



WITTENSTEIN

move

The magazine for customers and partners of WITTENSTEIN SE

# Make the impossible possible

Galaxie® is superior on principle

New opportunities for high performance engineering

# move

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Dear readers,

The Galaxie® train is rolling – this is the unanimous opinion among experts in universities and industry. And many of them go a step further: it's high time for machine builders to hop on board if they don't want to be left standing by the way at the station of high technology. Three years on from the spectacular premiere at the Hannover Messe 2015, the Galaxie® Drive System is meanwhile regarded as a basic technology which enables two key sectors of the German economy – engineering and automobiles – to make the next developmental advance in terms of precision, energy consumption and material use. Our motto for this year's Hannover Messe sums it all up very neatly: "Make the impossible possible. Galaxie® – superior on principle".

To return to my original analogy, the train is rapidly picking up speed. Based on our experience during the recently completed market maturity phase, we have now laid the foundation for the establishment of a modular Galaxie® portfolio, which will pave the way for new applications with special performance or installation requirements with different designs and variants. Among other things, the exhibits at our stand F10 in Hall 15 will focus on the use and benefits of Galaxie® in machine tools,

cutting heads and robot welding guns. Moreover, for the first time, WITTENSTEIN will show how operating data can be transmitted to an IoT cloud using a Galaxie® Drive System equipped with sensors.

As co-founder and former Managing Director of WITTENSTEIN subsidiary attocube systems AG, I am obviously particularly pleased to have two exciting news items to report from Munich. First, the company will move into the new NanoFactory mid-way through the year and second, on pages 22 and 23 of this issue we celebrate exactly twelve months since the market launch of a breakthrough industrial application for the IDS3010 Industrial Displacement Sensor – as the "technological core" of an interferometric calibration system from Etalon AG.

Dr. Dirk Haft

The WITTENSTEIN SE Management Board

# GALAXIE®

SUPERIOR ON PRINCIPLE

The Galaxie® DF  
has an ultra-flat, space  
saving design

## Galaxie®: New designs for new applications

From the outset, the Galaxie® Drive System has set a new benchmark with performance features that were previously unattainable. The technological superiority of the Galaxie® principle has been proven in numerous applications over the last few years. Not surprisingly, customers regularly approach us with ideas for new uses. WITTENSTEIN has now responded to this need with a modular system concept and new designs that open up yet more innovative applications for Galaxie®.

Our experience during the last three years – with several hundred gearboxes and drive systems meanwhile in operation – confirms that the performance data in the original Galaxie® specification has not only been achieved but exceeded by a large margin. “On top of that, countless applications have shown that with its low wear, this Drive System also sets benchmarks when it comes to reliability,” says Nadine Hehn, a sales engineer in WITTENSTEIN’s Startup Galaxie team.

### Versatility embedded in the “Galaxie® DNA”

Furthermore, during the run-up to full-scale production since the market launch in 2015, the foundation was laid for the establishment of a modular Galaxie® portfolio, which with five different sizes and four variants will pave the way for new applications with special performance or installation requirements. The Galaxie® D (D = drive) Drive System is a mechatronic unit comprised of a specially developed, high performance synchronous motor and a Galaxie® gearbox.



It was the desire expressed by some customers to just use the hollow-shaft gearbox and integrate it into their own motor unit or servo motor which led to the Galaxie® G (G = gear) as a mounted version for servo motors. It also became apparent that there would be good justification for a right-angle version of the gearbox – and the Galaxie® GH (GH = gear hypoid) was born. “Flexibility and versatility, and hence openness to new requirements, have been a part of the Galaxie® DNA from the start,” adds Bastian Minke, he too a Startup Galaxie sales engineer.

### New Galaxie® variants at the Hannover Messe 2018

The new Galaxie® D Drive System in size 085, which will be unveiled at the Hannover Messe 2018, is further evidence of this application oriented modularity. It is designed for use in axes with very high compactness and precision requirements or for applications where high torsional rigidity and freedom from backlash are called for in addition

## Drive system transmits operating data

### The Galaxie® D Drive System

is a compact mechatronic unit comprised of a special permanent magnet, high performance synchronous motor and a Galaxie® gearbox



to torque. “Compared to a strain wave gearbox with the same torque, this Galaxie® Drive System delivers more than double the maximum output speed and almost three times better torsional rigidity,” Nadine Hehn explains. On the one hand, the size 085 Galaxie® D enables new applications for the machine tool industry in this way while on the other, it creates opportunities in new fields such as automotive machinery, handling systems or material removal robots.

The Galaxie® DF Drive System is another new variant in the product family. The “F” stands for “flat” – and an up to 30 percent reduction in length compared to the Galaxie® D. Bastian Minke reveals how this was achieved: “This space saving is possible because the motor is positioned radially around the gearbox rather than axially behind it.” “Superior on principle means users will not have to forego the familiar performance features of the “big brother” – like the high torque density, zero backlash kinematics and low wear behavior – with either of the 110 and 135 sizes which are initially available. Milling machines are among the applications to profit from the

At the Hannover Messe 2018, WITTENSTEIN will show for the first time how operating data can be transmitted to an IoT cloud using a Galaxie® Drive System equipped with sensors. This data can in future be accessed anywhere and on any device throughout the drive lifecycle, regardless of the control system.

Galaxie® DF’s extraordinary compactness: their cutting heads are also more compact as a result, enabling even narrower contours and 3D shapes to be machined.

### Production and organization tailored to fast delivery

The modular portfolio and multiple designs allow Galaxie® to expand the mechatronic solution space in numerous use scenarios. More and more machine manufacturers are recognizing how the Galaxie® portfolio enhances the performance of high-tech machines, creates perspectives for new machine generations – and gives users a technology lead. “That’s why we didn’t simply build up a modern production base with high performance precision machines; we also designed the processes within the startup organization so that short lines of communication and tolerable delivery times are guaranteed,” says Volker Sprenger, Startup Manager Galaxie.

### Superior on principle

Instant added value without long waiting times – Galaxie® proves that this does not mean squaring the circle. This is all the more important in that Galaxie® causes many high performance machines to be completely “reinvented”, putting their manufacturers even further into the lead. All of this is possible because Galaxie® has meanwhile gained general acceptance among scientists as an independent generation which is superior on principle.

Find out more: [www.wittenstein-galaxie.com](http://www.wittenstein-galaxie.com)



Top aircraft manufacturers put their trust in Electroimpact's high performance machines featuring the Galaxie® Drive System.

**Precision**  
in flight

**Galaxie®**



The manufacture of composites for the aerospace industry presents some very daunting challenges involving complex, automated production steps where absolute precision and repeatability are vital. Electroimpact, a world leader in aerospace tooling and automation headquartered in a suburb of Seattle (USA), trusts in WITTENSTEIN SE's torsionally stiff and completely backlash-free Galaxie® gearbox for exactly this reason.

With its unique combination of intense precision abilities in a compact space, Galaxie® delivers next-generation performance for engineering efforts by Electroimpact – with aircraft manufacturer Boeing just one of those to reap the benefits.

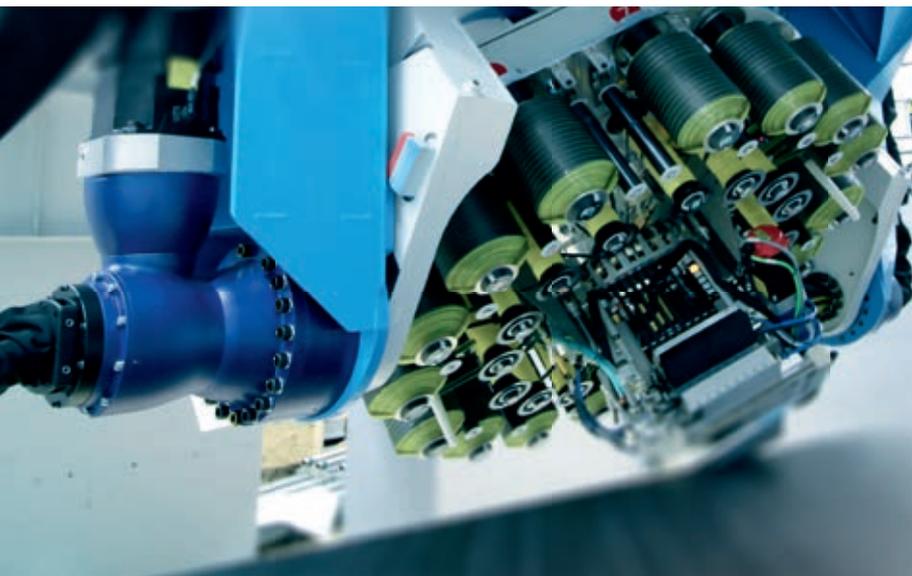
#### **New machine generation for the wing panels of the Boeing 777X**

Four Automated Fiber Placement (AFP) machines designed by Electroimpact representing the latest state of the art are used for the development and serial production of the future Boeing 777X wing panels and wing spars at the Boeing facility only a few miles away. Only one step is required – as opposed to three in the past – to make the forward and rear wing spars, which are up to 33.5 meters long. A robot head weighing about 0.5 tons is integrated in a mobile gantry structure 6 meters wide for this purpose. It applies several

hundred layers of epoxy resin-impregnated carbon fiber strips and sheets to the basic structures with absolute precision. After applying one sheet, the robot head does a 180° turn, positions itself anew and applies the next sheet in the opposite direction. The AFP machine for the wing spars is additionally capable of swiveling the robot head through  $\pm 90^\circ$  with the necessary dynamics, so that the U-shaped spar structures can be made in a single operation.

#### **Galaxie®: Enabler for the new AFP composite manufacturing technology**

The special kinematic precision and repeatability of the mobile gantry structure and the robot head which can be swiveled through any angle are the key to the high productivity now achieved in the aircraft part production process. The WITTENSTEIN-built Galaxie® was welcomed by Electroimpact's engineers as a gearbox solution which, owing to its special design with separate thrust tooth kinematics, meets the high technical demands of the AFP machines in every respect. Galaxie®'s crucial benefits are its high torsional rigidity and complete freedom from backlash, enabling ultra-precise positioning at each direction reversal of the gantry and robot head during the application processes. Zero backlash can be realized throughout the drive system's entire lifetime through selective inner tensioning and the build-up of a hydrodynamic lubrication film during surface contact. On top of this, the compact design permits more flexible motion control for use in the swivel axes. For the first time, Galaxie® allows highly complex composite aircraft parts to be manufactured efficiently in one piece with the required precision – successfully underlining its claim to be the "Next Technology Drive" for high performance engineering efforts by Electroimpact.



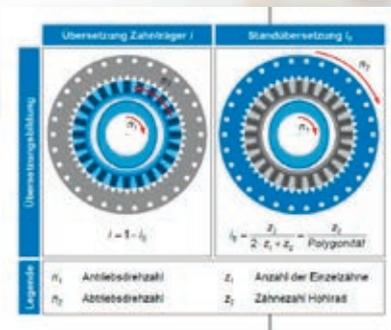
A robot head weighing about 0.5 tons and integrated in a mobile gantry structure six meters wide applies several hundred layers of epoxy resin-impregnated carbon fiber strips and sheets to the basic structures with absolute precision. After applying one sheet, the robot head does a 180° turn, positions itself anew and applies the next sheet in the opposite direction.

**Electroimpact –**  
the largest integrator of  
aircraft assembly lines in  
the world

Electroimpact is an established world leader in the design and manufacturing of aerospace tooling and automation. The company's wide range of projects include complete automation assembly systems for commercial aircraft wings, riveting machines with tools for wing panel and fuselage assembly, advanced fiber placement machines, robotic assembly systems, and spacecraft handling equipment. The customer base includes Airbus, Boeing, Bombardier, Embraer, Kawasaki Heavy Industries, Mitsubishi Heavy Industries, Fuji Heavy Industries, Spirit Aerosystems, Vought, Northrop-Grumman, Israeli Aircraft Industries, Xi'an Aircraft of China, NASA and GE among others.

# Galaxie® - Superior on principle

“The new gearbox generation” – this is how it was referred to in umpteen publications back in 2015, when the Galaxie® Drive System was launched at the Hannover Messe and honored with the Hermes Award. What we at WITTENSTEIN knew all along is now also a recognized fact in the scientific community: the first academic textbook testifying to Galaxie® as a new and independent gearbox generation is due to appear at the end of the year.



The textbook **Machine tools and manufacturing systems 3: Mechatronic systems, controls and automation** will be edited by Professors Christian Brecher and Manfred Weck of the Department of Machine Tools at RWTH Aachen University. The left diagram of the Galaxie® operating principle is taken from the textbook's ninth edition, which will be published at the end of the year.

It's an undisputed truth: Galaxie® is superior on principle. Several decisive features – dynamic teeth instead of rigid gear wheels, hydrodynamic tooth contact over the full surface and a new type of bearing with a segmented outer race ring – mean that Galaxie® is clearly superior to other, established principles in all key technical disciplines when measured against the market standard. Galaxie® provides exceptional freedom from backlash, synchronous running, stiffness and torque density – all at once and with no structural or design compromises. This is no exaggeration – it's a scientifically proven fact which has been confirmed in numerous real applications.

### Logarithmic spiral as the basis for scientific reasoning

The “International Conference on Gears”, hosted by the Institute of Machine Elements / Gear Research Centre (FZG) at TU Munich in September 2017, is the world's most important academic conference for gear and transmission development, with more than

700 participants. Also on the agenda were two presentations, reviewed and approved by professors, on the Galaxie® system – which demonstrated the Galaxie®'s status as a new gearbox generation by scientific abstraction.

“The underlying scientific reasoning was that Galaxie® introduced the mathematical function known as the logarithmic spiral as a fundamentally new principle in gear unit design,” explains Thomas Bayer, inventor of Galaxie® and today Manager Innovation Lab at WITTENSTEIN. “The toothing takes the form of an input polygon, around which the individual teeth are grouped, leading to full-surface contact and mathematically precise synchronous running.” In the meantime, both the theoretical functionality of Galaxie® and its technical performance features and benefits have become generally accepted in the scientific community. This is reflected, for example, by the inclusion of the new gearbox generation in standard reference works for research and teaching – like the ninth edition of “Werkzeugmaschinen Fertigungssysteme 3: Mechatronische Systeme, Steuerungstechnik

»I would definitely class the Galaxie® gearbox as a revolutionary innovation.«

PROFESSOR KARSTEN STAHL



und Automatisierung” (Machine tools and manufacturing systems 3: Mechatronic systems, controls and automation), edited by Professors Christian Brecher and Manfred Weck of the Department of Machine Tools at RWTH Aachen University. A separate chapter dedicated to the Galaxie® gearbox will describe the design, operating principle and key benefits of this new generation.

Technological superiority confirmed by the **“Galaxie® community”**

Yet a “Galaxie® community” of enthusiasts, who have praised the new gearbox generation as a “milestone in engineering” in various publications and presentations, emerged among businesses and industry associations even before scientific proof was established. The German Research Association for Power Transmission (FVA), whose basic research as well as insights gained from research projects – for instance on highly dynamic plain bearings – were adapted to the Galaxie® kinematics and leveraged for the development of the gearbox, is one such admirer. In its book “50 Jahre FVA: sharing, drives, innovation” (50 years of the FVA: Sharing, drives, innovation), the FVA mentions the WITTENSTEIN Galaxie® in the same breath as a long list of outstanding inventions of the modern era, on a par with the pioneering feats of Leonardo da Vinci, August Otto, Friedrich Fischer and Rudolf Diesel. The German Engineering Federation (VDMA), too, is a member of the “Galaxie® community” because leading companies in the industry – among them Profiroll Technologies, DMT Drehmaschinen, Broetje Automation, MAKAS Systems and NIMAK – trust in this innovative transmission and drive technology and have confirmed the new gearbox generation’s technological superiority in practice. It is therefore not surprising that experts are meanwhile predicting that the Galaxie® technology is on the verge of exponential market penetration – especially since WITTENSTEIN has established a modular product portfolio which will pave the way for new applications with special performance or installation requirements with different designs and variants.

Times are changing and Galaxie® will continue to make the impossible possible in the future – as a new generation, as a gearbox and as a drive system.

**Galaxie® – the ideal solution for robotic drives**

Professor Karsten Stahl is Head of the Institute of Machine Elements and the Gear Research Centre (FZG) at TU Munich.

*move: When did you first hear about Galaxie®? What thoughts and ideas occurred to you spontaneously?*

Professor Stahl: I first set eyes on the Galaxie® gearbox in Igersheim at the end of 2013. I was struck by the notion that a gearbox with such a totally different physical principle compared to established gear trains could have so many advantages.

*move: What, in your opinion, is the single most important differentiator of the new Galaxie® generation?*

Professor Stahl: I would say that the high stiffness is the outstanding feature. In contrast to gear drives, where the tangential force must be transmitted by a small number of Hertzian contacts, the Galaxie® gearbox has a large number of full-surface sliding contacts. Significantly higher rigidity can be achieved in this way due to the nature of the system.

*move: Exceptional freedom from backlash, synchronous running and stiffness all at once – what new solution concepts and applications does Galaxie® enable in the machine tool industry and beyond?*

Professor Stahl: The Galaxie® gearbox seems to me to be the ideal solution for robot drives, especially when very high stiffness is called for. I’m assuming that robots will play an increasingly key role in the machine tool sector, whether autonomous or collaborative. Robots with relatively low resilience can certainly score here in combination with ultra-stiff drives.

*move: Galaxie® introduced the logarithmic spiral as a brand new principle in gear unit design. How will this be implemented didactically and methodologically in academic teaching?*

Professor Stahl: The logarithmic spiral has not actually featured yet in lectures at the Institute of Machine Elements. It looks like a rethink will be necessary here, and our curriculum will need to cover the special characteristics and benefits not only of the involute but also of the logarithmic spiral.

*move: Evolutionary or revolutionary – which category, in your view, is a more apt description of this invention as a technological innovation?*

Professor Stahl: I would definitely class the Galaxie® gearbox as a revolutionary innovation. After all, it was developed making conscious use of creativity methods, the aim being to depart from traditional ways of thinking and explicitly seek alternative physical principles. I’m convinced that it would have been impossible otherwise to come up with a gearbox that is based on totally different principles from conventional gear drives, yet has characteristics which are clearly superior to those of a normal gear.

# Muy bien

premo servo actuator  
wins over Spanish supplier Zayer



The compact design of the cutting heads and the ability to rotate them up to 30° during the machining process are key features of Zayer's ARION bridge type milling machines.

The machine-tool manufacturing company, at home in Vitoria (northern Spain), opted for [WITTENSTEIN alpha's](#) space saving and power dense [premo servo actuators](#). Its verdict: "muy bien".

ARION supplements the larger and well-established TEBAS and NEOS bridge type milling machines as a separate series with a lower loading and milling capacity that is ideal for machining small parts. It was redesigned with a comparatively compact and space saving layout for this reason – and these same requirements also had to be met by the ARION's brand new cutting heads. The answer: the servo drives are integrated directly in the cutting heads. Size, power

density, modularity – it didn't take long for WITTENSTEIN alpha's premo servo actuators to be revealed as the optimum solution. All the more so because these motor-gearbox units allow the cutting heads to be continuously rotated through 30° while machining complex geometries – unprecedented among bridge type milling machines in the ARION's performance class.

#### **Sound advice and a modular system for the perfect design**

The ingenious modular system based on novel, space saving design principles and the efficient support from the engineers at WITTENSTEIN S.L.U., WITTENSTEIN's Spanish subsidiary, meant the perfect premo servo actuator configuration was achieved for the ARION's cutting heads. The ARION user's intended machining process plays an important role here: either the servo actuator "simply" has to execute a pure positioning motion or it must also slave the milling axis continuously. "In the former case, one premo servo actuator is installed per axis; it first of all positions the head precisely and then starts machining the workpiece," explains Luis Calleja, Manager



## WITTENSTEIN Spain

WITTENSTEIN S.L.U was established in Barcelona in November 2011. WITTENSTEIN's Spanish subsidiary and its Managing Director, Thorsten Weiß, are proud of the steady growth in sales – not to mention the payroll. Xabier Rodriguez, a 35 year-old engineer, is one of eight staff to work there at present. He serves northern Spain from the Sales Office in San Sebastian. That makes him a close neighbor of milling machine manufacturer Zayer, whose headquarters are only sixty miles or so away in Vitoria.

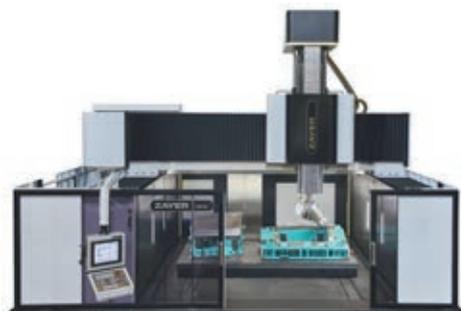
"Zayer is one of our key accounts and one of Spain's most innovative engineering companies," Xabier Rodriguez enthuses. "We've built up

a trusting and constructive partnership over the years, and each new project generally kicks off with us getting together to discuss the machine's design. As soon as the drive technology becomes a central issue during the development phase, Zayer gets in touch with us." In the meantime, WITTENSTEIN products are first choice for the Spanish supplier – in all axes, from the gearboxes through the servo actuators to the racks and couplings. The new ARION series of machines is the newest manifestation of this successful partnership.

### premo servo actuator: scalable for perfect performance

Dynamics, speed, positioning accuracy, output geometry, encoder design and degree of connectivity – the ingenious premo system allows motors and gearboxes to be configured modularly to obtain customized servo actuators with graduated performance characteristics tailored to the particular application.

**"premo base line"** – the basic class – provides optimum performance for all positioning tasks. **"premo advanced line"** – the dynamic class – guarantees high precision for special positioning tasks where higher dynamics and forces are called for. **"premo high line"** – the extra class as used in the Zayer ARION – convinces with high torques and torsional rigidity, leading to the very highest levels of productivity, precision and versatility.



The resulting functionality is crucial if the ARION is destined for highly mechanized applications like mold and die making – and equivalent to that offered by the NEOS, Zayer's larger model.

One premo servo actuator per axis positions the head precisely and then starts machining the workpiece.



Development at Zayer. "If the axis needs to be slaved, it is equipped with two premo actuators which are electrically preloaded with one another." The resulting functionality is crucial if the ARION is destined for highly mechanized applications like mold and die making – and equivalent to that offered by the TEBAS and NEOS, Zayer's larger models.

### Successful market launch

When ARION bridge type milling machines featuring premo servo actuators in the cutting heads were exhibited at a Spanish engineering show, the feedback was highly encouraging. "Eight of these machines were subsequently sold very quickly, and five more have since been put into operation by customers in the aeronautics and die manufacturing industries," says Luis Calleja, who is delighted with the successful market launch.

User experiences to date have been more than satisfactory – so that Zayer, too, has no hesitation in giving the premo actuators an altogether positive verdict: "muy bien".

## Zayer

### Cutting-edge technology from northern Spain

Based in Vitoria (Spain), Zayer employs around 150 people and is one of the world's leading manufacturers of high-tech bed type, moving column, gantry and bridge type milling machines.

Approximately 80% of Zayer's total milling and machining solutions are exported: they are used, among other things, to machine nose wheels, turbines and fuselage sections in the aeronautic industry, to manufacture platforms, hubs and rotors for wind energy, to make cross rails, bogies and structures for railways, to machine large components in the energy industry or in foundries and to build turbines for the hydroelectric sector.

### V-Drive Basic

haprotec GmbH was pursuing several goals when it launched the development of a new series of rotary converters for electronics production: the ability to adapt the conversion rate dynamically, the shortest possible cycle times and more accurate positioning. Those goals were achieved with the help of high performance V-Drive Basic worm gearboxes from WITTENSTEIN alpha.

## The dynamics of worms

The significantly better positioning accuracy and repeatability are largely due to the V-Drive Basic's special tooth geometry.

Rotary converters round off the haprotec portfolio of lifters and transfer systems, with which workpiece carriers or masks are supplied to the various placement, manufacturing and testing processes in electronics production. "In a combined rotation and conversion step, the product being conveyed – for example, a solder frame – is first of all separated ahead of the converter module, then pulled in by the drive unit in the rotary station, positioned, turned through 90° with a safe, vibration-free rotary motion and finally discharged again. Rotary converters that work on two levels – one for feeding and one for return – are particularly efficient here," explains Christian Happ, proprietor and CEO / General Manager of haprotec.

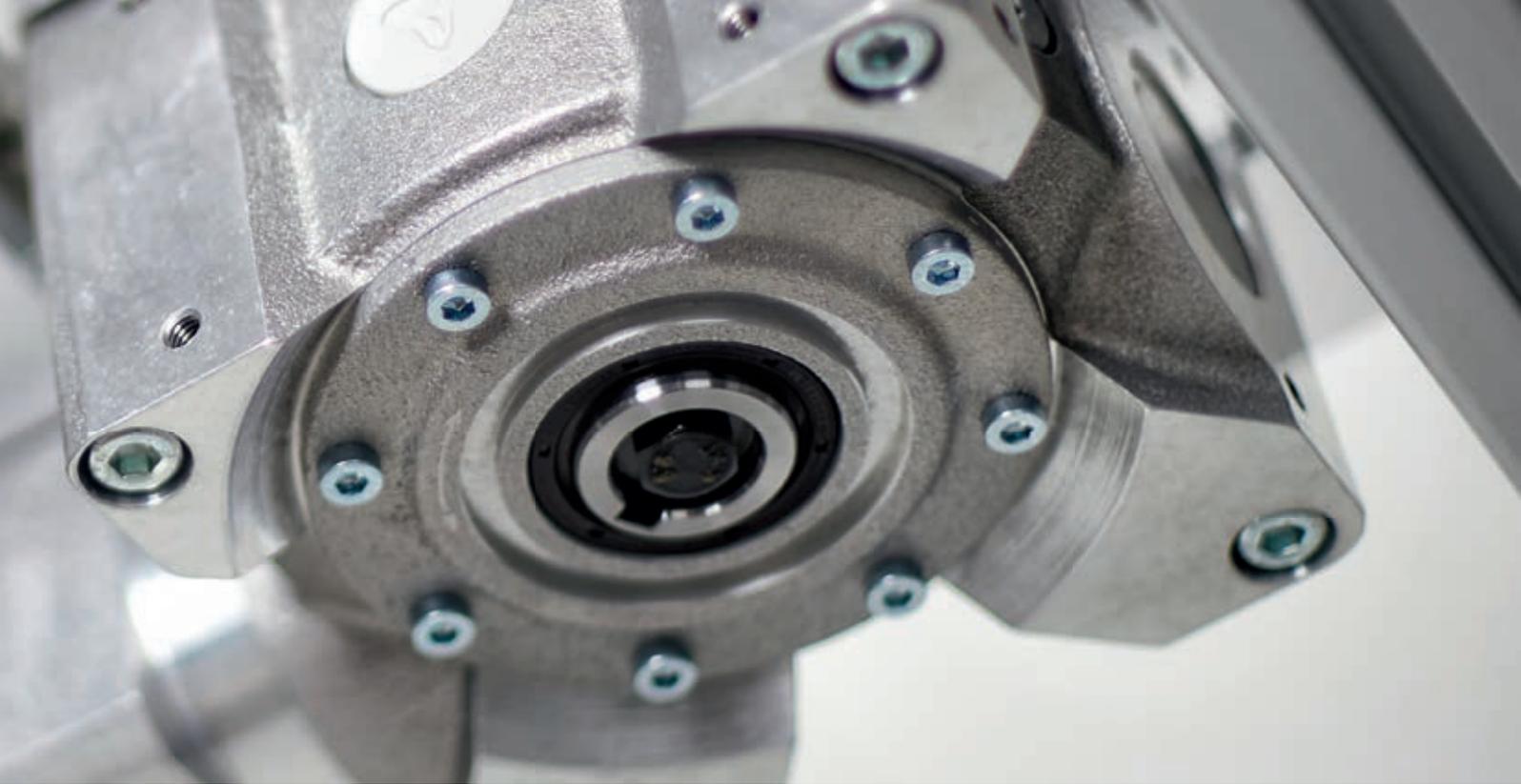
#### Special requirements for a new, dynamic rotary unit

The development specifications for a new rotary converter for workpiece carriers with a maximum overall weight of 15 kilos were absolutely clear: to further optimize the actual rotary motion – and hence the performance of the module as a whole. "We identified two possible ways to boost efficiency: to add dynamics to the rotary motion according to the workpiece and to increase the rapid speeds when the rotary unit is reset," recalls Holger Engelhart of haprotec's Electrical Design department. "We were hoping to achieve significantly shorter cycle times here – and correspondingly higher throughput."

The new drive solution had to fit into the enclosure such that the workpiece carriers could be returned on the bottom level – without altering the overall height and regardless of any third party system installed upstream. The close cooperation between his company as the manufacturer of the machine, Siemens as the motor and controller supplier and WITTENSTEIN alpha as the specialist for transmission technology resulted in a drive unit that meets all of the above requirements – and in some cases even exceeds them.

#### V-Drive Basic: Dynamics and positioning accuracy in a power dense package

Siemens chose a SIMOTICS S servo motor with a SINAMICS V90 converter for this task: this combination enables dynamic and accurate positioning of the new rotary converter as well as precise motion control. WITTENSTEIN alpha's V-Drive Basic worm gearbox provides all of these performance features for the rotary converter in the shaft version. The redesigned involute toothing of the worm is key here. The positioning accuracy of less than 15 arcmin which is specified for the V-Drive Basic and required by the application is permanently achieved by the dynamic rotary converter. "What is particularly interesting here – and of course positive too – is that even different rotational speeds have no noticeable impact on the precision of the



rotary motion,” says Holger Engelhart. Finally, thanks to the geometric design and manufacturing execution of the gearing, the V-Drive Basic additionally impresses with high torque reserves, so that the full power potential of the servo motor is unlocked for the rotary converter. In spite of all the dynamics the worm gearbox is acoustically very discreet, with a maximum of 65 dB (A) at full load and no more than 50 dB (A) at medium speeds.

#### Success all along the line

Christian Happ sums up: “The bottom line is that the new, dynamic rotary converter has acquired a high quality drive system combining altogether adequate positioning accuracy with excellent value for money”. “That’s why we also decided to use the drive package with the single-stage V-Drive Basic and a ratio of 40 for series production.”



Christian Happ (left), proprietor and CEO / General Manager of haprotec GmbH, shown here in conversation with Markus Kleinhenz of WITTENSTEIN, has also decided to use the drive package with the single-stage V-Drive Basic and a ratio of 40 for series production.



Rotary converters that work on two levels – one for feeding and one for return – are particularly efficient here.

## haprotec GmbH

Partner for automation systems and custom machine construction

haprotec GmbH of Kreuzwertheim, about 55 miles south-east of Frankfurt, currently employs around 30 people and has been working in the fields of automation systems and custom machine construction for 15 years now. Its core competencies comprise production lines for automotive components, fully and semi-automatic assembly cells and lines, optical and mechanical testing systems, handling solutions for medical technology, in-line and off-line systems for electronics production and the development of the necessary software.

Anyone who has ever attempted to screw a mobile phone open and then put it back together again will have no trouble imagining the kind of requirements that are specified for the automatic screwdriving systems used during the micro assembly of electronic items.

## Screwdriving made simple

STÖGER AUTOMATION, the screwdriving and fastening systems specialist, has come up with a groundbreaking screwdriving unit featuring highly dynamic small servo motors from the cyber® dynamic line family and high-resolution servo amplifiers belonging to the simco® drive series which sets benchmarks in terms of cycle times, automatic feeding of the fasteners and screwdriving quality. The space saving external dimensions and low mass of these industrial grade small servo motors on the one hand and the smart servo amplifiers, with their high switching frequency and exceptionally high current resolution, on the other were the crucial features identified by STÖGER AUTOMATION in this servo drive solution.

### Quick and easy handling of delicate screws

“To insert a screw two millimeters long, with a thread just one millimeter in diameter and a head two millimeters across, in under a second and then process it efficiently without using sensors to measure the torque – that was a really daunting challenge,” recalls Artur Kornelsen, a developer at STÖGER AUTOMATION. It was made even more difficult by the high process speed. “Cycle times of less than a second were stipulated, which meant the screws had to be fed as intelligently as possible,” says Lorenz Stöger, the company’s founder. “Feeding hoses were rejected due to the tiny screw size while pick & place would have been too slow – we therefore opted for a screwdriving system with two spindles, where one drive is responsible for the screwing process while the other makes the next screw available in parallel.” However, speed was only one aspect because the screws are delicate and have to be inserted very carefully; what’s more, the speed has to be reduced for tightening to ensure a secure connection. Finally, the two-spindle screwdriving system needed to be simple to adapt to different screwing scenarios with different screw sizes and types, thread lengths, torques and speeds.

**Screwdriving system with two spindles:** One drive is responsible for the screwing process while the other makes the next screw available.

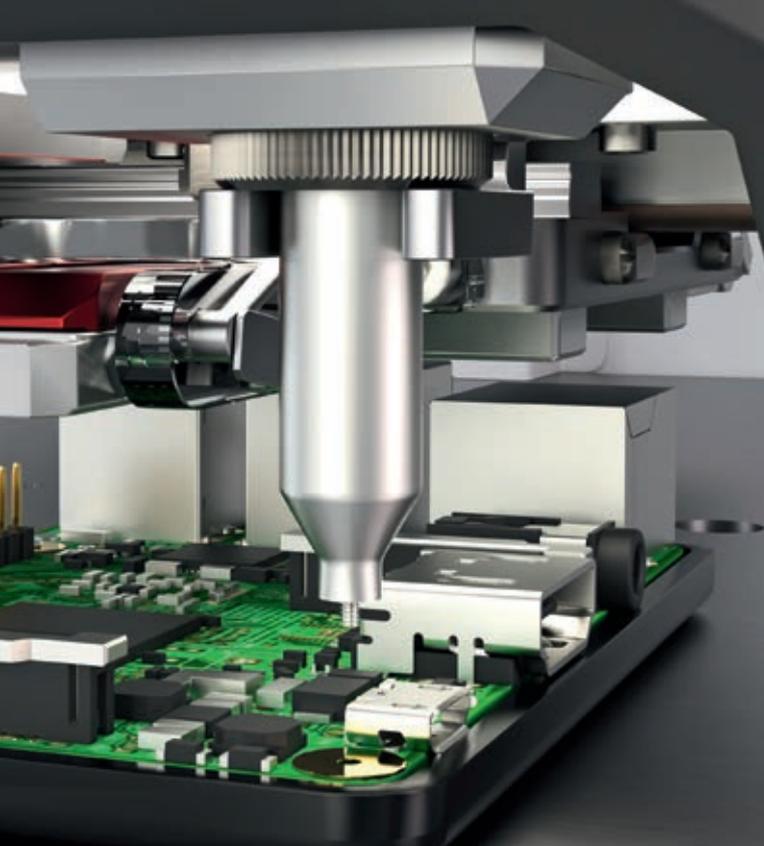


simco® drive  
cyber® dynamic line

### Servo technology enables high performance screwdriving system with two spindles

“Thanks to the small motors and servo amplifiers built by WITTENSTEIN cyber motor, we were able to develop a solution for supplying, inserting and tightening miniature screws with unprecedented efficiency, unlike anything ever seen before in the procurement markets of electronics manufacturers or other, similar users,” explains Artur Kornelsen. Out of the four small servo motors from the cyber® dynamic line family which are used in the screwdriving system, two are designed with an integral ball screw drive. As a highly precise solution for the Z axis, they position and guide the screw on the workpiece. The other two motors execute the rotary screwing movement. “The motors are distinguished by an excellent ratio of high torques to low motor weight,” adds Carolin Ank, Product Manager at WITTENSTEIN cyber motor. “Owing to the high dynamic factor, they’re just as suitable for rapid acceleration as they are for short movements with frequent changes of speed.”

Each motor is operated by a servo amplifier belonging to the simco® drive series, providing high-resolution current control in measuring



## STÖGER AUTOMATION

Leader for screwdriving and fastening systems

True to its own motto "Better than the rest", STÖGER AUTOMATION GmbH of Königsdorf (Bavaria, Germany) is the technology leader when it comes to developing and manufacturing highly efficient screwing solutions for workpieces. More than 8000 machines are currently used worldwide in various branches of industry – from handheld screwdrivers in standalone operation to complex, fully automatic and integration enabled systems with automated feeding of the fasteners for medium to high volume production.

### New cyber® dynamic line variants

#### Long-stroke variant

- Max. stroke length: 200 mm
- Available for all four sizes
- Mass inertia much lower than if the screw is simply attached to the servo motor
- Specifically optimized for high forces up to 2 kN
- Stainless steel housing with IP54 protection

#### Dynamic variant

- Max. travel speed: 900 mm/s
- Available for all four sizes
- Good alternative to pneumatic cylinders, even in extremely dynamic short-stroke applications
- Better, more reliable and more economically efficient machining processes
- Stainless steel housing with IP54 protection

All cyber® dynamic line variants are typically used for positioning, joining, bending, gripping and dispensing in reshaping and handling applications, the semiconductor industry, packaging machinery or assembly automation.

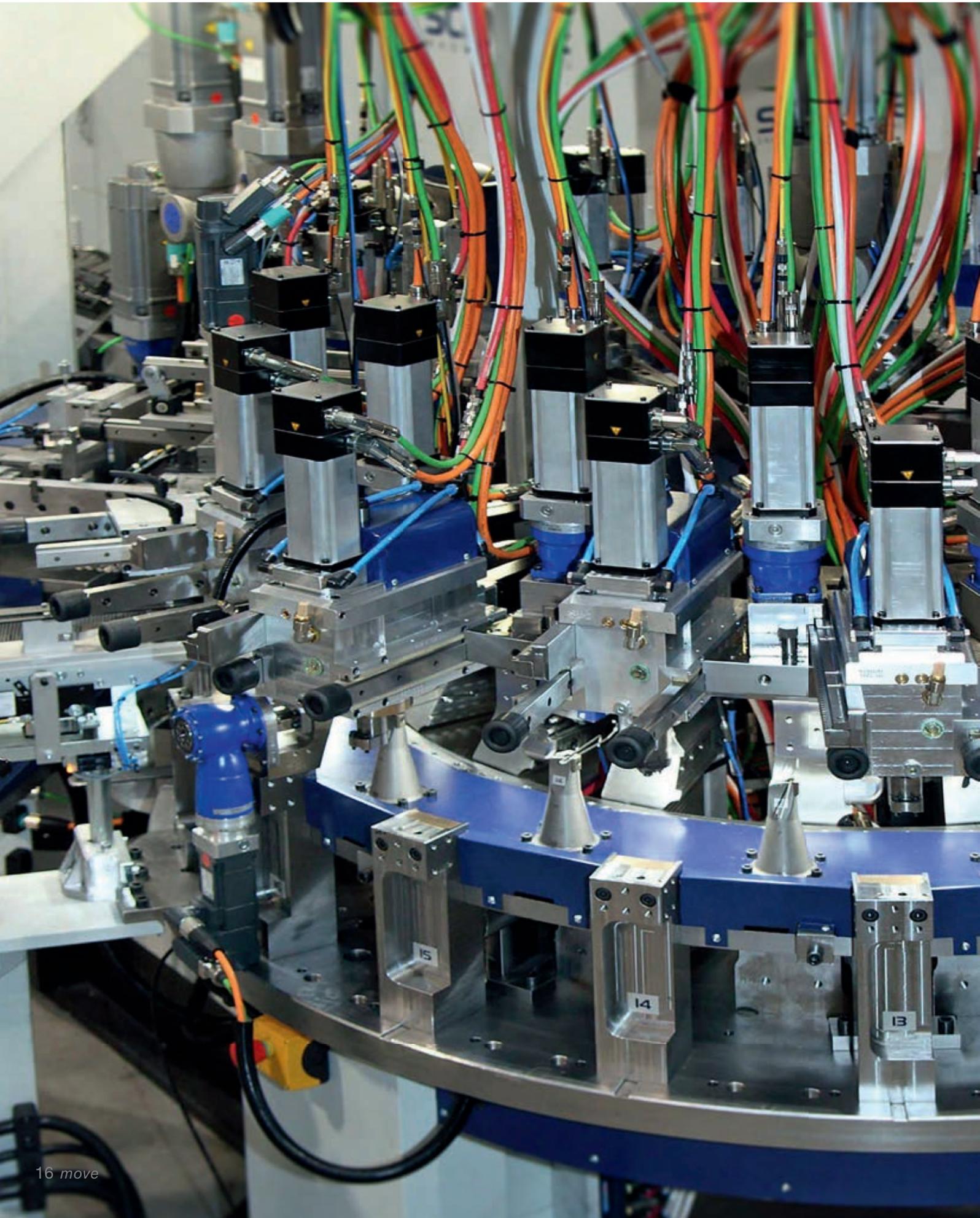


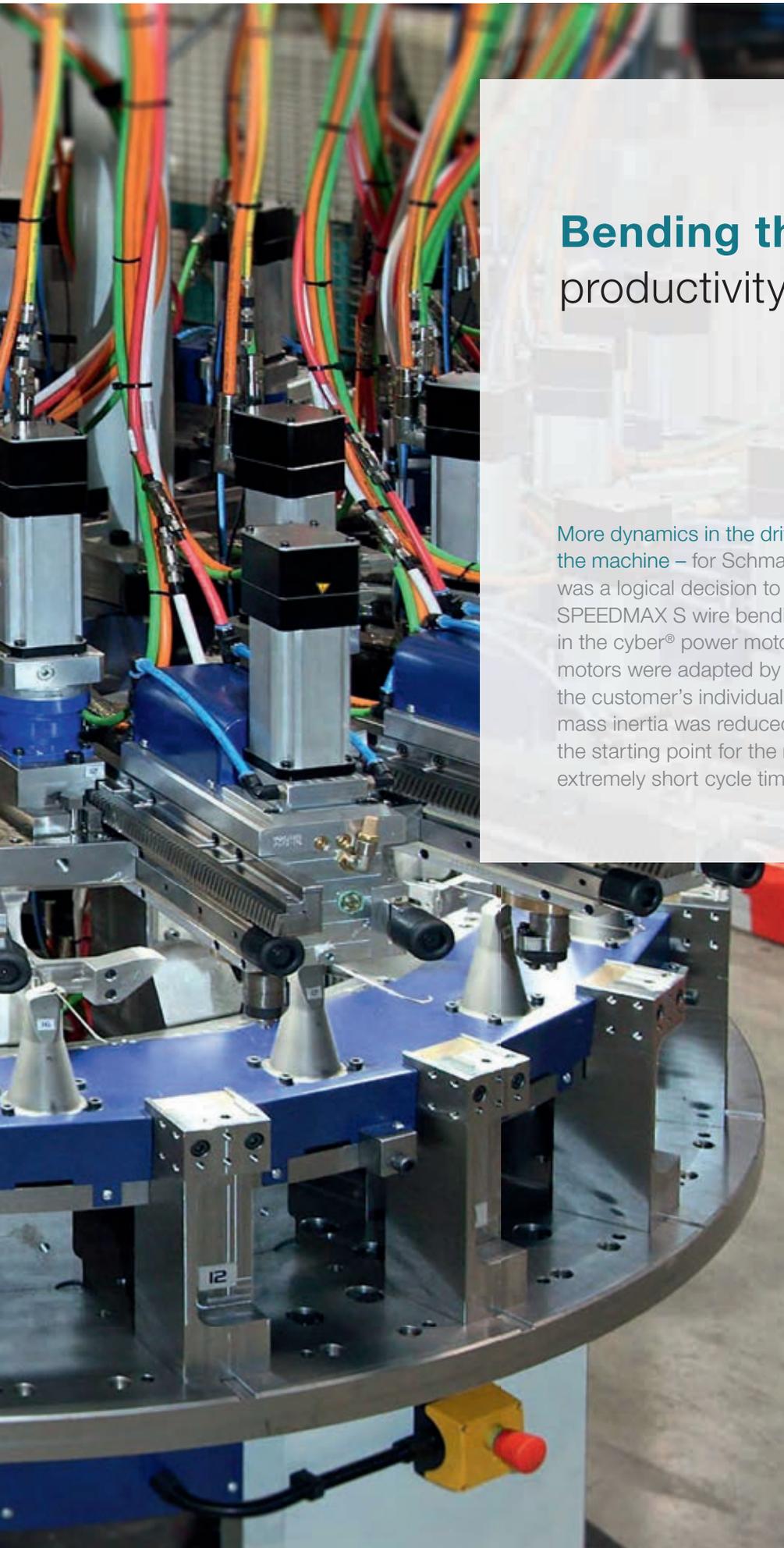
### A turn for the better

The **simco® drive** servo amplifiers and the small servo motors in the **cyber® dynamic line** paved the way for **STÖGER AUTOMATION** to realize the perfect drive solution for a screwdriving system for miniature screws. Encouraged by the high technical performance and the successful partnership with **WITTENSTEIN cyber motor**, the company is already planning to adapt the motion control solution to more screwdriving systems – a lasting turn for the better.

applications as well as a high scanning rate. "This is ideal not only for high dynamics in the current control loop but also for measuring and controlling the torques directly based on current consumption," Artur Kornelsen comments. "The entire development step for a miniaturized torque sensor was eliminated as a result." Complete screwing movements can be controlled extremely accurately because the motion tasks are freely programmable in the **simco® drive**. The two-spindle screwdriving system is thus able to insert the miniature screws, which are the norm in micro assembly processes, very precisely with

torques of as little as 0.05 Nm. "The programmed motion task reduces the speed for tightening to ensure an optimal, secure connection with a defined tightening torque," confirms Jan Rohde of Technical Sales at **WITTENSTEIN cyber motor**, when asked to describe the motion control principle.



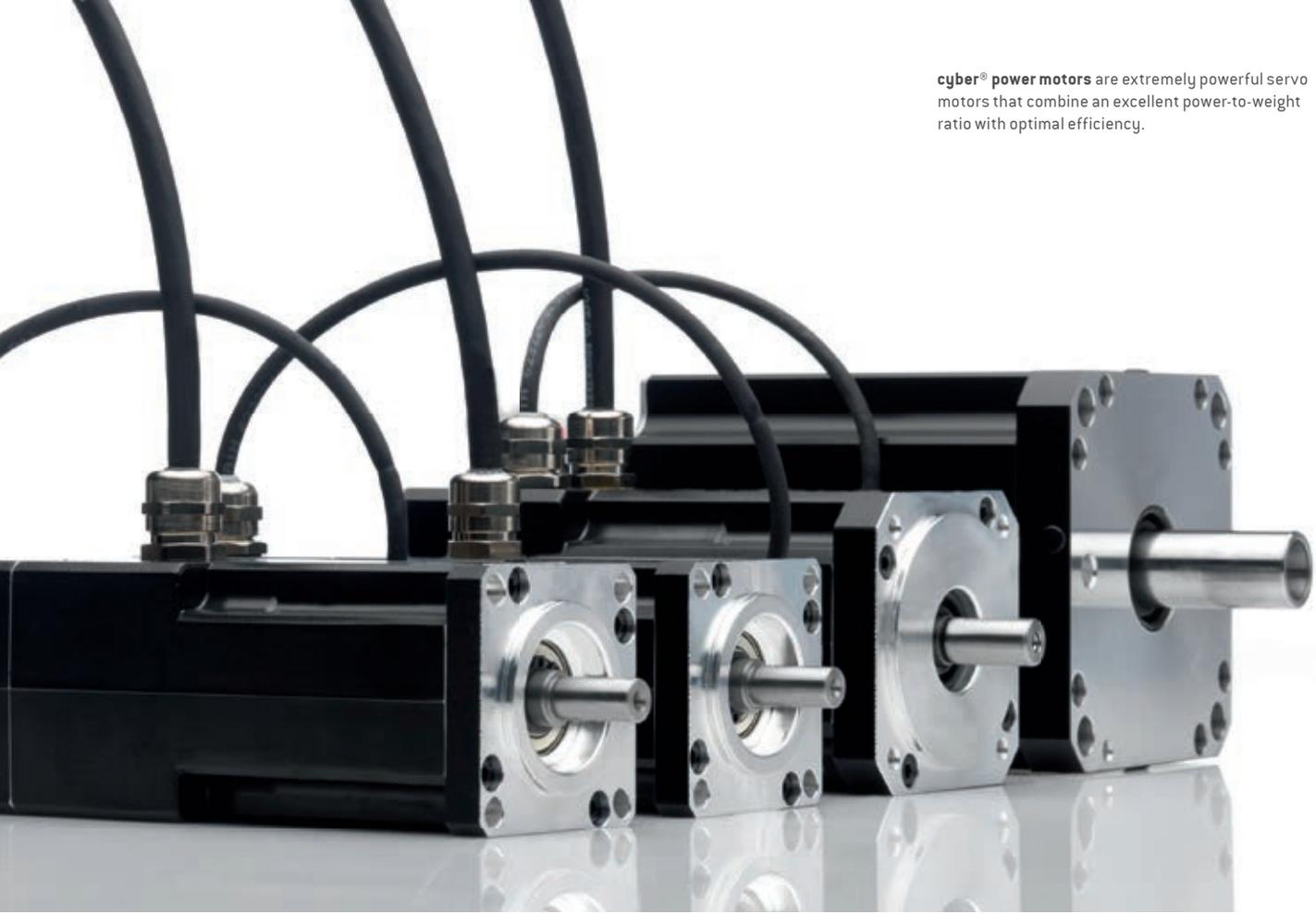


## Bending the productivity curve

More dynamics in the drive means more output from the machine – for Schmale Maschinenbau GmbH, it was a logical decision to equip their high performance SPEEDMAX S wire bending machines with servo motors in the cyber® power motors series. These extra-powerful motors were adapted by WITTENSTEIN cyber motor to the customer's individual requirements, for example the mass inertia was reduced to a minimum, thus providing the starting point for the machine's high acceleration and extremely short cycle times.

Compact drives when space is limited  
About 90 servo motors are accommodated in the SPEEDMAX S in a very small space.

**cyber® power motors** are extremely powerful servo motors that combine an excellent power-to-weight ratio with optimal efficiency.



The development of the motors, which feature a holding brake, multi-turn absolute encoder, temperature sensor and angled receptacles and are precisely attuned to the novel machine concept, was a joint project by Schmale and WITTENSTEIN cyber motor. “Without those motors, this version of the SPEEDMAX machine with this performance data would never have been feasible,” observes Andreas Goseberg of Service & Sales at Schmale Maschinenbau GmbH. The name of the new wire bending machines says it all: a SPEEDMAX S, for example, can produce as many as 200 parts with up to 20 bends each per minute. “Since there are more cycles, customers using a SPEEDMAX can now achieve a much higher output per time unit and manufacture their wire bending parts at a substantially lower cost,” Andreas Goseberg asserts. This increased efficiency is the outcome of an unusual underlying concept for the SPEEDMAX – in which WITTENSTEIN servo drives play a leading role.

**WITTENSTEIN servo technology: At the forefront of the “wire bending revolution”**

According to Schmale, the SPEEDMAX philosophy is currently revolutionizing wire bending technology. “The production speed of conventional CNC machine concepts with finger benders or wire bending slides has already been stretched to the limit,” Andreas Goseberg adds. “We’ve managed to unite the benefits of both concepts in the SPEEDMAX but without the drawbacks.” The integration of high performance servo actuators which meet the requirements for the new machine series was a basic precondition. “Schmale opted for the cyber® power motors series because they not only provide extreme

power and functionality; they can also be conveniently adapted to specific applications,” says Carolin Ank, Product Manager at WITTENSTEIN cyber motor GmbH. “The three different motor types which were developed for the SPEEDMAX together with Schmale

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**cyber® power motors**

Bending, embossing, notching, flattening,  
joining, punching, swaging –  
**in less than 0.2 seconds**

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Each achieved significantly higher dynamics owing to the special design of the rotor and also to the stator winding with its high copper fill factor.” Without this enhanced performance, the project would have been doomed to failure because in the maximum configuration a SPEEDMAX machine has twenty servo-driven processing stations arranged in a ring around the rotary table, which get their respective jobs done – bending, embossing, notching, flattening, joining, punching, swaging – in less than 0.2 seconds. “All in all, roughly 90 servo motors are installed in the machine and synchronized with one another by means of virtual curves. They can perform precisely coordinated motion sequences in the region of a few hundredths of

»Schmale opted for the cyber® power motors series because they not only provide extreme power and functionality; they can also be conveniently adapted to specific applications«

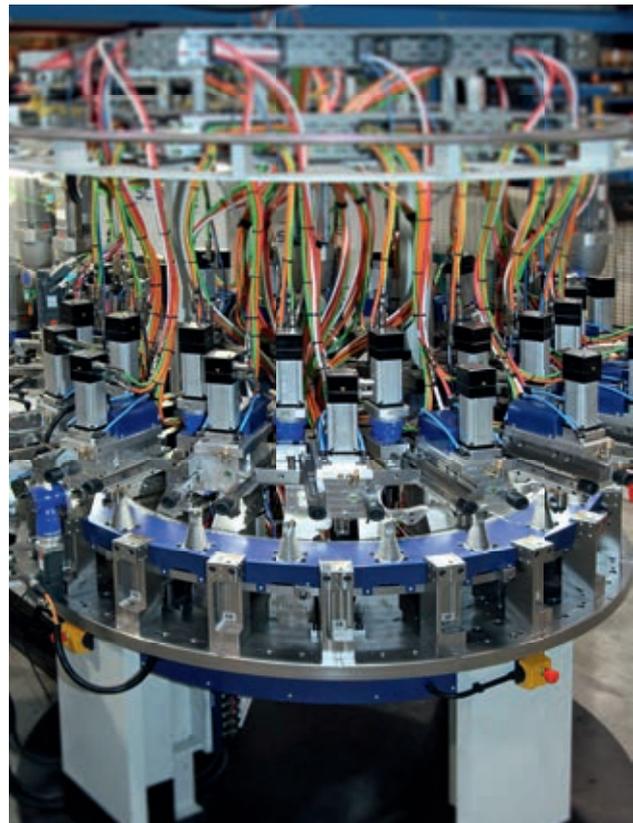
CAROLIN ANK,  
PRODUCT MANAGER, WITTENSTEIN CYBER MOTOR GMBH

a second in this way,” explains Philipp Maurer, a sales engineer at WITTENSTEIN cyber motor. Thanks to their very low mass inertia, the motors themselves only need a small amount of torque for self-acceleration, enabling correspondingly high acceleration in the workstations of the SPEEDMAX as well as in the rotary table. Andreas Goseberg sums up the situation: “More torque is therefore available for the process and the machine’s cycle times are extremely short. More than three finished parts leave the machine every second as a result.”

#### Servo technology for the entire SPEEDMAX series

The SPEEDMAX S for wire thicknesses from one to four millimeters is the smallest model in this bending machine series from Schmale. The SPEEDMAX M and the SPEEDMAX L are designed for thicker wires. They, too, harness the power of cyber® power motors in order to realize highly dynamic, precise and efficient production of wire bending parts.

Thanks to WITTENSTEIN cyber motor’s servo technology, each bending station gets its particular job done in less than 0.2 seconds.



The Schmale Maschinenbau SPEEDMAX is designed as a rotary table machine with **up to 20 workstations**.

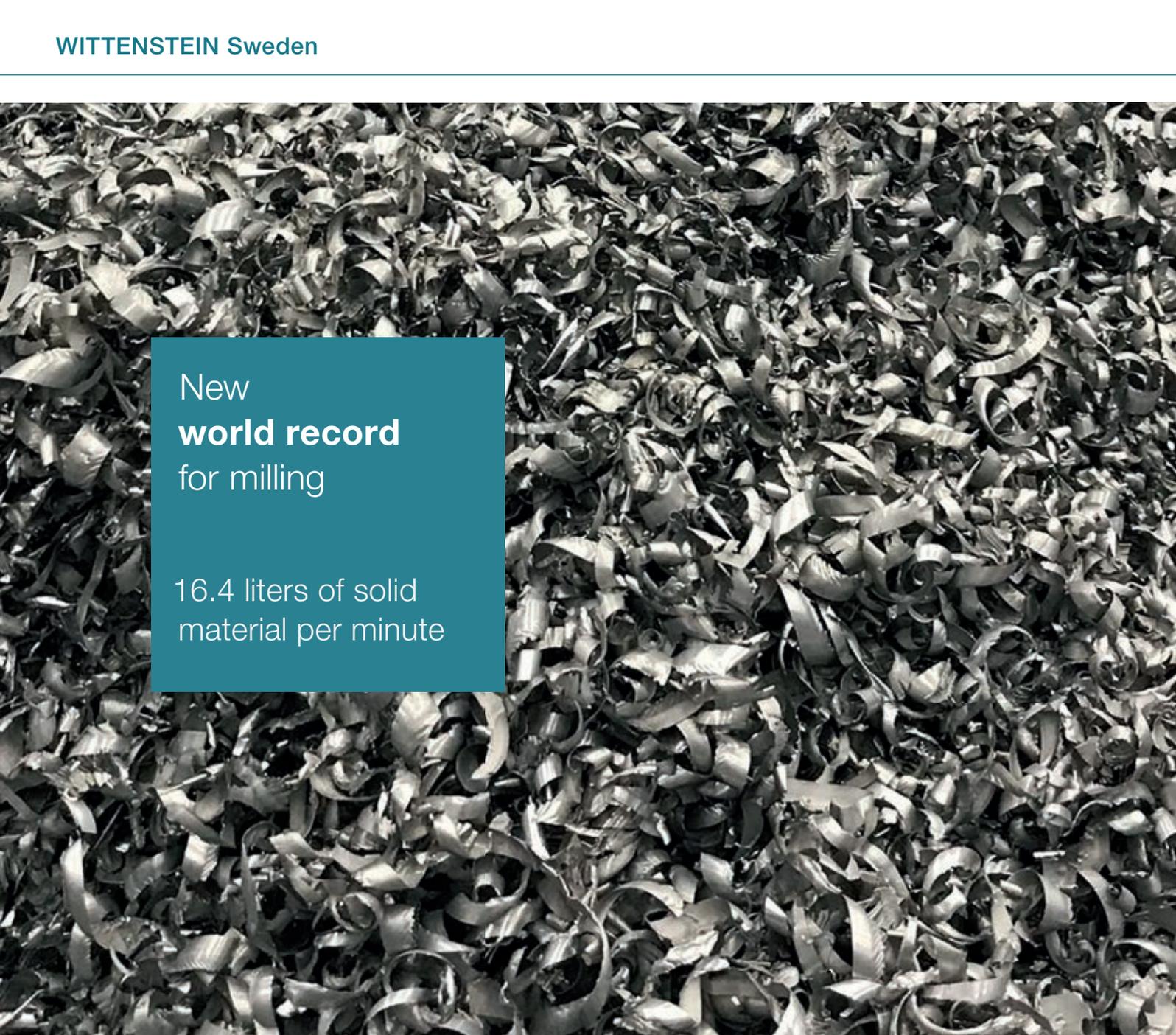
### Schmale Maschinenbau GmbH

Focused on servo technology and energy efficiency

Technology based planning inspired by a modular system rather than solutions off the rack – that’s the doctrine of Schmale Maschinenbau GmbH of Altena (Germany). The company sees itself as an engineering consultant that also builds machines, specializing in complete solutions for wire, pipe and strip lines – ranging from modularly designed machining centers to tailor-made special machines. Schmale systems can be found at suppliers to the automotive and railway industries, in the packaging sector or at the manufacturers of kitchen appliances, bicycles or DIY products.

The company regularly sets benchmarks with its consistent integration of energy efficient servo solutions in the construction of machinery and control systems – notably the TPM+ series of servo actuators from WITTENSTEIN alpha and now also cyber® power motors from WITTENSTEIN cyber motor.





New  
**world record**  
for milling

16.4 liters of solid  
material per minute

Life in the little village of Virserum in Sweden's historic Småland province is generally very tranquil. Yet quite the opposite was true last October, when leading aerospace industry representatives got together at an in-house exhibition hosted by machine tool maker Modig Machine Tools AB. It wasn't the product portfolio that was the focus of attention, though – it was a new world record in which a whole series of WITTENSTEIN products played a crucial role.

Established in 1947, Modig Machine Tool AB specializes in high speed machining centers and is a global leader when it comes to aircraft production equipment. Top manufacturers like Airbus, Boeing, Bombardier or Cessna are all part of Modig's customer base. They particularly have confidence in the machine builder's customized solutions and in the continuous development and improvement of the

machining technologies, for example the reduced production times. Johan Sjoelin, Managing Director of WITTENSTEIN Sweden / Denmark, and his team have for many years supported Modig's efforts to fulfill these high expectations. "The partnership between Modig and WITTENSTEIN has grown steadily stronger over the last few years. We started off with small projects to do with product and motor



The RigiMill does not only take over the rough (roughing) but also the subsequent finishing (finishing).

sizing and selection, each one adding to the customer’s overall impression of our know-how and experience. The fact that almost 70 components of ours can be found in the new RigiMill is the outcome of this mutual, trustful cooperation.”

**RigiMill – roughing and finishing in aluminum or titanium**

Thanks to the RigiMill milling machine from Modig Machine Tool, it is now possible for the first time ever to operate one machine for high speed roughing and optimal finishing. Customers can choose between two preconfigured gantries, which were specially developed for demanding metals such as titanium or aluminum. “It was very important that the RigiMill be designed with much higher dynamics. The master-slave function of our cymex® 5 sizing software was exactly what Modig was looking for because it lets you map two electrically preloaded drives. By tensioning each other, the master and slave eliminate backlash from the drive train and increase the machine’s stiffness”, explains Johan Ralmark, a sales engineer at WITTENSTEIN Sweden / Denmark. But is that really enough to set a new world record?

**16.4 liters of solid material per minute – with WITTENSTEIN’s help**

October 4, 2017: The distinguished visitors to the Modig in-house exhibition have all gathered around the RigiMill to watch. Their smartphones are ready and waiting. The machine starts up. The motor accelerates to 18,000 rpm. The 295 horsepower are unleashed. The countdown begins: 60 seconds! They’re probably the longest 60 seconds the Modig crew have ever spent.

A quick check suffices to confirm that a new world record has been set for milling – 1001 cubic inches or 16.4 liters of solid material per minute! Johan Sjoelin is among the well-wishers: “Congratulations to the entire team at Modig Machine Tool! We’re every bit as proud as you are that our components have contributed to the new world record in this way. And we’re looking forward to helping Modig defend the title in the future.”

Every RigiMill milling machine includes the following WITTENSTEIN products:

- Servo gearboxes
- 2 CP planetary gearboxes
- 2 LP+ planetary gearboxes
- 4 RP+ planetary gearboxes

- Right-angle gearboxes
- 2 LPK+ bevel gearboxes
- 2 SPK+ hypoid gearboxes
- 1 SK+ hypoid gearbox

- System components
- 12 LMT lubricating pinions
- 32 High Performance Racks

- Accessories
- 12 LUC lubricators

David Modig (left), President of Modig Machine Tool in Sweden, with Keith Lopez, President of Modig North America, following the successful world record attempt.

All pictures (C) Modig Machine Tool AB



Since the successful launch at the Hannover Messe 2017, the IDS3010 Industrial Displacement Sensor from attocube systems has opened up a whole series of interesting applications – for example in the [LineCal® interferometric calibration system](#) from Etalon AG. This Braunschweig company's calibration system is used for volumetric compensation of systematic geometrical deviations in medium to very large machines with between three and six axes.

# Laser interferometry:

## Ultimate precision in machine calibration



The **IDS3010** determines the effect of the combined axis deviation by measuring directly at the tool center point (from left to right: Daniel Raschke, Etalon, and Dr. Danilo Schmidt, attocube).

"It measures positioning deviations, straightness, pitch, yaw and roll in all three axes as well as the perpendicularity of these axes relative to each other," explains Daniel Raschke, who is responsible for sales and product management at Etalon. "Since the recurring setup and alignment of the calibration is not necessary for the LineCal® system, it outperforms conventional single and multiple-beam interferometers, so that a complete, unattended measurement routine can be carried out in just sixty minutes. This significantly reduces the time and costs for calibration."

### All 21 deviation parameters in under an hour

To enable all 21 systematic deviation parameters to be measured, Etalon has developed a measuring frame which can be specifically adapted to almost any machine needing to be calibrated. The eye-safe sensor heads of the IDS3010 are arranged on this frame for capturing specific measurement lines that are needed to create a highly precise geometric image of the machine. "The machine follows the pre-installed measurement lines automatically and sequentially. The patent-pending LineCal® method enables any deviations

between the target distances of the machine and the actual distances in space to be recorded with sub-micron accuracy via the interferometer channels," Daniel Raschke adds. "Our Trac-CAL software calculates the deviations for all machine axes and outputs control or customer-specific compensation data."

### The future: Calibration in space with light

Thanks to LineCal® – and the IDS3010 – Etalon has opened up novel future avenues for calibrating small to medium-sized machines. The machine-specific measurement frame, together with the IDS3010 fiber-based interferometer, creates defined conditions for volumetric compensation of all deviation parameters, reduces the time and effort for setting up measurements to a minimum and makes the measuring system mobile.

This makes it an attractive option for the most diverse use scenarios – from repeated calibration of a particular machine to calibrating identical machines in the same series, for instance as an automated final acceptance measurement on the manufacturer's premises prior to shipping.





## Etalon AG

### Specialists for interferometric calibration technology

Etalon AG was founded in 2004 as a spin-off company of the Department of Coordinate Metrology at the German National Metrology Institute (PTB) in Braunschweig. "Since then, we've increasingly specialized in interferometric calibration technology," recalls Dr. Heinrich Schwenke, CEO of Etalon AG. "Today, we're a provider of applications for CMMs and machine tools as well as scientific applications, with a set of system solutions for precise and comprehensive geometric analysis, monitoring and accuracy improvement. Ultimate precision – as a precondition of controlled, deterministic and reproducible manufacturing processes – is our main goal."

Etalon is a key technology partner for many different customers and industries – in the mechanical engineering, industrial instrumentation, automotive, aerospace technology and research sectors. "We even supply measurement solutions for space research, for example for the Giant Magellan Telescope and the CCAT radio telescope observatory," Dr. Heinrich Schwenke reports.

Eye-safe fiber-laser sensors are arranged on the machine-specific frame for capturing specific measurement lines that are needed to create a highly precise geometric image of the machine.

Etalon's LineCal® is an innovative system which considerably simplifies the calibration of measuring and testing machines – not least, due to the industry oriented design and the sub-micron accuracy of the IDS3010 from attocube systems.

The **IDS3010** from **attocube systems AG** is the technological core of Etalon AG's innovative LineCal® interferometric calibration system.



### IDS3010 – ultimate precision in industrial design

The IDS3010 interferometric, multi-channel displacement sensor opens up a totally new dimension in precision in high-end industrial applications. Positions and motions can be simultaneously measured in up to three axes with a digital resolution of one billionth of a millimeter. One measurement is generated every hundredth of a microsecond. This interferometric sensor easily surpasses the performance of any other presently available sensor technology. At the same time, the IDS3010 also scores

with a concept that is perfectly aligned to industrial environments: a space saving, integration-friendly design, multi-channel capability, ease of use, data output every hundredth of a microsecond and unlimited connectivity thanks to the integrated web server with remote and Industry 4.0 connectivity as well as real-time interfaces for standard industrial networks and controllers.



# Ideas in motion

No matter how much technology moves forward, innovations are always the doing of people – people driven by passion and a pioneering spirit.

“Oh, it’s the French lady from WITTENSTEIN!” That’s how Fabienne Laville-Isabey, who actually holds dual nationality (French and Swiss), is frequently greeted when she welcomes visitors to an exhibition stand somewhere out there in the world with her delightfully charming smile. An employee in Marketing & Sales at WITTENSTEIN motion control, she knows from her many years of experience how important first impressions can be, even (or especially) where highly complex products are concerned like mechatronic systems for oil and gas exploration three thousand meters deep down on the ocean bed: “When our innovations are unveiled to the public at a trade fair, it’s as if they’re my babies. And that’s exactly how I describe them to visitors to our booth.” She laughs, of course, as she says this. The same goes for business contacts when she’s working in the office: “They can picture the expression on my face just by listening to me over the phone.” Fabienne Laville-Isabey is convinced that “a smile is always the shortest route between two people.” That’s the first step completed: in the second, she hands the conversation over to her colleagues, the sales engineers and designers. The conversation then moves on to the technology.

Fabienne Laville-Isabey has an MBA in International Business and is delighted to be one of the faces of the WITTENSTEIN Group’s new employee campaign: “Ideas in motion – the slogan is a perfect description of what I

do, and I do it with passion and conviction. If it wasn’t for the people, for the interpersonal relationships that breed inspirations and ideas, there’d be no successful innovations.” To Fabienne Laville-Isabey, it’s only natural that she should welcome her visitors in their own language and respect their national customs: “There’s not much point in phoning someone in Paris before half past eight in the morning; on the other hand, nearly everyone in Norway has gone home by four-thirty.”

Around 2500 people work for the WITTENSTEIN Group worldwide in the meantime; more than 200 of them joined the company last year alone, divided roughly equally between career entrants and experienced experts. When Fabienne Laville-Isabey is asked to sum up what it is that every employee should have in order for a company like WITTENSTEIN SE to maintain its momentum and growth in the future, she doesn’t have to think long for an answer: “Openness to new ideas. The products we sell aren’t mass-produced and our manufacturing lines aren’t fully automated. We develop customized solutions together with our users. To do that, you need ideas and the courage to explore new thoughts while they’re still only half-baked. It’s always a win-win situation that we’re aiming for. It’s particularly rewarding if we can then show our products to the public at a customer’s booth, built into that customer’s application. When a client honors us with an ‘invitation’ like that, we know we’ve made a good job of it.”

Fabienne Laville-Isabey is one of some 2500 people at WITTENSTEIN whose great passion contributes to the development of customized solutions in partnership with users.





## Once you get started...

It's symbolic of technology in its simplest form, yet no two are ever absolutely alike: children (and grown-ups) the world over love to build paper airplanes. The idea of making toys out of paper originated about 2000 years ago in China. Leonardo da Vinci is considered to be the founding father of paper planes in Europe. As a central visual element of "Ideas in motion", the WITTENSTEIN Group's new employer campaign, paper airplanes are symbolic of creativity and dedication. Because there are so many different forms and techniques. And because you can always find something to improve and work on. It's inevitable, once you get started...

»A smile is always the shortest  
route between two people.«

FABIENNE LAVILLE-ISABEY  
WITTENSTEIN MOTION CONTROL GmbH



## Even closer to our customers worldwide

### Sales Hub opens in Austria

Without the close cooperation between WITTENSTEIN and its customers, we would be unable to realize innovations together with them and in doing so strengthen their competitiveness. These partnerships are essential to support the development of new machine concepts effectively from the outset with new technologies and technical consulting. To further underline this closeness, WITTENSTEIN is expanding at selected sales locations worldwide.

WITTENSTEIN GmbH of Leobersdorf, not far from Vienna, recently became the first subsidiary to be upgraded to a Sales Hub; since fall last year, our Austrian branch has been offering extensive support to the international markets. Local expertise has been developed and enhanced, with the result that project lead times are now shorter, as is the time to respond to customer inquiries. It goes without saying that native speakers provide assistance to customers in their own language as a crucial pillar of effective and targeted communications.

Established in 2001, WITTENSTEIN GmbH is today a reliable partner for top companies in many different segments of the Austrian engineering industry. Owing to the central location, the firm's eleven employees never have to travel extreme distances to project meetings or seminars. And thanks to the regional reorganization of sales activities in the Czech Republic, Hungary, Slovenia and Slovakia from a strong base, customers are already reaping the benefits of our Austrian Sales Hub.

"We have very good relations with our eastern neighbors for historical reasons, and because the mentality is similar, and WITTENSTEIN GmbH is excellently placed to develop those markets. It's a challenge we're delighted to accept, and we're confident that we'll enjoy considerable success in these markets in the future!"  
**Franz Luschnig**, Managing Director WITTENSTEIN GmbH (Austria)

Two customer statements testify to this: the collaboration between Salvagnini Maschinenbau GmbH and WITTENSTEIN GmbH Austria on low-backlash planetary gearboxes which began back in 2005 has long turned into a genuine success story. At the time, manual tool changers were used on small machines and servo hydraulic ones on larger machines; over the years, with WITTENSTEIN's support, these have gradually been replaced by servo electric drive systems. According to our Purchasing management, "The feedback from the customer was very positive and a massive increase in sales ensued in the small machines segment".

For many years now, WITTENSTEIN has supplied gearboxes and racks to TOS VARNSDORF a.s, the Czech machine manufacturer. "Our corporate strategy is to work exclusively with well-known and proven European partners," says Tomáš Jäger, a buyer. "WITTENSTEIN products satisfy our quality requirements in every respect and the price is right too. There's been many an occasion in the past when mutual cooperation has been a big help in handling new projects. The support we receive from the Engineering department has been particularly valuable."

"The overwhelmingly positive feedback from stakeholders left no room for doubt that the reorganization was a success. That was good encouragement for us. We have plans to further strengthen the collaboration with our customers in the long term by expanding more WITTENSTEIN sites. That will be our contribution to making them more competitive."

**Björn Proschinger**,  
 Sales Hub Concept Officer / Managing Director WITTENSTEIN GmbH (Austria)



"In view of the geographical proximity, and above all the central location, it was a logical decision to expand eastward and step up our market development activities in the Czech Republic, Slovakia, Hungary and Slovenia via the WITTENSTEIN Sales Hub Austria."

**Günther Hornaus**, Sales Manager,  
 Sales Hub Austria



Leobersdorf, not far from Vienna

# Trade fair calendar 2018

WITTENSTEIN is represented at numerous trade fairs and exhibitions worldwide.  
**We look forward to meeting you!**

## Hannover Messe

Hannover, Germany  
WITTENSTEIN SE  
**April 23 to 27, 2018**

## FEIMEC

São Paulo, Brazil  
WITTENSTEIN do Brasil  
**April 24 to 28, 2018**

## ILA Berlin

Berlin, Germany  
WITTENSTEIN aerospace & simulation GmbH  
**April 25 to 29, 2018**

## OTC

Houston (TX), USA  
WITTENSTEIN motion control GmbH  
**April 30 to May 3, 2018**

## Hispack

Barcelona, Spain  
WITTENSTEIN S.L.U.  
**May 8 to 11, 2018**

## Metalloobrabotka

Moscow, Russia  
WITTENSTEIN alpha GmbH  
**May 14 to 18, 2018**

## SMART

Vienna, Austria  
WITTENSTEIN GmbH  
**May 15 to 17, 2018**

## Elmia Automation 2018

Jönköping, Sweden  
WITTENSTEIN AB  
**May 15 to 18, 2018**

## Sps ipc drives Italia

Parma, Italy  
WITTENSTEIN spa  
**May 22 to 24, 2018**

## BIEMH

Bilbao, Spain  
WITTENSTEIN S.L.U.  
**May 25 to June 1, 2018**

## lpack-Ima

Milan, Italy  
WITTENSTEIN spa  
**May 29 to June 1, 2018**

## Aerospace Machining Exhibition

Taichung, Taiwan  
WITTENSTEIN Co., Ltd.  
**June 8 to 12, 2018**

## Eurosatory

Paris, France  
WITTENSTEIN motion control GmbH  
**June 11 to 15, 2018**

## Shanghai Automotive Manufacturing Technology & Material Show (AMTS)

Shanghai, China  
WITTENSTEIN (Hangzhou) Co., Ltd.  
**July 4 to 7, 2018**

## Farnborough International Airshow (FIA)

Farnborough, UK  
WITTENSTEIN aerospace & simulation GmbH  
**July 16 to 22, 2018**

## Taipei International Automation Exhibition

Taipei City, Taiwan  
WITTENSTEIN Co., Ltd.  
**August 1 to 4, 2018**

## SINDEX

Berne, Switzerland  
WITTENSTEIN AG  
**August 28 to 30, 2018**

## IMTS

Chicago (IL), USA  
WITTENSTEIN holding, Corp.  
**September 10 to 15, 2018**

## China International Industry Fair (CIIF)

Shanghai, China  
WITTENSTEIN (Hangzhou) Co., Ltd.  
**September 19 to 23, 2018**

## MSV

Brno, Czech Republic  
WITTENSTEIN GmbH  
**October 1 to 5, 2018**

## WOTS (World of Science & Technology)

Utrecht, Netherlands  
WITTENSTEIN BVBA  
**October 2 to 5, 2018**

## M-Tech 2018

Osaka, Japan  
WITTENSTEIN Ltd.  
**October 3 to 5, 2018**

## Bi-MU

Milan, Italy  
WITTENSTEIN spa  
**October 9 to 13, 2018**

## Pack Expo

Chicago (IL), USA  
WITTENSTEIN holding, Corp.  
**October 14 to 17, 2018**

## CeMAT Asia

Shanghai, China  
WITTENSTEIN (Hangzhou) Co., Ltd.  
**November 6 to 9, 2018**

## FMB

Bad Salzuffen, Germany  
WITTENSTEIN alpha GmbH  
**November 7 to 9, 2018**

## Taiwan International Machine Tool Show

Taichung, Taiwan  
WITTENSTEIN Co., Ltd.  
**November 7 to 11, 2018**

## electronica

Munich, Germany  
WITTENSTEIN cyber motor GmbH  
**November 13 to 16, 2018**

## Automation Fair

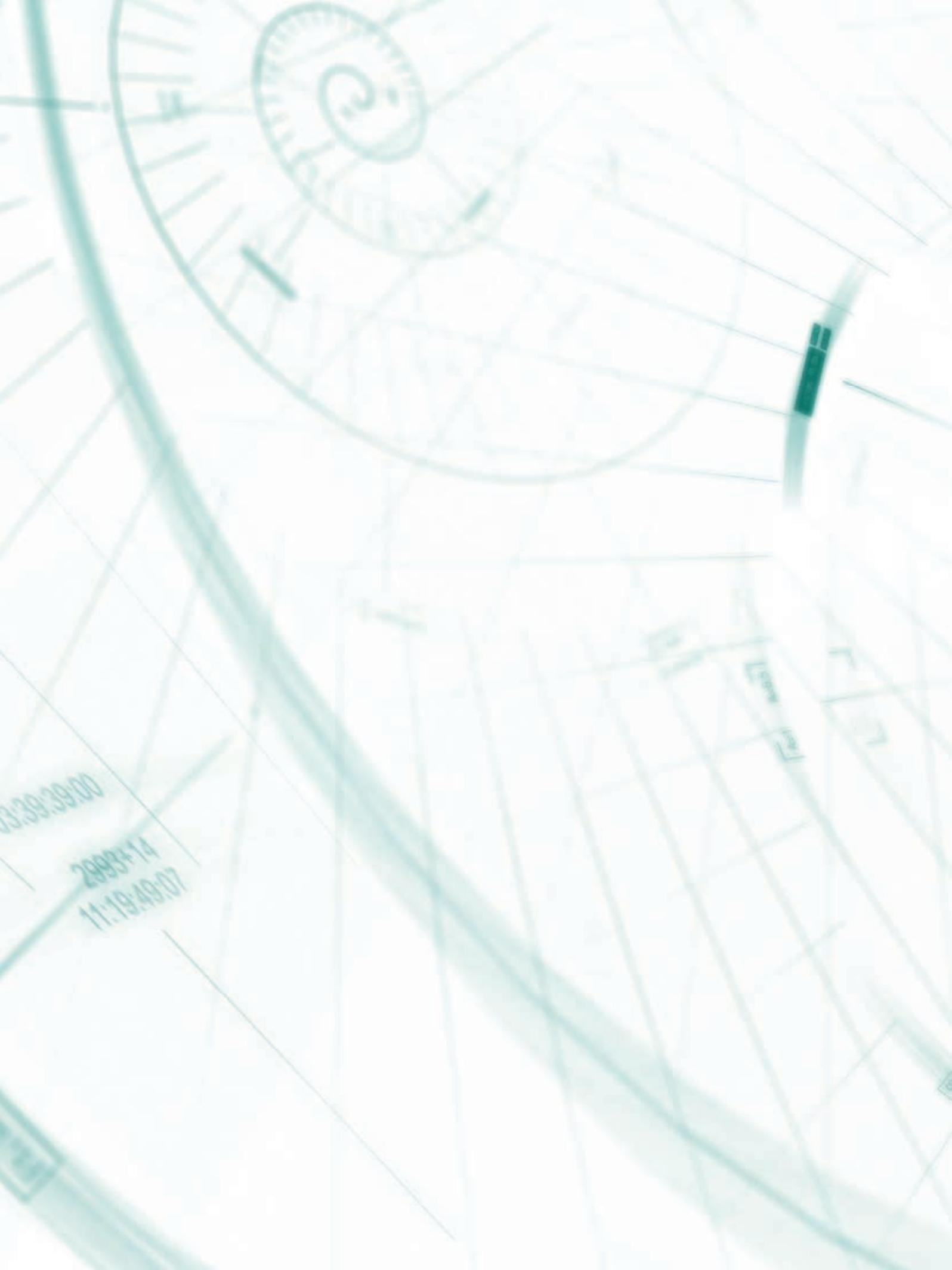
Philadelphia (PA), USA  
WITTENSTEIN holding, Corp.  
**November 14 to 15, 2018**

## I/ITSEC

Orlando (FL), USA  
WITTENSTEIN cyber motor GmbH  
**November 26 to 30, 2018**

## SPS IPC Drives

Nuremberg, Germany  
WITTENSTEIN alpha GmbH,  
WITTENSTEIN cyber motor GmbH  
**November 27 to 29, 2018**



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