Rorschacherberg and a corresponding competence centre. This allows us to design the spindle precisely for the machine and the respective application, which is very



Rainer Hungerbühler,
Sales Director Aerospace and Turbines

“Our gear-driven spindle is almost indestructible. This means it ensures high process and work safety and causes virtually no machine downtime.”

Rainer Hungerbühler,
Sales Director Aerospace and Turbines



important for us as a solution-oriented supplier of turnkey production systems.”

A win-win for customers. You get products in which the kinematics of the machine, the drives and the spindle perfectly fit together. This accompanies the fact of machining difficult-to-machine materials such as titanium and Inconel, structural components made of aluminium or to other applications. Rainer Hungerbühler explains: “To do this, we design the spindle characteristic curve in such way that the required cutting parameters are available for optimum machining of the respective components.”

The sales manager points out another advantage: “In-house production means we are independent of external spindle manufacturers. During the coronavirus

pandemic, we saw how very good suppliers had problems meeting their delivery commitments. Because of our in-house production, we and our customers were not affected by this.”

Long-term success with gear-driven spindles

Starrag began manufacturing gear-driven spindles back in 1920 and has acquired a great deal of expertise over many years. Today, this feature is on all machines of the STC series produced in Rorschach-berg. The five- and six-axis machining centres enable to extremely economical machining of demanding structural components as well as multi-blades and casings with long cycle times. “Our STC machines benefit from Starrag’s own gear-driven spindle in many ways,”

explains Rainer Hungerbühler. “Because their design has a very small interference contour, we can get very close to the workpiece with the head. This means the user can use short tools, which support a stable milling process and results in long tool life.” He highlights another strength: “Our gear-driven spindle is almost indestructible. This means it ensures high process and work safety and causes virtually no machine downtime.”

To meet the different machine sizes and applications, Starrag offers the gear-driven spindles with two different motors and in different gear ratios. The 37 kW version with a maximum speed of 8,000 rpm and 940 Nm torque at continuous load (S1 operation) is used most frequently. However, a variant with 1,600 Nm and a speed of 4,500 rpm is also available.



Starrag boasts an extremely wide range of motor spindles. The range begins with a 2.5 kW spindle with 2 Nm torque. The upper limit is marked by spindles with a torque of up to 350 Nm.

"Our gear-driven spindle (620 Nm torque) rotating at up to 12,000 rpm with the HSK-A100 interface common to the STC machines is quite something. I don't know of any other supplier who has a spindle like this in their product range," explains Rainer Hungerbühler.

Motor spindles on the road to success

The Spindle Competence Centre deals primarily with motor spindles – in addition to the long-established gear-driven spindles. Starrag has also been developing and building these for around 25 years. But recently they have been experiencing a push. Silvan Huber, Master of Science FHO in Engineering, is responsible for motor spindles and direct drives as a development engineer since 2014. "So far, we have installed almost 2,500 motor spindles in our machines. We installed 160 last year alone, twice as many as the year before." He is convinced that the output will double again in the next two years.



Silvan Huber,
Master of Science FHO in Engineering

He thinks the reason for this is in the quality and leading technology of Starrag motor spindles – which is largely due to "our team of experts working with state-of-the-art development, assembly, overhaul and testing facilities to ensure the best products for customers." This has also convinced those responsible at the plants in Chemnitz and Vuadens, to use Starrag motor spindles in the Heckert H series and the new Bumotec centres s181 and 191^{neo}.

"All five-axis turbine blade machining centres of the LX series and the NB 151 blisk machining centre are equipped with our own motor spindles. On the STC milling centres, if no gear-driven spindle is installed, our 18,000 HSK-T100 is used," Silvan Huber explains.

New developments at the highest level

Starrag boasts an extremely wide range of motor spindles. The range begins with a 2.5 kW spindle with 2 Nm torque. The upper limit is marked by spindles with a torque of up to 350 Nm. In terms of speeds, the range extends from 12,000 rpm to 40,000 rpm.

Silvan Huber highlights the recently introduced 80 kW motor spindle (250 Nm and 18,000 rpm; S1 rated operation), which promises unprecedented productivity and is therefore offered for the entire STC series. It is equipped with an HSK-T100 tool interface, provides a tool clamping



The Spindle Competence Centre deals primarily with motor spindles – in addition to the long-established gear-driven spindles.

force of > 45 kN, a shaft clamping force of 1,400 Nm and is suitable for internal coolant supply up to 140 bar. According to Silvan Huber, the spindle is attractive not only because of its performance data, but also because of its high quality, which is based on in-house production and components such as bearings and motors that are purchased exclusively from renowned manufacturers. This has an impact on stability, running times and service life. It is also equipped with various sensors that ensure high precision.

The plant in Chemnitz, which equips its Heckert machining centres with this spindle, recently provided measurement results for axial shaft displacement – less than 10 µm over the entire speed range. “Considering that a speed of 18,000 rpm and the resulting thermal expansion result in a displacement of around 200 µm, we have succeeded very well in compensating for this deviation by means of sensor technology,” the technical developer is pleased to report.

Technology leader

Starrag is already working on further optimisations. Silvan Huber explains: “At the moment, we are focusing in particular on increasing the spindle speed and thus the cutting performance. This paves the way for innovative and

process-optimised milling strategies.” The latest new developments also apply to details. On some spindle types, this includes coolant spray nozzles in the spindle nose, the spray angle of which can now be programmed and thus automatically adjusted to the tool length. Another innovation are spindles for the Bumotec machining centres s181 and 191^{neo}, which support cryogenic machining. Silvan Huber comments: “We have developed a motor spindle with a special rotary feed-through so that the cryogenic CO₂ cooling can reach the tool cutting edge. This is a special solution that is suitable for machining 3D-printed prostheses, but can also be significant beneficial for PEEK (high-performance plastic) machining or drilling titanium parts.”

In any case, he is certain that: “With the motor spindle developments over the last few years, we have risen to the technological forefront. And we will continue to improve until we reach the top of the world.”

As good as new again after overhaul

A third factor that the developers are focusing on – the service life of the motor spindles. Starrag usually provides a warranty for one year. Sales Director Rainer Hungerbühler comments on this offer: “The service life of a motor spindle depends not only on its quality, but also on the load to which it is subjected. Therefore, we cannot make any general statements about the service life. We can, of course, provide all our customers with assistance immediately if they need an overhaul of their spindle or experience downtime.”

Starrag has a great level of experience and expertise in overhauling motor spindles, a task which is carried out by highly qualified personnel in Rorschacherberg. There, original spare parts are stocked and the spindle can be restored to almost new condition. Moreover, a renewed manufacturer’s warranty on the components replaced. Starrag also maintains spare parts warehouses worldwide which can ship spindles within 24 hours. ▀

“With the motor spindle developments over the last few years, we have risen to the technological forefront.”

Rainer Hungerbühler,
Sales Director Aerospace and Turbines



100 machines for the wind power world champion



“When the winds of change blow, some build walls and others windmills.” True to this old Chinese saying, China continues to extend its lead as world champion in wind power – now strongly supported by 100 Starrag machine tools. The success story started in 2006 with a machine from the Heckert Large Athletic series.



“Our customers benefit from our specially developed quill, based on our experiences with orders for a large, very well-known pioneer in wind power.”

Jörg Heinrich, Director of Application & Technology Starrag China, Shanghai

Huge, modular and flexible. These three characteristics distinguish the machine tools of the Heckert Large Athletic series. These are horizontal machining centres in four- and five-axis versions designed for the economical machining of workpieces weighing up to 13 tons with a maximum edge length of 3,300 mm.

2006: Start of the Chinese success story

The Chinese success story started in 2006 when the Starrag plant in Chemnitz delivered a Heckert HEC 1600 with quill to a German manufacturer in the wind energy sector in China. In 2007, a well-known Chinese company also received a Heckert HEC 1600 as a turnkey solution. The customised solution was well received, as shortly thereafter

the company ordered three Heckert HEC 1800s, the largest model in the Heckert Large Athletic series to date.

“Supplying products to two important customers in the wind power sector early on has laid the foundation for Starrag’s success in the Chinese wind power industry,” claims a delighted Hubert Erz (Dipl.-Ing.), Senior Consultant Sales/Renewables. “A total of 100 Starrag machines from the Heckert, Dörries and Berthiez product ranges went to China, where they have since been turning, milling and grinding very high-quality wind turbine gearbox components.”

The feedback from customers on these two particularly popular models shows what companies in the wind power sector attach particular importance to –

and not only in China. We are talking about the Heckert HEC 1600 and Heckert HEC 1800, the two top models in the Heckert Large Athletic series. The horizontal machining centres from Chemnitz are suitable for complete and multi-sided machining of gearbox housings and planetary gear carriers used in wind turbines with an output of 1.5 to 6 MW. Thanks to the modular design principle, they can be customised in terms of loading mass, pallet size, interference zone and XYZ tracking.

Quill specially developed for the wind power industry

The secrets to success include special developments, which is one of Starrag’s strengths. “Our customers benefit from our specially developed quill, based on



"In total, around 100 Starrag machines from the Heckert, Dörries and Berthiez product ranges have gone to China since 2006, where they have been turning, milling and grinding very high-quality wind turbine gearbox-components ever since."
Hubert Erz, Senior Consultant
Sales/Renewables



our experiences with orders for a large, very well-known pioneer in wind power," Jörg Heinrich, Director of Application & Technology at Starrag China in Shanghai says, looking back. "With a diameter of 150 mm and an extension length of 750 mm, it meets the special requirements of this industry."

Because the later performance of a wind turbine crucially depends on its drive elements, the companies in the industry rely on the highest precision in machining. Beneficial features of the Starrag machines include machining quality

IT 5/6 and the high long-term accuracy of the linear and rotary axes. Heinrich: "These are not exaggerated advertising claims, but facts thanks to which our customers achieve higher machining accuracies compared to the competition."

Automation increases processing speed by up to 25%

In addition to precision, productivity is also required. Here too – according to

feedback from the Far East – the two machining centres perform very well: This is partly owed to the high degree of automation of the machines, thanks to the Heckert HEC models which machine workpieces up to 25% faster than competitor machines. Setup times are reduced by the standard equipment with pallet changer, which enables workpieces to be set up during machining and thus enables unmanned shifts over a longer period of time.



25 %
faster than
competitor
machines

The enormous amount of space available in the Heckert tool magazines increases productivity even further: This calls for the compact tower magazine with up to 450 tool positions. Bridge tools weighing up to 50 kg and with a diameter of 950 mm can be accommodated here. In addition, the tower magazine can hold 30 tools up to 800 mm long for automatic use in the main spindle.


"All in all, there is a lot to be said for the successful duo from Chemnitz," emphasises Hubert Erz, Senior Consultant Sales/Renewables. "This is also shown



An Athletic start: The success story of around 100 Starrag machines for the Chinese wind power industry began in 2006 with a Heckert HEC 1600.

by the sales statistics, because roughly every second Starrag machine sold came from Chemnitz. I am delighted that the topic of wind power is now also being dealt with more intensively in our geographical region and that we will be able

to incorporate on our experience from the China projects over the past decades here in Germany. With our Heckert, Dörries and Berthiez product ranges, we have all the prerequisites to write many more success stories." ▀



"Our precision measuring room with integrated full air conditioning and vibration-decoupled machine foundation meets the strict provisions of German VDI regulation 2627."

Jens Knöfel, Head of Quality Management



Precision check –

The truth lies in the Chemnitz measuring centre

When it comes to high-precision parts, quality assurance is the moment of truth – it depends crucially on meticulously planned measurement with seamless documentation. For six years, the Chemnitz measuring centre, which works not only internally for the Starrag Group but also for external customers, has played an important role in terms of μm precision. A highlight is a simultaneous precision check of several components in the ghost shift.

“Measurement is knowledge,” Werner von Siemens recognised as early as the 19th century. This truism has not changed over 100 years later. Today, components can be calculated and designed very reliably and accurately with the help of software, and their manufacturing process can be simulated. But at the end of the day, high-precision workpieces still have to undergo final inspection on a measuring machine.

Measuring centre: High precision even for XXL formats

This task has been taken over by the Chemnitz measuring centre since May 2016. Experienced experts not only check the dimensional accuracy of small and medium-sized workpieces with four 3D measuring machines and programming workstations from ZEISS, but they also measure gigantic major parts weighing up to 12 tons.

“Our precision measuring room meets the strict provisions of German VDI regulation 2627,” proudly explains Jens Knöfel,

Head of Quality Management (QM).

“This is the highest standardised level there is. Our trademark is the accuracy we achieve with this measuring centre.” And they are impressive – for example, the ZEISS MICURA measures components with an edge length of 400 mm to an accuracy of 0.7 μm .

High-precision measurement thanks to flow optimisation and vibration decoupling

Chemnitz also owes this high precision to the holistic interaction of many measures. When ultra-high precision is required, the workpiece goes into the separate, fully air-conditioned area, which, thanks to a sophisticated ventilation concept in maximum climate class 1, keeps the temperature constant at 20 °C – with a maximum difference of 0.2 K. To ensure that passing trucks or vibrating machines from neighbouring halls do not falsify the measuring result, the measuring machines stand on a vibration-decoupled foundation and base plate ensemble.



Decoupled from the measuring process – instead of just one station, there are four ZEISS programming workstations, where four experts create measuring programmes based on CAD data using the ZEISS CALYPSO programme.

The selection of the measuring quartet in Chemnitz was targeted. "The MMZ major-part portal coordinate measuring centre, the MICURA high-accuracy measuring machine and the two PRISMO 3D coordinate measuring machines are graduated in relation to each other in terms of the size of the parts so that we get redundancies," says the Head of QM. "I can therefore also keep a machine completely free for a customer project." The four machines can accommodate small components with an edge length of 500 mm, medium-sized workpieces (900 mm x 1,800 mm x 700 mm) and XXL components with a maximum measuring volume of 27 m³. "Even a small car or a complete Heckert machine bed fits in the MMZ," says the expert. "I'm often at customers' and suppliers' sites, but at no company – including numerous well-known companies – did I see a comparably equipped centre."

The latest investment is a ZEISS PRISMO with a turntable for continuous four-axis measurement. The measuring centre thus responds to the trend at Starrag and its customers towards four-axis and five-axis machining of precision components. "With a three-axis measuring

"Even a small car or a complete Heckert machine bed fits in the MMZ."



Seamless quality check: The latest investment is a ZEISS PRISMO with a turntable that can measure via four axes.

machine, a cylinder with many bores cannot be measured completely because the sensor cannot get into every bore," says Knöfel, citing a typical example from practice. "The turntable allows us to position the cylinder so that the measurement succeeds. Thanks to the turntable, the PRISMO is now also a four-axis 3D coordinate measuring machine – and not everyone has that."

High level of expertise: Three quality engineers for programming and operation

The measuring centre also differs from others in another respect. Instead of just one station, there are four ZEISS programming workstations where experts create measuring programmes using the ZEISS CALYPSO programme. The advantage is that, because programming is decoupled from the measuring process,

no measuring machine is blocked. "The expertise is also remarkable," emphasises the Head of QM. "Our three quality engineers programme and operate the four measuring machines – supported by a skilled worker as a stand-in. These experts are particularly distinguished by their many years of experience, which helps them to interpret measuring results correctly." This is a demanding task for contract measuring jobs, which are often in the narrow tolerance range of four to five micrometres – far outside the usual limit of machining centres.

As the Group's centre of excellence, the experts primarily look after the Starrag plants in Bielefeld, Rorschacherberg and Chemnitz. Measuring expertise is particularly in demand when Starrag sells a Heckert machine with complete technology. Centres for machining engine blocks are a typical example. The measuring centre

then proves that the machine tool has been run in correctly and that the engine blocks comply exactly with the strict tolerance provisions in the specifications.

Saxony's measuring expertise also came externally from the very beginning. For example, Chemnitz took over the calibration of wheel axles on behalf of the German Railway until the state-owned company acquired its own measuring technology. Starrag now also wants to increasingly offer its measuring services to its typical clientele. This includes, for example, manufacturers of compressors, electric motors and combustion engines for the automotive industry, drives for trucks, construction machinery, agricultural machinery or ships, as well as industrial components of all kinds.

Secure measuring work even for development orders

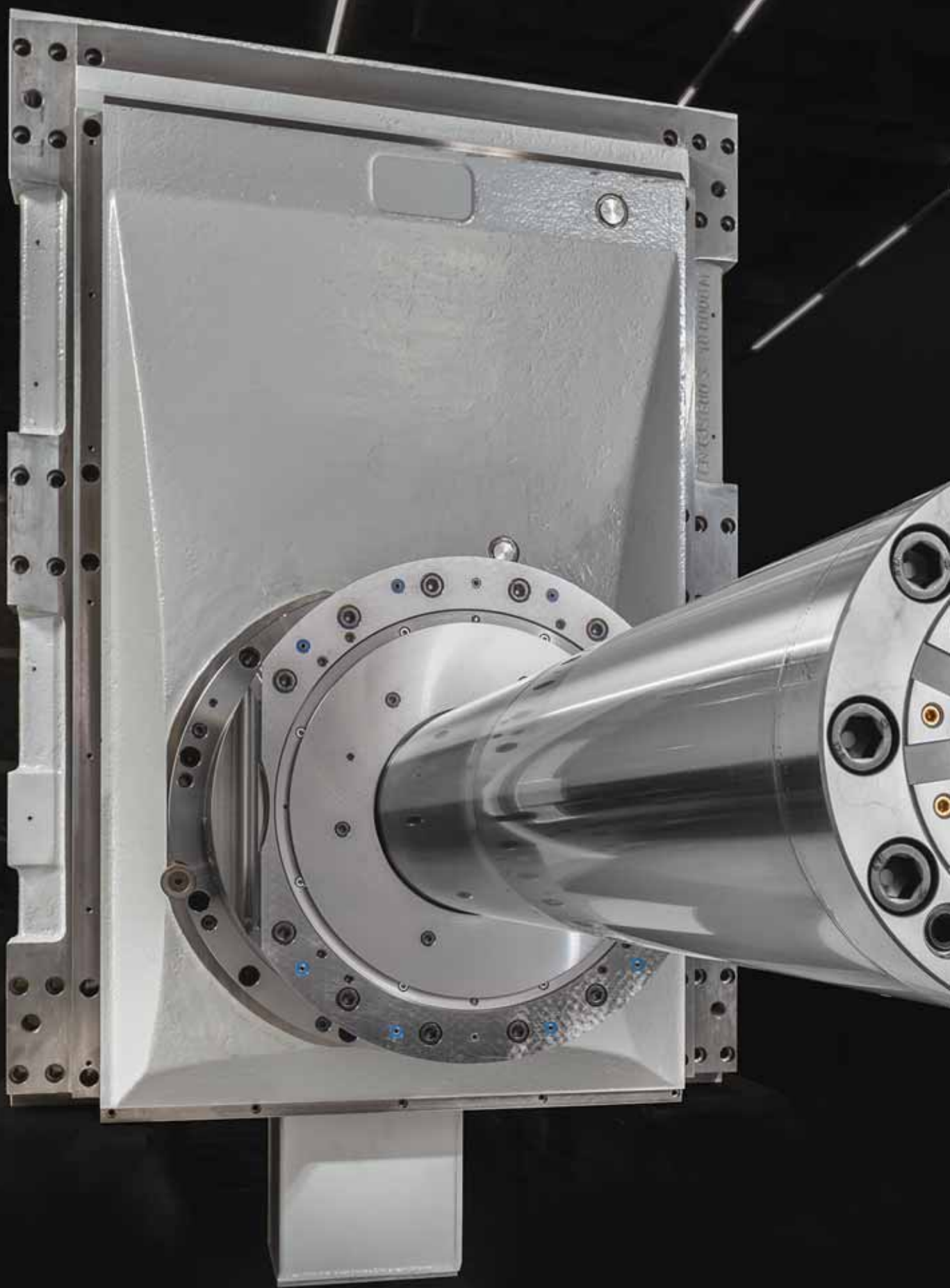
But how does Chemnitz ensure confidentiality – for example in the quality check of prototypes? "Only authorised persons can enter the 250-square-metre measuring room, which is strictly separated from the rest of production through a secured roller shutter," Knöfel explains. "We always know who comes in and out of here and when, thanks to the use of a card reader."

Chemnitz even feels equipped to handle several projects at the same time. "We often have two or three projects at short notice, but sometimes even up to eight longer projects at the same time," reports the Head of QM. "Then we approach the work in two to three shifts. That already requires a very high degree of flexibility on the part of the staff."

But the Saxons are also flexible when it comes to measuring technology – they recently tackled a specialty that only very few have mastered so far. "Due to our machine size, we can measure parts with multiple clamping," Knöfel gives details: "For example, we recently performed an unmanned run-in and measurement of eight components with multiple clamping. With such a late ghost shift, the flexibility and performance of machining processes can be increased enormously." ■



Expandable: Starrag now also wants to increasingly offer its measuring services to its typical clientele.



Heckert NC quills:

For higher cutting values and improved process reliability

Metalworking can be demanding in many ways. Mould elements situated inside the workpiece pose a particular challenge. To machine these precisely and economically, a horizontal machining centre with NC quill is recommended – from the Heckert compact or large machine series, for example.



How can large gearbox housings for construction and agricultural vehicles, planetary gear carriers for wind turbines or even large flow bodies for the chemical industry be machined in an economically and technically optimal way? Especially when high-precision bores, bearing seats and similar elements have to be created deep inside?

Such workpieces are clamped on a correspondingly large machining centre and then on a boring mill for the internal mould elements – accompanied by the expense of machine changes, loss of time and loss of accuracy due to reclamping errors.

Or you can use the machining centre for complete processing. This avoids the negative aspects of changing machines. For this, however, the machine must be equipped with long tools in order to reach the elements situated in the workpiece. This is also a costly affair, often accompanied by uncertain machining results in limited quantities.

Or – the user decides on a machining centre that is equipped with a work spindle designed as an NC quill. This can machine deep surfaces and bores with short standard tools, thus saving tool costs. Extremely smooth running also increases tool life and surface quality. Compared to the use of long tools, the quill solution offers machining with higher cutting values and improved process reliability.

Many years of experience in quill construction

Starrag's Heckert plant in Chemnitz offers machining centres with such a quill support. Klaus Frost, head of the test workshop, reports: "We developed our first quill with a 125 mm diameter and 500 mm extension travel in the mid-90s. It was intended for gearbox housing construction in the tractor sector and immediately proved its worth to the world's leading manufacturers. Because of this, they were able to produce bearing bores in a much

higher quality than previously possible with conventional tools – and in large-scale production.”

The Heckert developers already recognised the potential of such fully enclosed milling centres. Initially, they developed the 125 mm quill for the Heckert CWK 1000 to 1600 series – large machining centres that were transferred to the Heckert Large Athletic HEC 1000 to 1800 series in the early 2000s. With the development of the Heckert Athletic HEC 500 to 800 compact machines, customers also wanted a quill support in these smaller centres. No sooner said than done – from 2008, the 125 mm quill was also available as an option for this.

With the growing demand for wind turbines featuring gearbox housings with even larger dimensions, manufacturers expressed the desire for a more powerful quill with even greater extension travel. This was fulfilled in 2004 with a 150 mm

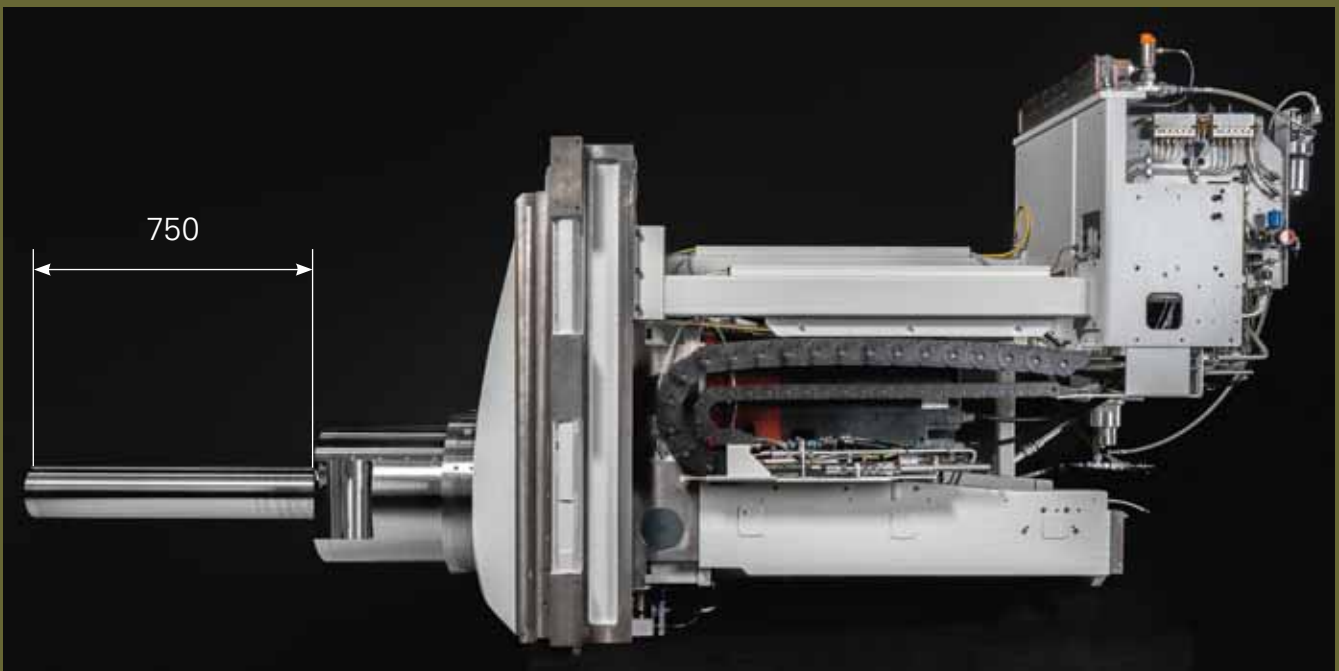
quill that can extend the tool 750 mm beyond the edge of the pallet into the workpiece. This proved to be a successful model that was continuously improved in the following years – for example, with thicker walls and a water-cooled motor that enabled spindle power to be increased to 82 kW (S6). Due to internal and external cooling, the speed could be increased to a maximum of 5,000 rpm. The 125 mm quill also received a water-cooled motor, boasting 53 kW of power and a speed of up to 4,000 rpm.

Successful application in heavy machining

Eckardt Vogel, application technologist and quotation project manager, explains that large gear manufacturing has remained an important area of application to this day: “Our quill machining centres are still purchased for classic gearboxes for tractors, agricultural tractors and other agricultural vehicles as well as

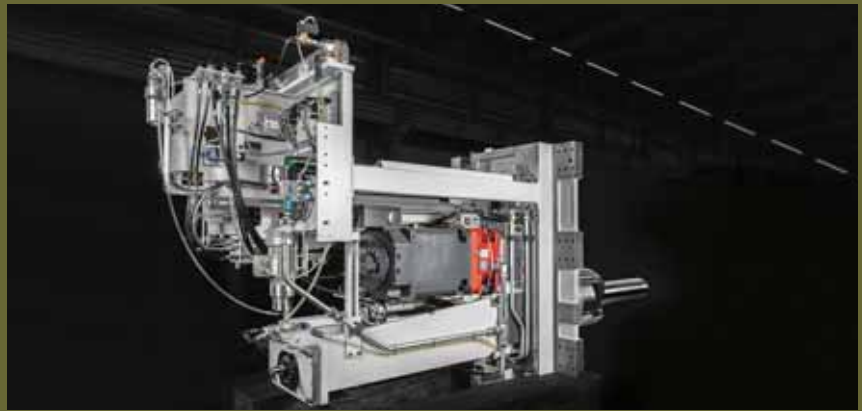
for stepped gearboxes in construction machinery, for planetary gear carriers and conventional gearboxes in wind turbines. However, we also supply manufacturers of gearboxes for mixing plants in the process industry and for flow bodies in the chemical industry. A niche application has also developed in electrical engineering. This involves boring out stator housings for heavy electric motors, as required in the power-generating industry.” In almost all cases, this involves heavy machining of various types of cast iron as well as high-alloy steels.

The success of quill technology is based on the fact that there is virtually no competitive alternative, either economically or technically. Eckardt Vogel explains the tooling problem for machining centres without a quill in detail: “To reach the inner areas of a gearbox housing, tools with a long projection length are needed that tend to vibrate considerably. They must be vibration-damped, finely balanced and equipped with all kinds of



refinements in order to achieve acceptable concentricity." In addition, there are usually problems with the tool magazine and tool changer. This is because an exemplary cutter head tool with a 400 mm long shaft is extremely heavy and has a very large tilting moment. This means that a pick-up solution must be installed in the workroom. "That's not desirable either," the application technologist just knows: "Besides, you end up needing more than one tool – one for each depth and each attachment. This has a very unfavourable impact on manufacturing and, ultimately, unit costs."

In contrast, a quill gives the user a high level of flexibility. To a large extent, they can fall back on relatively inexpensive standard tools. A second effect of the two Heckert quills is that due to their low-backlash sliding guide, they have a strong vibration-damping effect, which



Classic application: Machining the bearing surfaces of an angular gearbox housing.

"I know customers who report a payback on their quill within a year."

Carsten Bergmann, Product Manager Heckert

makes higher cutting values possible, increases process reliability and produces better surfaces.

Sophisticated design and monitoring

The features of the Heckert quills are largely identical to those of the otherwise normal spindles. Both offer the HSK-A100 or SK50/BT50 tooling interfaces, which are also available with a face contact. The quill is designed for internal coolant supply at up to 80 bar. "This is an important factor," emphasises test workshop manager Klaus Frost. "Because with internal machining, the coolant is not supplied to the cutting edge of the tool externally."

Beate Göbel, the designer responsible for the 125 mm quill, explains further design details: "We introduce motor

speed and power into the quill spindle via a drive free of lateral forces. We also put a great deal of technical effort into the bearing. The 125 mm quill, for example, is equipped with a 170 mm diameter angular contact ball bearing lubricated for life. The 150 version contains an oil/air-lubricated angular contact ball bearing with a diameter of 200 mm. And we offer work spindle diagnostics for the quills, as is common with our other spindles, but expanded to include additional quill-specific bearings." In addition to the bearings, the following conditions are monitored: Spindle imbalance, vibration during machining and impact. The data is stored in the evaluation device and can be read out and visualised via evaluation software.

That still leaves the question of cost. According to Carsten Bergmann,

Product Manager Heckert, the quill support will set you back 120,000 euros more – taking a Heckert HEC 630 as an example. However, he emphasises that the investment is definitely worth it when you consider the possibilities that it opens up, such as complete machining, the savings in tooling costs and the benefits in terms of productivity and unit costs. Carsten Bergmann provides assurance, saying "I know customers who report a payback on their quill within a year."

For all interested parties, the Product Manager points out that the new H series is currently being upgraded at the Starrag plant in Chemnitz to include the Heckert H95 and H105 models: "The Heckert H95 will replace the previous compact machine Heckert HEC 800. We will present this machine at EMO 2023 equipped with a 125 mm quill." ▀



In 1921, under the direction of Fernand Turrettini, the Managing Director of SIP, the MP4 jig boring machine was created and was considered a very important piece of work: with the extreme rigidity of the portal frame and its precise slide rails, it set standards about a century ago that the company still uses as a guide.

Precision as a sole focus

160 years of the Société Genevoise d'Instruments de Physique (SIP)

Auguste de la Rive and Marc Thury from Geneva had no knowledge of control electronics, artificial intelligence or computers. Nevertheless, 160 years ago, when they founded the Société Genevoise d'Instruments de Physique (SIP), the scholars and scientists dared to do something unimaginable at the time: build scientific instruments that could measure accurately to hundredths of a millimetre. The company, which is now a Starrag subsidiary, entered the global machine business in 1921 with the introduction of their "Machine à Pointer" jig boring machine, which, according to Wikipedia, was not only the world's first mass-produced machine tool, but also the first production machine capable of boring to micrometre accuracy.

"SIP has lived precision since the very beginning," says Jean-Daniel Isoz, Managing Director of the Ultra Precision Machining Centers Business Unit at Starrag, looking back. From the very beginning, a special role was played by botany professor and physics teacher Thury, who developed many instruments and apparatuses that were already capable of measuring to an accuracy of ten micrometers. As early as 1865, a dividing machine was created that precisely subdivided measuring rulers to within a few micrometers.

Shortly thereafter, the young company presented a special masterpiece at the World Fair in Paris: a telescope with a high-precision clockwork drive that moved parallel to the Earth's axis of rotation and thus made it possible to

track the path of a star. This innovation from Geneva caused a sensation in the French capital, and de la Rive and Thury received a medal for this mechanical masterpiece.

Precision work with a rare copy of the standard metre

Proud of their medal, the scientists return from Paris to produce tachometres, water motors, gas ovens, refrigeration machines, electricity metres and precision rulers with the same meticulousness. But the two scholars made a name for themselves with high-precision apparatus and instruments. In 1899, de la Rive and Thury were awarded one of the twelve platinum-iridium copies of the third version of the standard metre for their

precision work, which was usually only granted to state calibration institutes.

Thus exclusively equipped, over the next few years the Geneva-based company took their next steps in the field of high-precision: its achievements in precision are in demand, for example, by the Swiss Navy, for which a gigantic artillery target is being built. But SIP became famous in 1921 with the introduction of the "machine à pointer" jig boring machine, which, according to Wikipedia, was the world's first machine tool to go into series production. Its Technical Director, Fernand Turrettini, described it as a "grand oeuvre"; an important piece of work for SIP. With the extreme rigidity of the portal frame and its precise slide rails, it set standards around a century

ago that the company still follows. At the heart of this is a departure in machine production from the empirical process that was customary up to that point. Turrettini transferred the principles of scientific metrology to industrial production without compromising the precision in any way.

Jig boring machine: first mass-produced and most precise machine tool in the world

In keeping with the tradition of the famous watchmaking factories in his hometown, Turrettini relied on manual labor. Without compromising on manufacturing costs, he has specially trained experts scrape all the machine elements that are essential for precision - from the machine bed, linear guideways and ball screws to the spindle heads and axes. This elaborate manual work and the precise assembly of all the elements is possible thanks to the 1921 launch of the jig boring machine. According to Wikipedia, was the first production machine that was capable of drilling to the micrometre.

"The quest for precision requires practical know-how and theoretical knowledge."

SIP-100th Anniversary publication

But even in the age of electronics, SIP has maintained their century-long focus on mechanical accuracy; a primary reason for the "long-term accuracy" of machines from this manufacturer of precision machine tools, which is now a subsidiary of the Swiss Starrag Group. "If the geometry of a machine deteriorates over time because of changes in the tensile stresses created during assembly, then no amount of laser measurement accuracy will benefit a user," explains Jean-Daniel Isoz, Managing Director of the Ultra Precision Machining Centers Business Unit at Starrag. "Only when we have achieved the perfect geometry we do worry about compensating

for the last few micrometres with electronics, for example."

The Machine à Pointer was so well received, especially because of its "long-term accuracy," that by its 100th anniversary in 1962 SIP had been able to sell 6,000 ultra-precise drilling machines with the abbreviation MP worldwide. The company remains loyal to precision through solid mechanics at its new site in Vuadens in the Swiss canton of Fribourg. "Our predecessors developed the constructive basis for mechanical design in the 1920s, which still proves to be the best way for high-precision engineering," Managing Director Jean-Daniel Isoz notes in retrospect. "That's why senior mechanical engineers keep telling us 'If you want to continue to offer top precision, please don't change anything!'"

Geneva honors SIP with exhibition

However, the city of Geneva is also proud of the former metrology manufactory. In 2005, the Geneva Office of Cultural Heritage and Sites honored the technical



Recognising the importance of Geneva as the place where SIP was founded, Starrag also revived an old logo from 1915. Geneva is represented by a stylised G that encloses SIP.



The Geneva-based company developed an artillery sighting device for the Swiss Navy.



SIP 7000 jig boring machine inclusive palletiser unit.

“We manufacture very precise machines because it is a passion for us. Yes, we are proud of it.”

Adriano Della Vecchia, Head of Product Line SIP



Ford's Detroit plant (1930). The car manufacturer was the largest customer at the time.

and industrial heritage of an important company to which many Geneva residents still have a positive emotional attachment with the exhibition “SIP, from microscope to machine tool” at the Museum of the History of Science. The importance of Geneva for SIP was also recognised by Starrag a year later: after the takeover in 2006, the new owner revived an almost century-old logo, with a stylised G for Geneva once again enclosing the SIP lettering.

The company's founders would certainly be proud of the fact that SIP machines now rank as top products for the very highest quality standards within the Group's portfolio. Indeed, the spirit of

the famous watchmaking metropolis of Geneva lives on after the relocation to the new Vuadens site in the Swiss canton of Fribourg, where Starrag Vuadens SA has been manufacturing the Bumotec and SIP product ranges since 2017.

Within the portfolio of the entire Starrag Group, both product ranges are among the top products for the very highest quality demands, yet it is not just the many years of expertise of the SIP team that is important. Adriano Della Vecchia, Head of Product Line SIP: “We manufacture very precise machines because it is a passion for us. Yes, we are proud of it.”

Listening to customers' needs for 50 years



Founded in 1973, Bumotec SA specialises in the development and manufacture of machine-tools dedicated to the complete machining of high precision micromechanical components. Since its creation, Bumotec has focused on the watchmaking market and the luxury goods industry, offering machine-tools adapted to the increasingly stringent requirements of these markets. Now celebrating 50 years of expertise, the Fribourg-based company was acquired in 2012 by the Starrag Group.



Starrag in Vuadens, production site of the Bumotec and SIP product ranges.



View of the Starrag production hall in Vuadens where the 191 series is produced.

Samuel Boschung, Head of Production at Starrag Vuadens SA.



“The key to our success has always been our ability to fully understand our customers’ needs.”

Under the name Starrag Vuadens, and based in the Swiss municipality of the same name since 2016, the entity brings together two flagships of the Swiss machine-tool industry. At opposite ends of the spectrum, Bumotec, the micro-machining specialist, rubs shoulders with SIP, an expert in ultra-high precision mechanics. However, these two historical manufacturers share the same philosophy, the quest for the last few microns thanks to manually scraped surfaces, SIP’s field of expertise for 160 years.

With the introduction of the Bumotec 191^{neo}, the latest evolution of the range’s flagship ‘s191’ model, Bumotec is setting a new milestone in terms of versatility. The path taken by Bumotec over 50 years, from a dozen employees when the company was founded to the two hundred that make up the company today, has its origins in the excellent relations that its founder had with the players in the watchmaking market. This proximity to the watchmaking world played a pivotal role in forging the DNA of the product range, ensuring it listened to its customers’ needs in order to offer specific machines perfectly adapted to the production of watch components.

Nevertheless, it was a bold gamble to start manufacturing highly specialised machines.

Jean-Daniel Isoz, Managing Director of the Ultra Precision Machining Centers business unit at Starrag Vuadens, explains how this balancing act was brilliantly executed by Bumotec.

“In the early decades of Bumotec, a large number of different machines were developed. They were adapted to certain profiles of watch parts, such as cases, bracelets and clasps. Manufacturing specialised machines are more risky



Bumotec S-92XL, 3- to 5-axis CNC in single- or multi-spindle configuration, produced in the early 1990s.

without the security of mass series production. The economic risk is higher, but our predecessors had done very well. To mitigate this risk, there have always been a few bestsellers in our portfolio. The key to our success has always been our ability to fully understand our customers’ needs, which has led us to develop specific solutions. There is no better machine than the one adapted to the real needs of our customers, and we were naturally inclined towards the watch industry due to our geographical location and the network build by our founder. Today we strive to produce machines that are increasingly versatile whenever possible. To achieve this, we have focused on a portfolio of parts rather than a single type of part when developing our new machines. This allows us to offer more economical machines and facilitates after-sales service. This approach has also opened up new markets for us, such as medtech, aeronautics, and all micromechanics besides the luxury goods, because the machining challenges for these players are relatively

similar to those of the luxury goods industry, which remains the core of our business. Thanks to Starrag, we have a strongly developed distribution network overseas. This has been essential to adapt to all customer needs and to overcome the language barrier in sales and after-sales services. This is another key to Bumotec's success as it is recognised within the industry and the rising reputation proves this fact. We spend a lot of time talking with our customers so ensure we can offer them a machine perfectly adapted to their needs. It is a win-win partnership, and that is the only way to move forward. The next challenges we are facing concern the digitalisation of the industrial environment, but our main priority will be reducing the environmental impact of our machines. We are working to reduce our carbon footprint during production, in particular thanks

to our factory's equipment, heat pump, deep geothermal probes and the 8,300 m² of solar panels on the building's roof. Issues relating to the supply chain and the many parties involved is another area we are currently working on. Our ongoing initiatives include the elimination of paper use by introducing digital brochures and going more and more remotely (training, technical project sessions, troubleshooting, etc.)."

LEAN transformation and how to make your company sustainable

Bumotec has been experiencing strong growth for several years now while the machines constantly increase their innovation. One of the major challenges was the implementation of a LEAN production line. This is nothing new and applied by many companies, but it becomes complex



Bumotec 191^{neo}: Precision at every stage of its production.

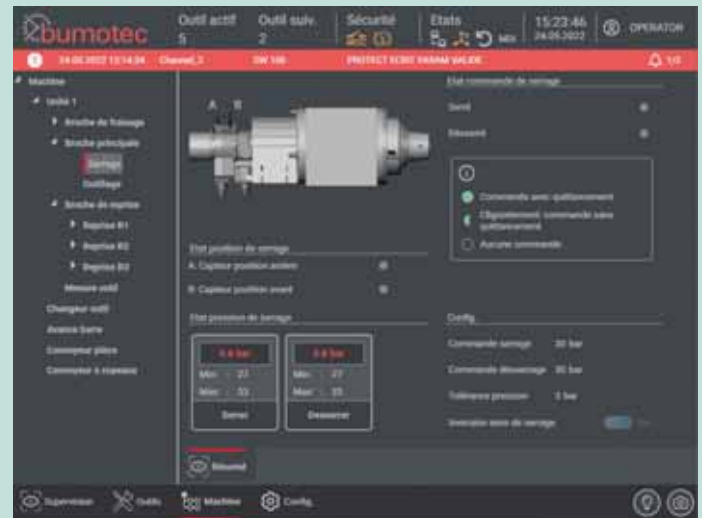
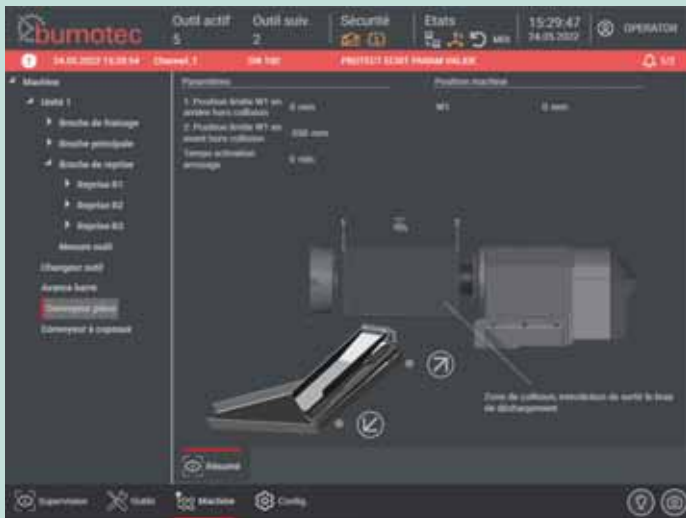


The new Bumotec 191^{neo} machining centre equipped with the latest generation HMI.

quite quickly when manufacturing highly customised machines. Despite these difficulties, and with the help of an external consultant, Bumotec successfully made the transition to LEAN production.

Samuel Boschung, Head of Production at Starrag Vuadens, looks back on this development, which began in 2014 and was fully implemented at the new production site in Vuadens.

"Our objective was to create a layout compatible with the new flows we wanted to implement at our new plant in Vuadens. Before, we used to work to order and each machine became a specific job. There was no standardisation. We couldn't find a common ground to standardise our assembly line because of the specifications of each machine. To solve this problem, we analysed the different tasks, which allowed us to "split up" the machines by station:



Easy to use, the new human/machine interface simplifies the configuration of data parameters in production, and also facilitates the training of operators.

machine base, peripherals and customer-specific features. The results of this study allowed us to identify common threads in order to implement strategies that could save us time. But we also needed to keep enough flexibility for our customers and their customisations during the built process. To structure our new factory, we divided our floor in several marked areas and we had already defined the functioning of the store. Afterwards, the implementation of the production line followed naturally by setting up specific workstations with immediate great success. This is a new way of working that has saved us a lot of lead time. This success encouraged us to deploy this philosophy also on other machines than the 191. We then focused on phases 2 and 3 of our LEAN transition. Reducing waste, decreasing non-value-added time, setting up employees on the stations, these were all essential steps to gain time and increase efficiency. We have also introduced a procedure to create instructions

for each machine. Things have also changed at management level. We have set up an SIM (Short Interval Management) initiative. Each department has a contact person who meets with the employees every morning at a fixed time to review the situation in order to provide information as quickly as possible. We are extremely satisfied with the results: for the s191 we have saved between 15–20% on lead time, and up to 35% for the 191^{neo}! The substantial common ground of the 191^{neo} allows us to manufacture this machine without customer orders, stock it and then customise it for future buyers within 6 to 8 weeks. It is a real change to the way we produce. It is quite a radical shift and requires a real strategy. In 2016, we employed about 30 mechanics and 15 electricians, which has now increased to 50 mechanics and 27 automation specialists. We have almost doubled our workforce!"

For half a century, Bumotec has been able to stand out from its competitors

"For the s191 we have saved between 15–20% on lead time, and up to 35% for the 191^{neo}!"

Samuel Boschung,
Head of Production
at Starrag Vuadens

without being confined to a niche market. Bumotec's ability to listen carefully to its customers has enabled it to always offer the machine best suited to a specific type of need. Throughout its history, the company has seized the opportunities to develop innovative, high-performance machines. From the beginning to today, Bumotec machines have spread to many markets, starting, of course, with the luxury industry, but now including many others, all won over by the added value they bring. ▀



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