WITTENSTEIN

move

The magazine for customers and partners of WITTENSTEIN SE

WITTENSTEIN in all axes

move talks to WITTENSTEIN alpha

November 2017

move

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Contents

Masthead

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Dear readers,

Superiority proven in practice. If you turn to page 16 of this newest issue of our customer magazine, you'll find this headline there – in connection with our Galaxie® Drive System. Its outstanding technical merits and the stunning performance enhancements it enables in machines have already caused existing design strategies to be overturned and rebuilt in many places. It is only when technical innovations turn out to be a genuine success factor for users that their inventors and developers have done everything right – and only then can they claim superiority proven in practice for their particular "babies". The bar is set high – not only for drive systems and machines but also, of course, for their production and sales processes. Ever more complex technical innovations by users and the dynamics of the market environment demand ever higher levels of excellence in production and logistics.

Our motto for the upcoming SPS/IPC Drives 2017 will be "FOCUSED ON YOUR NEEDS". You can look forward to some fascinating applications from industry and research with drive technology made by WITTENSTEIN – both here in this magazine and "live" at our booth in Nuremberg. No matter how ambitious our growth plans, what matters most is our ability to continue exciting you, our customers. With an optimized product portfolio that is fully in tune with the market and the highest levels of delivery reliability. It is thanks to you alone that our order book has been permanently well-filled for some time now: every single order and every single project we receive from you is a clear vote of confidence in us. It shows us that you trust in our passion for innovation and excellent products. You can discover in an interview with Managing Director Michael Müller, Sales Manager Andreas Mei and Michael Soeding, Manager Export Sales, how our biggest subsidiary WITTENSTEIN alpha intends to live up to this commitment in the future.

I have held the responsible office of Board Spokesman since the summer. Dr. Manfred Wittenstein, proprietor and present Chairman of the WITTENSTEIN SE Supervisory Board, provides inspiration and motivation to me personally as well as to my colleagues on the Management Board. On pages 24/25 he describes in an essay titled "Prosperity for everyone" what has been his driving force all his life and indeed continues to drive him today: the desire to run a company successfully yet nevertheless act ethically. Is that actually possible? He believes it is – and he cites several good reasons for accepting responsibility. Not simply as an entrepreneur, not simply as an engineer but as one of the countless people who want to create a good future for themselves and their children.

Dr. Bernd Schimpf

Spokesman of the Management Board, WITTENSTEIN SE

move talks to:

Michael Müller, Andreas Mei and Michael Soeding

Putting strategy into practice

WITTENSTEIN alpha shifts its market focus

The biggest and most tradition steeped subsidiary of the WITTENSTEIN Group has launched a campaign to advise and serve its customers even faster, even more comprehensively and in an even more focused way, no matter where they happen to be in the world. The portfolio of products and services has been significantly expanded as a result of consolidating several business segments Group-wide – leading to even closer cooperation between Managing Director Michael Müller, Sales Manager Andreas Mei and Michael Soeding, Manager Export Sales.

Managing Director Michael Müller, Manager Export Sales Michael Soeding and Sales Manager Andreas Mei (from right to left) give customers a clear competitive lead with WITTENSTEIN alpha products

move: WITTENSTEIN alpha now covers a sweeping portfolio – from mechanical drives through gearing (as the core competency) to special-purpose gearhead solutions. This would appear to be a visible consequence of your internal reorganization.

Müller: Yes, the sales and development functions for motor-gearhead units as well as special-purpose gearheads and customized gearing components have been transferred to us from other Business Units of the WITTENSTEIN Group. An approach that has gradually evolved over the last few years has now been integrated.
If we take a look at what is happening in the market, the standardization and consolidation of our internal structures and processes is a logical outcome. In other words, our strategy has now been put into practice. And incidentally, the optimization of our worldwide production network in Germany, Switzerland, Romania and the U.S. is also a part of this strategy.

move: Customers have a right to expect clarity, reliability and speed. Aside from excellent products, supply performance is crucial for successful business relationships. Yet what options are available to you when this performance suffers because the level of incoming orders remains permanently high?

Mei: Intensive consulting is necessary in the capital goods sector, and in a metaphorical sense we don't sell products but confidence. There's no question that delivery reliability is a top priority; let's face it, the confidence of some of our customers has been severely tested in recent months. Our Sales team are working hand in hand with Development and Production to re-establish our traditional supply performance and we, too, have reorganized ourselves more efficiently during the last few months both in the back office and worldwide out there in the field.

move: Sustainable competitiveness is invariably driven by the ability to strengthen your own innovative vitality. Where does the emphasis lie for WITTENSTEIN alpha?

Mei: First of all, we've closed gaps in our portfolio of mechanical products, for example by rounding off our alpha Value Line gearhead series or with the newly developed V-Drive Basic. The market has also reacted with overwhelming enthusiasm to our patented, proprietary principle for chipless rack pinning. Not only the hardware but software tools too – which by the way have long had a firm place in our service portfolio – are growing in importance. We're pleased that our systematic efforts to optimize

cymex® and the launch of the SIZING ASSISTANT with new performance and excitement features have convinced our customers. Of course, we're also focusing more and more on digitalized products and – last but not least – on increasing the power density of all mechanical components.

move: WITTENSTEIN is a company with global reach: in the meantime, the Group employs around 2400 people. What is the next station on WITTENSTEIN alpha's global journey?

Soeding: As we see it, being close to where our customers are is an essential condition of sustained worldwide growth. Ever since our first international subsidiary opened in the eighties (in France), we've been steadily strengthening our presence throughout the world, most recently last year with the establishment of a Turkish subsidiary in Istanbul. Apart from our key home markets in Europe, notably Germany and Italy, the Asian market for industrial goods – take the distinct upward trend that can currently be observed in Japan and China in terms of investments and manufacturing – is playing an increasingly important role for us.
And the production capacities at our North American facility in Bartlett / Chicago have (fortunately) been exhausted for a while now. We'll soon be adding extra production space on the existing premises for that reason.

move: There are only a few weeks remaining until the year end after SPS/IPC/Drives 2017 is over. Would you care to give us your forecast for 2018?

Müller: All the lights are still green: both economic research institutes and many of our business partners estimate that the strong demand in WITTENSTEIN alpha's relevant industries is likely to continue into the next quarter. In view of the present general political uncertainty, however, I prefer to be cautious about the probability of any such forecast. One thing is sure: we're investing massively in the future in order to generate real competitive advantages for our customers, for example by expanding the networking capabilities of our products and solutions in the drive and measurement systems segment.

WITTENSTEIN
in all axes

Better, quieter, more reduction ratios
The optimized SP+ and TP+ low-backlash planetary gearheads

- Up to 20% more torque
- Up to 29% higher speeds
- Noise level: ≤ 59 dB(A)
- New reduction ratios: i=8, 32 or 64
- Service life: 1000 to 20,000 h

SP+, TP+

Higher output torques and maximum speeds with a larger range of ratios as well as more energy efficiency and minimized noise levels – these are the hallmarks of the new, low-backlash planetary gearheads from WITTENSTEIN alpha. With their increased power density, SP+ and TP+ enable better utilization of the motor's capacity and more dynamic processes. The outcome: shorter machine cycle times and higher productivity. The improved gearhead utilization and 96 percent efficiency simultaneously permit significantly lower energy consumption on the motor side. Thanks to their optimized helical teeth, both of these planetary gearheads are now quieter than ever before: even at speeds of 3000 revolutions per minute, the noise intensity never rises above normal conversational level. The combination of these benefits means the SP+ and TP+ low-backlash planetary gearheads are also an attractive alternative for retrofits and upgrades of existing machines.

Gearhead design now also reflects the service life

A precise, reliable and above all application-oriented gearhead design is vital in order to derive the full advantage from all of this. Once again, as a one-stop supplier, WITTENSTEIN alpha has exactly the right solution in the form of the cymex® 5 sizing software: in the future, the new release will allow the planned useful life of the gearhead to be included in the design process.

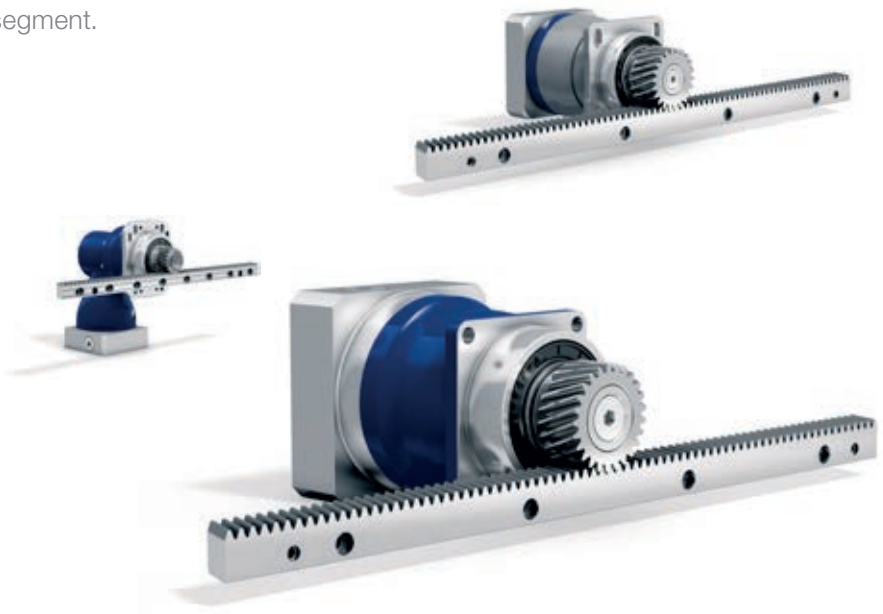
Performance, power, precision
The XP+ and RP+ planetary gearheads and

- Improved power transmission
- Significantly less torsional backlash
- Maximum torsional rigidity
- 5 sizes
- Additional binary reduction ratios

XP+, RP+

The redesigned output interface is one of the highlights of the compact Premium XP+ and RP+ gearheads. It was developed with very high torques in mind and enables improved power transmission far exceeding the industry standard. The gearhead kinematics and the exceptional tooth quality ensure permanently low torsional backlash of less than one arcminute – and hence lifelong precision. The RP+ low-backlash planetary gearhead particularly impresses with the high rigidity of its kinematics. The torsional backlash of less than one arcminute and the high stiffness of three key components – the shaft, bearing and flange

Ever more complex user specifications and wide-awake competitors characterize the dynamic market environment in which WITTENSTEIN alpha has gained a firm foothold over the past few decades as technology leader in all segments from general to high-end. In the meantime, WITTENSTEIN develops complete, single-supplier solutions for driving any axis. Power density, product quality and reliability are just as much a part of the WITTENSTEIN alpha brand essence as innovative vitality – as demonstrated by our intelligent upgrade spanning several product groups in the high-end segment.



their right-angle versions

– result in extraordinary positioning accuracy and repeatability, especially in applications in the high performance machine tool sector. Linear applications with a rack and pinion are a further field of use for this gearhead – for instance, as an integral element of the new Premium Linear System.

Right-angle stages provide optimum performance when space is limited

Both planetary gearhead series can also be supplied in a right-angle version, so that the high power density of the XP+ and RP+ can be optimally exploited, even in confined spaces. Customers can choose between versions with beveled or hypoid teeth.

Emphasis on design friendliness

Rack-and-pinion solutions as optimized, preferred linear systems

- Perfectly matched components
- Very high efficiency
- Maximum power density
- Easy mounting
- Different sizes

Linear systems

Reflecting modern feed force, positioning accuracy and smooth running requirements, the WITTENSTEIN alpha portfolio of linear systems consists of economical rack-and-pinion solutions with scaled performance – Value, Advanced and Premium – which are optimally adapted to each application.

Value Linear Systems with the NPR planetary gearhead are designed for comparatively low requirements and thus represent a particularly cost-effective solution for linear applications. Advanced Linear Systems with SP+ and TP+ planetary gearheads are adequate for mid-range to high requirements. They convince with excellent value for money and can also be combined with the HIGH TORQUE and HIGH SPEED gearhead variants. The re-engineered Premium Linear System is distinguished by very high overall linear stiffness and achieves excellent feed force and positioning accuracy values. It exploits the improved dynamics and the increased torque and power density offered by the new XP+ and RP+ planetary gearhead generations in both the coaxial and the right-angle versions.

Even easier configuring

All linear systems are also available as design friendly “preferred linear systems”. Customers can select them either directly from the catalog or using the cymex® 5 sizing software.

High performance, corrosion resistant planetary gearheads in a hygienic design from WITTENSTEIN alpha meet even the most stringent requirements of the food packaging industry.

Highly dynamic
and hygienic packaging

Packaging machine manufacturer MULTIVAC and WITTENSTEIN alpha worked in concert to set a new industry standard for corrosion resistant gearheads. The DP+ planetary gearheads, originally designed for delta robotics applications, satisfy not only the strict hygienic regulations of the food industry but also the high performance requirements for delta robots used in pick & place applications.

A motor with a **DP+ planetary gearhead** from WITTENSTEIN alpha is mounted to each gripper.

Sven Sanitz, Sales Manager at WITTENSTEIN alpha's Engineering Office South-East in Ottobrunn, (left) and Kurt Waizenegger, responsible for Design and Development within the MULTIVAC Systems division, (right) got together to adapt the corrosion resistant WITTENSTEIN alpha gearheads to MULTIVAC's specific requirements.

As a member of the EHEDG (European Hygienic Engineering & Design Group), WITTENSTEIN alpha has been a pioneer of hygienic planetary gearheads for many years now. "This is due not least to our cooperation with companies such as MULTIVAC, which consistently applies hygienic design principles in its open machine concept – and also insists on them for components like the planetary gearheads for delta robots", explains Sven Sanitz, Sales Manager at WITTENSTEIN alpha's Engineering Office South-East in Ottobrunn. "The reason is that washdown processes in the food sector – in other words, cleaning the machines at high or low pressure using chemical cleaning materials and disinfectants – demand drive and automation components providing above-average stability." However, Kurt Waizenegger, responsible for Design and Development within the MULTIVAC Systems division, does not believe in enclosing standard gearheads to protect them against external influences: "In our opinion, encapsulating the complete drive unit invariably has pitfalls", he adds. "It never guarantees a perfectly tight seal. If condensate forms in the encapsulation or heat builds up, this can lead to thermal problems for the electronics. That's why we decided that each component should also meet the hygienic requirements individually."

Consistent and uncompromising: No chance for germs

An illustrative look at the packaging and handling modules suffices to comprehend MULTIVAC's enormous commitment to hygienically designed machines. The portal structure comprises a welded, latticed, stainless steel frame with inclined surfaces, from which liquids can drain off freely and completely after cleaning or disinfection, for example. The frame section is easily accessible for wet cleaning and is free of undercuts, internal corners, gaps and dead spaces in which dirt could accumulate. The same also goes with regard to the integrated delta robot. Here, too, easy cleanability is a design feature, so that germs no longer stand a chance – any more than they do with the DP+ planetary gearheads which, as part of the drives for the robot axes, are supported in the top part of the open portal structure.

DP+ planetary gearheads – more than clean, more than the industry standard

The starting point for developing the hygienic DP+ planetary gearheads in a stainless steel housing was an existing standard gearhead coated with hygienic paint. On the one hand, it had previously achieved excellent results in a simulated five-year endurance test at MULTIVAC. "On the other, we wanted to make sure that its resistance to corrosion would not be impaired either at installation time or subsequently during operation, for instance as a result of flaking paint or other damage", Waizenegger continues. The outcome was a corrosion resistant gearhead variant, built according to hygienic principles, that also makes a strong impression when it comes to compactness, dynamics and power density, especially in delta robotics applications. It takes up less space, and is easily accessible, because it is accommodated in the portal frame – and the costs for integration are lower. The gearheads are screwed to the output flange of the robot's upper arms; these in turn move the articulated lower arms, which have no drive of their own, fast and precisely in all directions.

"The hygienic design of the planetary gearheads fulfills the requirements of all relevant guidelines and directives as well as EHEDG recommendations, among others", Sanitz comments. The austenitic stainless steel which was chosen offers maximum resistance to corrosive fluids of the type stipulated for washing down and disinfecting machines used in food processing applications. All other exterior parts like the output, the screw connection and the plug for the adapter plate are naturally also made of stainless steel, as are the adapter plates themselves. The easy-to-clean housing design prevents dirt and liquids from accumulating – and cleaners of all kinds can drain off freely. And since a food grade, non-toxic, class UH1 6 high performance gear oil is employed, the gearheads also run maintenance-free and are lubricated for life. Hygienic design is not restricted at WITTENSTEIN to the DP+ planetary gearheads; in addition to other WITTENSTEIN alpha gearhead series, servo actuators from this same Business Unit and small servo drive systems from WITTENSTEIN cyber motor also profit. And the hygiene pioneer's portfolio is still growing...

MULTIVAC

Efficient packaging with a high throughput

With around 5200 people on the payroll worldwide and over 80 service and sales companies, MULTIVAC Sepp Haggenmüller SE & Co. KG – at home in Wolfertschwenden (Bavaria) – is an internationally operating developer and manufacturer of the most diverse packaging solutions, from vacuum chamber machines for butcher's shops to fully automated, integrated packaging lines for all kinds of foodstuffs as well as life science, healthcare and industrial products.

To meet the specific needs of the food industry, MULTIVAC has developed its own delta robots, which have provided successful service for many years now. Apart from precision, speed is a vital requirement: the H 244 handling module, for example, produces at a speed of up to 120 pick & place cycles per minute depending on the product weight and pick distances. MULTIVAC and WITTENSTEIN alpha conceived the corrosion resistant DP+ planetary gearheads, which meet the rigorous hygienic and performance requirements reliably, for delta robots working in the wet areas of food packaging and filling plants.

cyber® kit motors

Frameless servo motors

A special market with special requirements

"A customer project generally begins with special requirements concerning the footprint, weight, integration or power and torque density of a motor. Sometimes, however, clients simply want to keep as much added value as possible within the company or have the motors adapted to their own corporate design. Thanks to the cyber® kit motors, we can now comply with extremely varied requirements", explains Christoph Weis, Product Manager at WITTENSTEIN cyber motor.

Distributed windings typically have a long service life and low cogging torque.

Nothing but the motor – frameless, bearingless and encoderless

Rotor and stator – this is essentially what the cyber® kit motors are comprised of, even though they can be extended with numerous options such as sensors, mechanical interfaces, liquid cooling or a special cable outlet. By varying the stator outer diameter, laminated core length, hollow shaft diameter and rotor variant, these motors can be either power or torque optimized. A performance range from 10 W to 200 kW, with outer diameters from 19 mm to 440 mm, can be covered in this way. "We start off with existing motors and use our sizing tool to calculate various predefined determinants of the cyber® kit motor such as voltage, temperature, frequency and current. We then adapt the torque-speed characteristic as precisely as possible to the requirements of the application", outlines Dr. Kay-Horst Dempewolf, Head of Development Automotive & Servo Drives.

Small batch manufactory for maximum flexibility

The WITTENSTEIN portfolio in the servo motor sector encompasses an array of sizes, designs and performance data. "The share of frameless servo motors is steadily increasing", observes Joel Frey, Manager Stator Production. "That's why, in the more recent past, we've invested heavily in stamping tools for customized laminated cores as well as in equipment for winding, impregnating and encapsulating stators." The result is a highly specialized manufactory for small batches, which is embedded in the optimized production and logistics structures and processes of the Innovation Factory. "It enables us to manufacture precision motors like the cyber® kit motors in low volumes – which can be anything from one to a few thousand – individually yet in a commercially efficient way", Dempewolf continues.

Special winding expertise

He and his colleagues are manifestly proud of their expertise when it comes to stator windings. The majority of our stators are manufactured with a so-called distributed winding, which typically has a long service life and low cogging torque, among other things. The exact winding design and the achievable copper fill factors are determined by requirements such as speed, torque, voltage and current consumption. Concentrated or – to meet particular safety exigencies – redundant windings can also be supplied on request. "We do all the actual winding by hand. The wires are inserted into the slot with great care and no mechanical stress, to avoid damaging the insulation", Frey points out. "It's a job that demands considerable sensitivity and the ability to keep calm at all times, which is why it's only ever entrusted to very experienced specialists. This also means we're capable of responding flexibly to whatever batch size the customer wants." Once the stators have been wound, they are either impregnated with resin or sealed with epoxy, including the winding head. "We recommend the latter method whenever the motor will be exposed to severe stresses or the specification calls for maximum possible heat dissipation", says Christoph Weis.

The customer decides

Finally, every bespoke cyber® kit motor is verified in the test lab. "The customer can then either integrate the frameless motor in the application themselves – with support from us if needs be – or take advantage of our offer of forward integration by sending us all separately provided parts and letting us assemble everything into a ready-to-install system. EHRT Maschinenbau GmbH is one client that chose the second option. Tobias Campe, the firm's Head of Construction, sums up the benefits: "WITTENSTEIN has the know-how and the tools to expertly assemble the motor and all the parts we supply. We would never have managed to develop the necessary capacities and processes in view of the short lead time of just six months. Aside from that, we are now also free to focus very effectively on our own core competencies." You can find a detailed account overleaf of the various other assets our cyber® kit motors have for this manufacturer of punching and bending machines.

With their compact design and ease of integration, the frameless motors provide maximum freedom when designing new machines.

Made to measure **exactly**

To design a direct drive for thread forming tools – this was the challenge at the center of a joint development project by EHRT Maschinenbau GmbH and WITTENSTEIN cyber motor.

EHRT Maschinenbau GmbH of Rheinbreitbach has been developing and producing punching and bending machines for more than 50 years now. During the last half a century, the company has grown to become a world leader for precision machining of flat materials thanks to a series of inventions and innovations – such as busbars and components for the construction of heavy-current switch cabinets. One particularly innovative project was recently implemented in cooperation with WITTENSTEIN cyber motor.

No suitable standard motors existed

A customer in the electrical industry approached EHRT inquiring whether it would be possible to punch round holes in flat copper material and form threads inside them with a single machine. The client's clearly stated requirement was that punching and forming should be even faster, more economical and more flexible than was so far the case. "No standard solutions existed as yet. They were all either too large or unable to deliver the specified torques", says Tobias Campe, Head of Construction at EHRT Maschinenbau. "After searching for a while for a suitable solution, we contacted the specialists at WITTENSTEIN." Within a very short time, development teams at the two companies got together to design a drive solution for the SingleTap, as the built-in thread forming tool is known.

Frameless cyber® kit motor as a customized drive solution

The concept which has meanwhile been realized is based on a frameless motor that was already available. "Both the rotor and the stator length and diameter were adapted absolutely flexibly to the mounting situation in the drive unit", explains Andreas Winters, the man responsible at EHRT for new development projects. "We opted for a bearingless, encoderless design in order to reduce the overall height, improve robustness and simplify integration into the machine." However, not only the size and connection are optimal – the performance of the SingleTap drive unit is equally impressive. "The countersunk boss in the punched holes holds the rotating tap and the tool is then drawn into the material automatically", Campe adds. "And if the thread forming tool happens to get stuck in the material, the drive briefly delivers up to 40 Nm of torque to enable it to break free again."

Prepared for condition monitoring functionalities

Throughout the thread forming process compliance with defined torque tolerances is monitored by the electronics based on the motor current. "The advance of Industry 4.0 is accompanied by increasingly digitalized production processes, and we've taken the opportunity to implement condition monitoring, for example", Winters continues. "If not enough torque is applied, this could point to a quality problem

It is now possible to punch round holes in flat copper material and form threads with a single machine.

The drive module developed for the thread forming tool as a cooperative venture between EHRT Maschinenbau and WITTENSTEIN cyber motor is not simply an interesting option for CNC punching machines.

such as a hole that has been punched too large. And if there's too much torque, the tool could rapidly approach the wear limit and need replacing very soon. Another possibility is that the machine has been fed with the wrong material. The SingleTap allows process and quality parameters to be monitored and documented to a certain extent, so that appropriate action can be taken where necessary.

Impressive example of successful forward integration

The roles within this partnership were clearly charted out: EHRT manufactured drawing parts for the jointly developed drive unit, while WITTENSTEIN not only designed a frameless motor to the customer's specification with components from our own cyber® kit motors basic toolkit but also assembled and function-tested the complete drive in defined processes. Both companies were thus free to concentrate optimally on their core competencies – reason enough to continue their successful cooperation in the future. Several ideas and sketches have already changed hands.

The spindle with the forming tool is driven at approximately **500 rpm**

Within a very short time, development teams at EHRT and WITTENSTEIN cyber motor got together to design a drive solution for the SingleTap.

Professor Asa Barber, an attocube customer at the University of Portsmouth (UK), and his team of research scientists have discovered that limpet teeth are the strongest natural material known to man – stronger even than spider silk, which has held the record up to now.

Snails have **teeth**

istock.com/susanemarley

Limpets (Patellidae) have a conical-shaped house anything between one and ten centimeters high and live mainly in the surf zone.

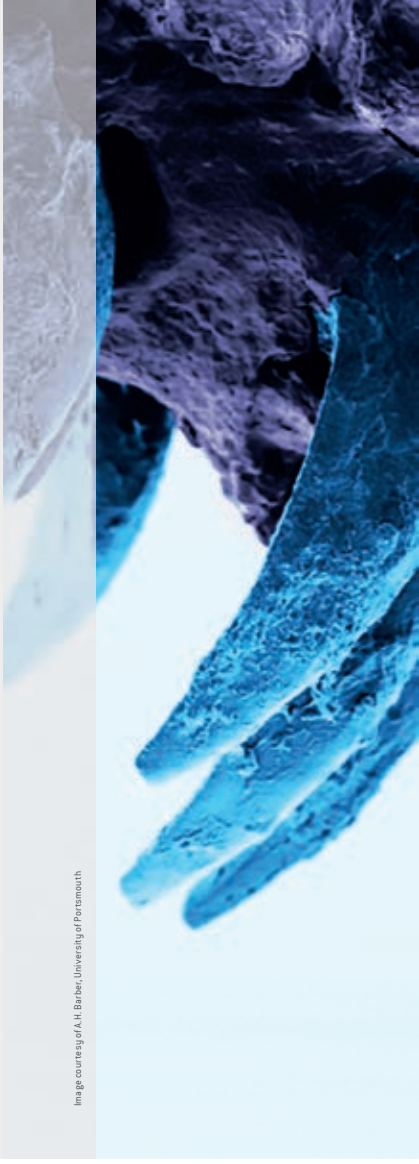


Image courtesy of A.H. Barber, University of Portsmouth

Limpets are conical-shaped creatures that are found clinging well-camouflaged to rocky shores braving the surf. Their entire organism has adapted optimally to life on hard, stony surfaces. They remain almost motionless all day long in exactly the same place until darkness sets in – then rasping over the rocks set off in search of food. They remove algae by scraping it off with their tongue, which is embedded with rows of teeth that are never blunted.

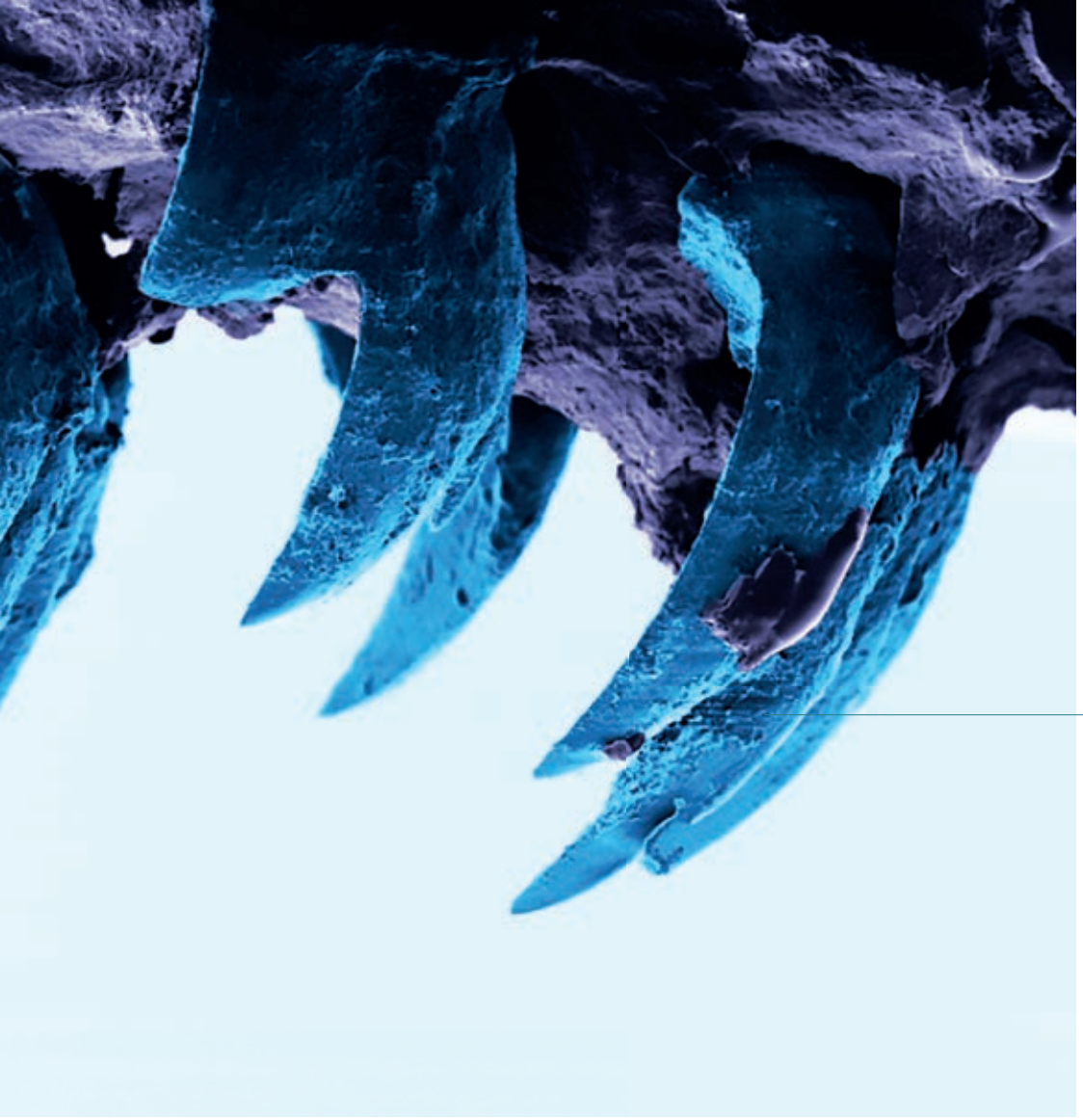
The key substance in these teeth is a hard, iron based mineral known as goethite, which allows the sea-dwellers to gnaw away at the rocks night after night.

The fibers themselves are no more than 3 microns long – or about 2000 times thinner than a human hair. Special systems are vital to investigate such tiny materials or specimens, which are no longer visible to the human eye. Professor Asa Barber, the scientist who led the study, is a long-time customer of WITTENSTEIN subsidiary attocube systems AG, which develops and manufactures drive and measurement systems for cutting-edge nanotechnology applications at its Munich facility. The attoAFM/SEM atomic force microscope is one of the products in its portfolio. This 3D micropositioning system was part of the experimental setup in Portsmouth – a microscope in a microscope, as it were.

The fiber ends were stuck to the two sample tables of the attoAFM/SEM and then moved apart at a rate of one micrometer per second. The tensile strength of ten fibers was determined in this way. The findings, published in the "Journal of the Royal Society Interface" were truly amazing: the strength of the limpet teeth fibers was about five gigapascals. They are stronger than spider silk and as resilient as man-made carbon fiber, making them the toughest biological material ever discovered. If researchers can manage to completely decipher the structure and composition of limpet teeth and adapt them to industrial applications, endless new possibilities will be created – for engineering, aerospace and automotive.

The limpet itself, of course, is totally unimpressed by the discovery of what will probably be one of the most important materials in tomorrow's world. It continues to wait day after day for darkness to fall, then deploys its miracle weapon again for its own purposes.

Original publication: A.H. Barber, D. Lu, N.M. Pugno, "Extreme strength observed in limpet teeth", J.R.Soc. Interface 12, 20141326 (2015)



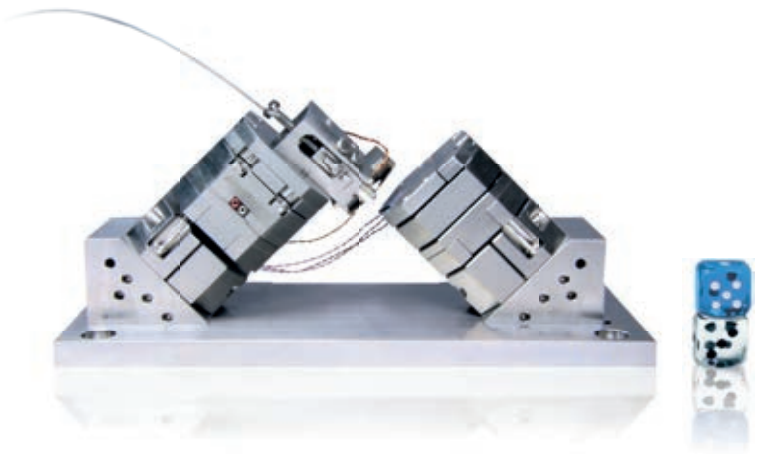
The tongue of the limpet is embedded with rows of tiny teeth, only visible under a microscope, whose fibers have a strength of about **5 gigapascals**.

attocube

attocube systems AG, a wholly owned subsidiary of WITTENSTEIN SE, is recognized internationally for innovation and excellence in the development, production and distribution of cutting-edge solutions for the most challenging nanotechnology applications in research and industry.

The portfolio includes nano drives, used for highly accurate positioning tasks and surface analyses, as well as ultra-precise distance sensors and fully integrated microscope and high performance cryostat systems, which work close to the limit of what is technically and physically feasible.

Atomic force microscope attoAFM/SEM



The attoAFM/SEM atomic force microscope from WITTENSTEIN subsidiary attocube was part of the experimental setup at the University of Portsmouth, where researchers discovered the toughest material known to man.

attoAFM/SEM

Operating temperature: 300 K
Operating pressure: 1E-9 mbar to 1 bar
Scan range: 40 x 40 x 15 μm^3 @ 300 K

Galaxie® Drive System

Superiority proven in practice

Since making its debut at the Hannover Messe 2015 – where it was presented with the "Hermes Award" – and winning the "Innovation Award of the German Economy", the Galaxie® Drive System has captured more and more applications in high performance engineering.

»Galaxie® achieves axis stiffness three times greater. Apart from a huge increase in precision and repeatability, that also significantly improves the control characteristics of the entire drive train.«

VOLKER SPRENGER,
START-UP MANAGER GALAXIE SYSTEMS AT WITTENSTEIN

Deeply committed to the Galaxie® Drive system (from left to right): Nadine Hehn (Sales Engineer), Tobias Burger, Volker Sprenger (both Start-up Manager Galaxie Systems) and Bastian Minke (Sales Engineer)

With its exceptional freedom from backlash, synchronous running and stiffness, the Galaxie® Drive System enhances machine performance and the quality of processes and products. It also causes existing design strategies to be overturned – as the examples described here demonstrate.

Farewell to mutually preloaded gearheads

In the past, engineers have gone to incredible lengths to develop drive solutions that are at once absolutely backlash-free, stiff and precise. Depending on the task at hand and the type of gearhead, for instance, designers have elected to screw the housings together directly, couple the output shafts rigidly by means of meshed elements or turn and clamp the input shafts in opposite directions. Until Galaxie® arrived on the scene, this was the state of the art – in the meantime, it's the WITTENSTEIN-built drive system that is itself setting technology benchmarks. It doesn't have to be assembled and adjusted in a complicated procedure and it takes up much less space in the machine. The Galaxie® Drive System avoids serious drawbacks, in other words, yet provides much better precision with alternating loads than preloaded systems. A manufacturer of optical glass workpieces, whose grinding processes have been improved several times over thanks to Galaxie®, heaps great praise on the drive system for this reason – just like a maker of machine tools, where Galaxie® has resulted in clearly superior precision and machining quality in a spindle's swivel axis.

Farewell to screw drives

A South German manufacturer of machining centers recently bid farewell to the traditional screw drive. This decision was based on two grounds: one, the precision of a worm gearhead deteriorates in the course of its life – no matter how exact it was originally designed to be – because the preloaded screw is subject to local wear. Two, the complete motor-gearhead unit used to be so large that it restricted the freedom of movement of the tool's opposite swivel axes. The Galaxie® Drive System is smaller, leading to a slimmer enclosure and better ergonomic accessibility. At the same time, it permits efficient, simultaneous and highly precise five-axis machining of even the most complex geometries. Galaxie® Drive Systems are permanently backlash-free and the fact that the drive no longer requires any maintenance is a welcome side effect – making the machine platform an even more attractive proposition for the manufacturer's customers.

Farewell to chatter marks

In another application, Galaxie® was selected for the C axis of a portal milling machine, where previously a motor with a shaft ring gear was fitted. Owing to the gear's low rigidity, the fork-type milling head had irregular damping and vibration characteristics. Unsightly chatter marks in the milled surface were the upshot. Galaxie® achieved axis stiffness three times greater and significantly improved the torque capacity and overload protection. The visible consequence: no more chatter marks – and a decisive quality boost.

Galaxie® set to become a series

In practice, Galaxie® transforms technical benefits into genuine success factors for users, compared both to standard gear types and to preloaded systems. It is therefore not surprising that the overwhelmingly positive feedback has inspired us to pave the way for a complete series. More highly integrated versions of this compact drive systems are planned for the near future – for example for applications where axial mounting space is severely restricted, extreme flexibility and agility are essential for all movements of the milling head movements or axis motions take place inside the machine's working range.

The list of potential applications is almost infinite...

Zero backlash in the drive

Precision is not a problem

Freedom from backlash for the maximum possible precision and quality, more rigidity for higher metal removal rates and innovative potential for future machine generations – the WITTENSTEIN Galaxie® Drive System creates a wealth of added value for MAKA, the German machine tool manufacturer.

The rapid and problem-free integration of the Galaxie® Drive System into a standard machine that had already been shipped to a customer in Taiwan is a particularly compelling example. At the same time, it isn't really astonishing – "because we'd already verified the drive system extensively on the test bed and found it to be excellent", says Dr. Jens Muckli, one of two Managing Directors at MAKA Systems GmbH. The machine builder is a global player and the prompt availability of the Galaxie® Drive System in the relevant local regions is an important advantage.

MAKA Systems: CNC machines for a variety of materials

MAKA Systems GmbH of Nersingen, not far from the South German city of Ulm, employs more than 170 people who develop and manufacture special CNC equipment for machining wood, aluminum, plastics and composites as well as for model making. Dr. Muckli sums up the essence of the MAKA brand: "For more than 60 years now since the company was first founded, we've been crafting solutions that meet the very highest technical and commercial standards, and with our rich development expertise we're currently a leading international specialist in the field". High accuracies with the smallest possible

tolerances as well as fast machine cycles and machining speeds with virtually no non-productive times – these are just a few of the key benefits of MAKA's CNC technology. Markus Hepp, Team Leader Development at MAKA, puts it in a nutshell: "Precision breeds quality. Both the A and the C axis of the cutting head are constantly in motion. That's why each individual axis has to be absolutely precise." The old solution consisted of a drive with more backlash. Yet the larger this is – regardless of the material – the larger the contour tolerances will be, especially since the precision errors soon start to add up.

Zero backlash drive system integrated in a standard machine

This explains why MAKA was so tempted by the prospect of a drive system with zero backlash – the promise made by the Galaxie® Drive System. This hope quickly yielded to certainty thanks to successful trials on the test bed, and at the latest following the problem-free conversion of a standard machine that had already been shipped to Taiwan. "We can now cut contours even more precisely and repeatably", Hepp continues. "What's more, the compact design of the Galaxie® Drive System gives the cutting heads greater kinematic flexibility, meaning we can achieve even more complex geometries, for instance when machining the interior fittings for cars." The zero backlash, improved stiffness and high dynamics of this compact drive system enable machining at high speeds.

Innovative potential for new machine generations

Another quality feature of MAKA's CNC machines is their rigid design, leading to remarkably precise and quiet machining processes. Thanks to the Galaxie® Drive System's unmatched stiffness and freedom from backlash at the zero crossing, even with alternating loads, MAKA can in future construct the complete machine with even more rigid geometry. Jens Muckli looks ahead with confidence: "The new generation of machines will be able to execute machining processes more precisely than ever before. A broader range of materials will consequently be possible because the machines will be even more robust and capable of cutting even harder and coarser workpieces."

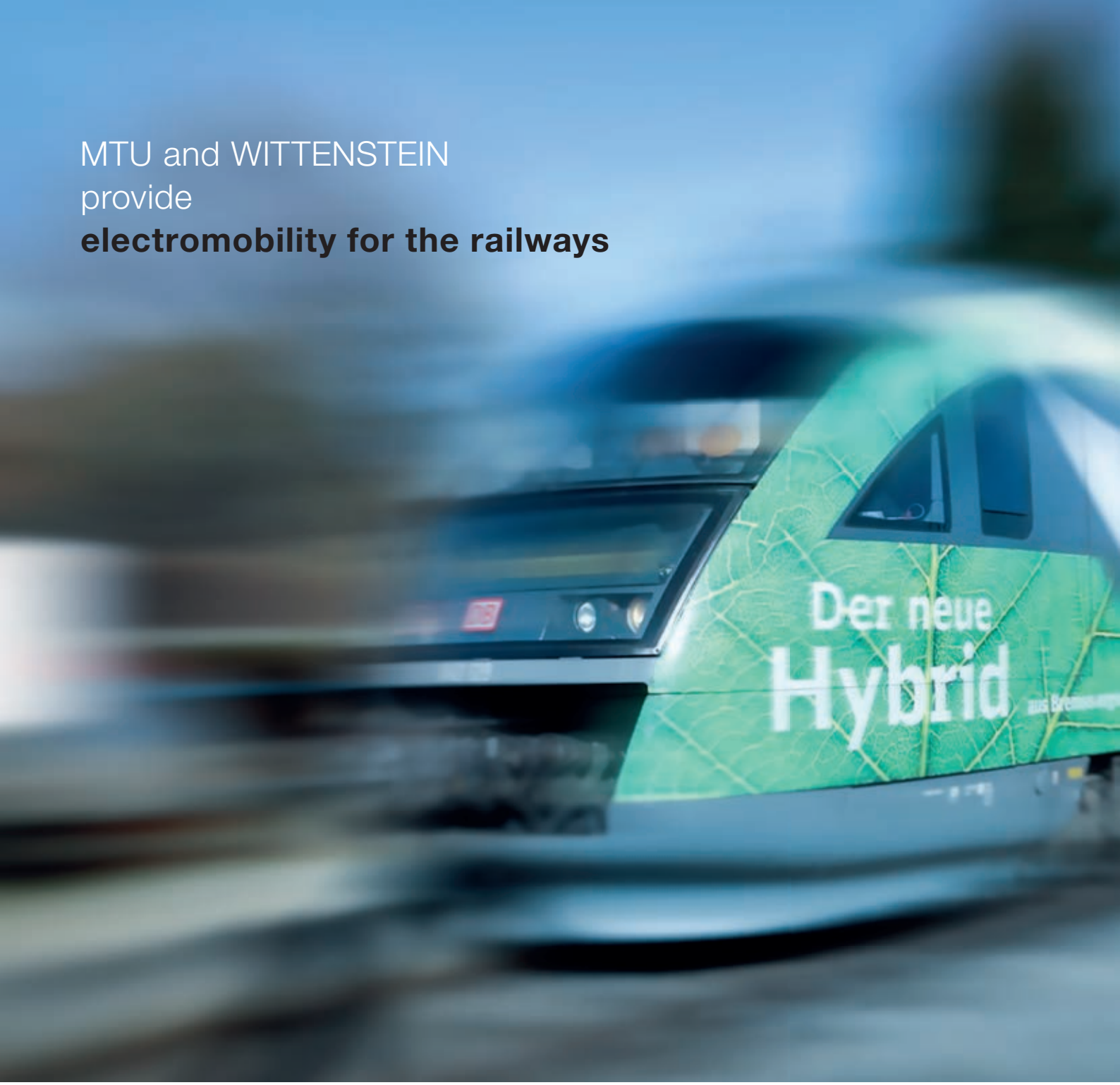
For MAKA, too, the Galaxie® Drive System is a "Next Technology Drive".

The compact design of the Galaxie® Drive System gives the cutting heads greater kinematic flexibility, meaning MAKA can now achieve even more complex geometries.

The **Galaxie® Drive System** fuses a brand new gearhead generation, in which each tooth is an independent and dynamic entity, with a newly developed high performance motor to form an ultra-compact hollow-shaft drive system.

Dr. Jens Muckli (center), Managing Director of MAKA Systems GmbH, in conversation with WITTENSTEIN. He particularly praises the torsional rigidity of the completely backlash-free Galaxie® kinematics, which is between three and six times better.

MTU and WITTENSTEIN provide **electromobility for the railways**



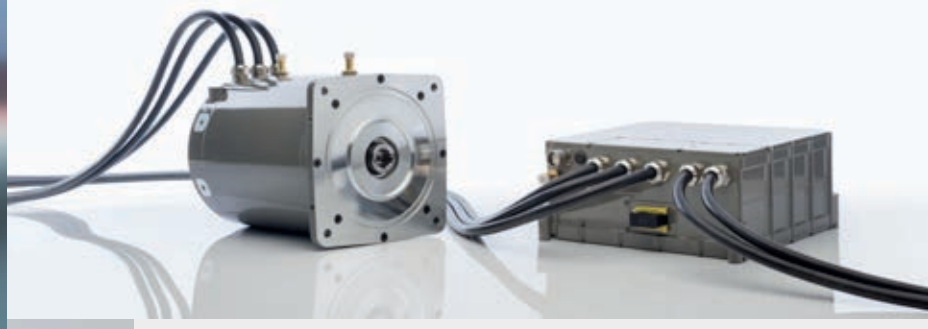
Diesel trains running in pure electric mode?
Yes, they really do exist – with crucial benefits like reduced fuel consumption, fewer emissions, less noise and lower costs, hybrid drive technology is all set to conquer the railways too in the future. This innovative form of electromobility is made possible by the close cooperation between MTU Friedrichshafen GmbH and WITTENSTEIN cyber motor GmbH.

Photo: MTU Friedrichshafen GmbH

MTU's Hybrid PowerPack reduces diesel consumption by up to 25 per cent and NO_x emissions by as much as 20 percent.

Reduced fuel consumption, fewer emissions, less noise, lower running costs – the hybrid drive technology for diesel powered rail vehicles which was developed jointly to market maturity by MTU Friedrichshafen GmbH and WITTENSTEIN promises to deliver all of that. Both the electric drives and the power electronics for the Hybrid PowerPack were contributed by WITTENSTEIN cyber motor as a development partner; the company also manufactures both system components as standard products.

High performance components



The outcome is the Hybrid PowerPack – a drive assembly for diesel powered rail vehicles, in which two electric motors with around 200 kW of continuous power output and associated power electronics support the MTU diesel engines, which deliver up to 390 kW. They can even replace these engines temporarily – for instance when a train enters or leaves a station in pure electric mode.

MTU Friedrichshafen: A pioneer of PowerPack technology

MTU Friedrichshafen GmbH is one of the world's leading manufacturers of large diesel engines and complete propulsion systems. They are used, among other things, in shipping, energy supply systems, heavy vehicles and railcars. The Rail PowerPack launched by MTU in 1996 is a drive module integrating all of a diesel drive's components in a standardized underfloor unit. Not only fitting vehicles with original equipment but also maintenance and retrofits have been made much simpler and more affordable when measured against the traditional practice of individually assembled components. From Siemens through Alstom to Bombardier, MTU-built diesel PowerPacks currently drive some 6000 low-floor vehicles from a variety of manufacturers.

Plenty of good arguments for electrified diesel drives

"The project for a hybrid diesel-electric drive kicked off about ten years ago", recalls Thies Schwanke, Manager Electrical Machines Research & Technology at MTU. The reasons are manifold. Even today, only about sixty percent of the German rail network is electrified. Conversely, this means that around 15,000 km of track, or nearly 10,000 miles, have no overhead contact line – and are hence predestined for hybrid powered rail vehicles. On the international front, the degree of electrification is lower in most countries than it is in Germany – in other words, an even higher basic need exists for hybrid drive technology for diesel locomotives.

There are also several real economic and ecological benefits – as confirmed by extensive practical trials on two lines covering a total of 15,000 kilometers. Compared to purely diesel powered rail vehicles, hybrid trains achieved fuel savings of up to 25 percent (approximately 50,000 liters of diesel per year depending on the actual vehicle and the line on which it was operated) as well as a corresponding 132,000 kg reduction in CO_2 emissions and 20 percent less NO_X. Finally, the exhaust-free, and to a large extent noise-free, driving in railway stations – up to 21 decibels quieter than classic diesel trains – are environmental arguments speak for themselves.

»Apart from WITTENSTEIN's expertise with regard to drives and controls and the predictability of the budget throughout the development phase right up to the prototype, it was their willingness to assume responsibility for the project's implementation that especially impressed us«

THIES SCHWANKE
MANAGER ELECTRICAL MACHINES RESEARCH & TECHNOLOGY
MTU FRIEDRICHSHAFEN

The Rail PowerPack launched by MTU in 1996 is a drive module integrating all of a diesel drive's components in a standardized underfloor unit.

This diesel hybrid option for the railways is equally impressive from an economic point of view: the reduction in fuel costs due to the recuperation of braking energy plus the use of the energy which is recovered in this way for acceleration, the more efficient supply to the vehicle's electrified auxiliary drives and the lower maintenance requirements – for example, because there is less brake wear – make the hybrid drive a particularly cost-effective solution that pays for itself within only a few years. The hybrid technology even has macroeconomic benefits in that it allows nonelectrified branch lines to be operated more affordably and disused lines recommissioned if necessary without the high costs normally associated with electrification. "That all adds up to enormous future potential for rail vehicles with hybrid drive technologies", explains Dr. Peter Riegger, Director Research & Technology at MTU Friedrichshafen GmbH.

WITTENSTEIN is the ideal project partner

In order to turn the vision of a hybrid diesel drive for rail vehicles into a reality, MTU had to integrate an electric motor into the existing Rail PowerPack. "The original idea of developing the electric motor and the power electronics in-house quickly gave way to a development partnership with a specialist in the field", Schwanke recollects. WITTENSTEIN didn't simply convince us with profound know-how and expertise in technology development and project management; they were also able to provide the manufacturing capabilities for future series production." A concept study was initially agreed in 2014. This led to a development order and eventually to the first close-to-series prototype in 2016.

Electric drive completely redeveloped

The electric drive system for the MTU Hybrid PowerPack, including the control technology, was completely redeveloped by WITTENSTEIN on the basis of the jointly drafted specifications. It consists of two permanent magnet electric motors in a compact design with a high power density as well as the two associated traction converters with a CAN bus interface to the powertrain control system. "During a journey the electric motors act as energy converters", Schwanke adds. "When functioning as a motor, to accelerate the vehicle for example, they convert electrical energy from the energy storage system into mechanical energy. As generators, when the vehicle is braking, they convert mechanical energy into electrical energy and charge the energy storage systems." These systems – several battery modules mounted on the roof, in the interior or underfloor – store energy and make it available to the electric powertrain. The electrically switched separating clutch decouples the electric motor from

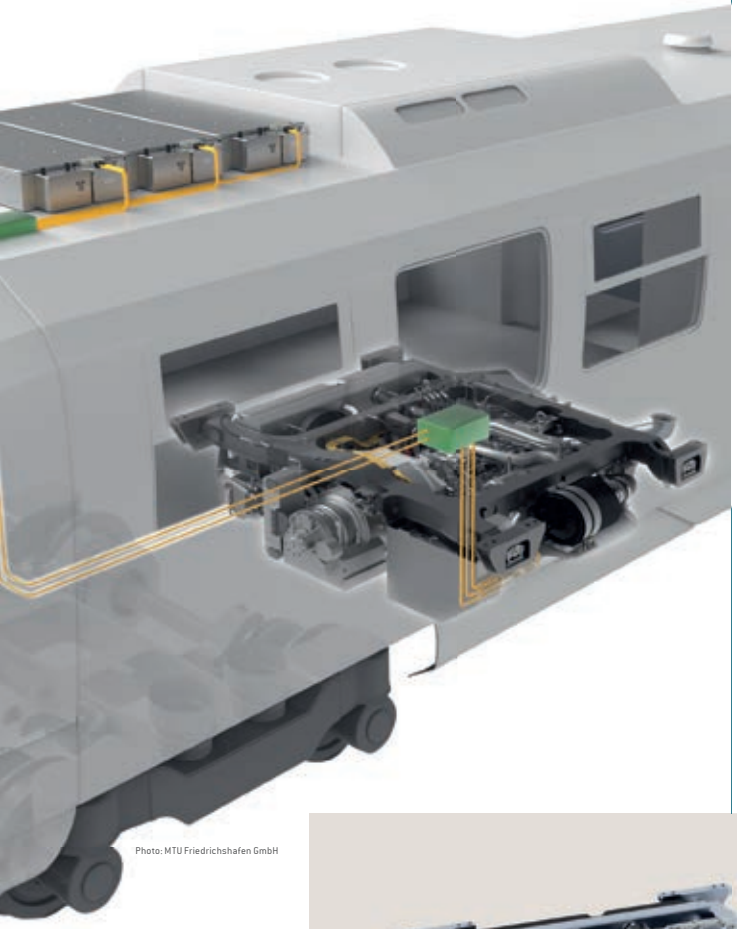


Photo: MTU Friedrichshafen GmbH

The **WITTENSTEIN electric motor** has a rated mechanical torque of 150 Nm, a short-time maximum torque of more than 300 Nm and a specified maximum operating speed of 10,000 rpm.

The **WITTENSTEIN traction converter**, which supplies the necessary three-phase current for the electric motor, has a rated current of 240 A; it provides the full continuous electric power output of 185 kVA in an overload protected voltage range from 610 to 730 VDC.

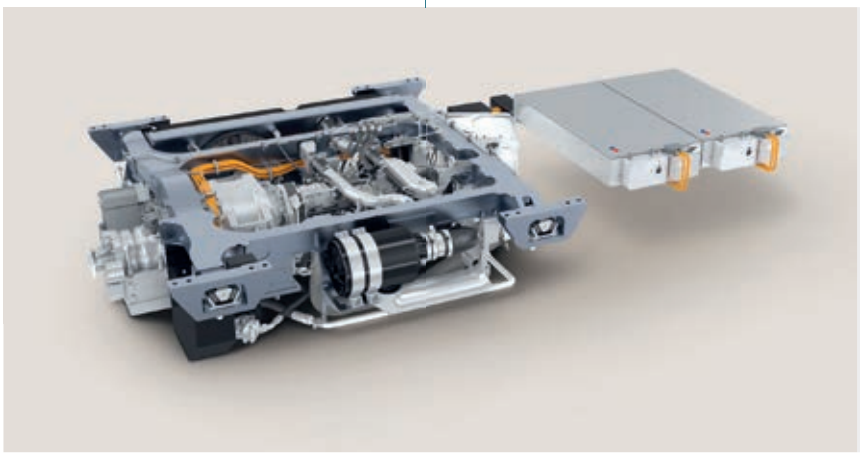


Photo: MTU Friedrichshafen GmbH

Hybrid PowerPack

It was absolutely vital that the entire electric powertrain should also be integrated in the underfloor unit without modifying its dimensions.

the diesel drive – enabling locally emission-free driving by the hybrid vehicle in pure electric mode without the diesel engine having to be "lugged" mechanically.

The traction converter supplies the necessary three-phase current for the electric motor. "The CAN bus of the traction converter is the interface for controlling the powertrain, but it also permits several traction units to be operated parallel to one another on a single physical CAN network, which is vital in complex drive systems in order to simplify the wiring", Schwanke remarks. "The CAN bus is additionally used to read out error messages or alarms and to communicate standardized diagnostic information."

Perfect example of a focused partnership

The development of the traction system, consisting of an electric motor and associated frequency converter, is the outcome of a development and implementation project in which several different departments at MTU and WITTENSTEIN cooperated very closely and engaged in a regular and trustful exchange of ideas and experiences. "Bringing together these various areas of knowledge was an interesting challenge", comments Schwanke, looking back. All in all, nearly 40 people from development and shop-floor departments were involved, from which a core team with about eight members, interacting very strongly, was formed. "Apart from WITTENSTEIN's expertise with regard to drives and controls and the predictability of the budget throughout the development phase right up to the prototype, it was their willingness to assume responsibility for the project's implementation that especially impressed us", Schwanke confesses. "From the outset, the entire electric drive system was designed in line with production requirements, so as to assure smooth and commercially efficient series manufacturing."

WITTENSTEIN has thus also started the ball rolling as a potential MTU partner in other fields of use for hybrid technology – such as ships and haulers, agricultural machinery and snow groomers, heavy mining vehicles or pump drives for oil and gas exploration.

Prosperity for everyone

Can you run a company successfully yet nevertheless act ethically? Is that actually possible? Dr. Manfred Wittenstein, who celebrated his 75th birthday on September 2, believes it is and cites several good reasons for accepting responsibility. Not simply as an entrepreneur, not simply as an engineer but as one of the countless people who want to create a good future for themselves and their children.

This portrait was taken in July 2017 in the foyer of the WITTENSTEIN Innovation Factory at the headquarters in Igersheim-Harthausen – where several works by German photographer Michael Najjar are on permanent display, including "Outer Space" which is partially visible in the background.

Dr. Manfred Wittenstein
Chairman of the Supervisory Board
WITTENSTEIN SE

Life has been kind to us. We were lucky enough to be born in a region where our existence is not threatened by natural disasters and war does not rage. Yet how does this gift of good luck impact on our daily lives? Can we use it to create opportunities that benefit society as a whole? It's still only a dream today, but it's my firm conviction that we can achieve prosperity – and a future worth living in – for everyone.

I grew up among people who were marked by World War II. They hastened through life searching for the economic prosperity that would give them back the security they had lost. In my youthful arrogance I knew that this was not the way I wanted to lead my own life. I left home to become a student at TU Berlin. No more war – that was the slogan and the mission awaiting us, and we engineers were no exception. This was the world I wanted to live and teach in.

But then I was needed to help out back in Igersheim. What followed were my "années folles", my crazy years when new departures and wrong tracks alternated in rapid succession. The responsibility for my employees bore heavy on me – and the responsibility for a company that was in danger of capsizing in heavy seas bore no less heavily on my employees. Yet in the end we made it. Together.

So how did we manage it? Maybe because I never forgot that my opposite number might just possibly be right too. With compelling arguments. Or with sheer stubbornness.

Some time later, when the most difficult years lay behind us, I asked my closest collaborators why they hadn't instead chosen to leave the sinking ship. Why they had worked through so many nights to get those orders out on time. They told me it was because they had a family to feed and because the firm needed them. Yet when I think back to all the hours we spent together at the workbench, I'm sure there must have been far more to it than that. I believe that, even though it was something we never really spoke about, we all knew we could only make it together as a team.

In the years that followed, I always tried to honor this special company spirit. Our philosophy reflects this with the words "responsibility, trust, openness, innovation and change". These words describe how we act and how we would like to live: we regularly have to inject new life into them.

WITTENSTEIN, the mechatronic technology corporation that emerged from a crisis-hit family business, has traditionally looked upon itself as a part of society at large. We've consistently done our bit to make the Tauber Valley, our local region, an attractive place for people to live. Our efforts have been rewarded because there were, and still are, many other companies in pursuit of a similar goal. Together, we've made pretty good progress in this respect.

Our attempts to shape our commitment in those countries where we opened a subsidiary were likewise driven by a sense of responsibility. It's easy to get the impression in this day and age that in both the United States and the United Kingdom the end of this particular road has been reached. Do we have time to wait until the pendulum swings in the other direction?

We, and indeed the entire human race, are facing a host of difficult challenges. Let me give you just two examples: how close are we to the point at which the overheating of our planet due to CO_2 emissions becomes irreversible? What hopes are cherished by all those people who set off on the perilous journey across the Mediterranean to mainland Europe?

Ever since I first embarked on my degree course, I've been convinced that technology can help make the world a better place. Not only in the Tauber Valley and not only in Germany, but everywhere on this planet of ours. Yet the ideas we engineers and scientists come up with can only ever make a meaningful contribution if they're based on a broad social consensus.

After all, technology is never simply good or bad – that's something only the demagogues would claim. A hammer fits just as snugly into the hand of the DIY enthusiast banging in a nail as it does in the fist of a murderer who uses it to smash his victim's skull. Despite all assertions to the contrary, it remains impossible to predict the long-term consequences of technical developments. I can remember very clearly how excited we were when a way was first found to keep food fresh for longer using cling film. And today? We worry about the huge quantities of plastic scrap floating around in the oceans.

Our future, which has to be a future for everyone, is worth whatever effort it takes. There is no doubt whatsoever in my mind that we humans avail of an incredible reservoir and potential that will steer us to the right solutions provided we all search for them together. I'm well aware that this is a very optimistic view of the future. I admit to being an optimist. It would be pointless being anything else.

Anyone who knows a little Greek will need no telling that “isos” means “equal”. The three letters ISO actually stand for the International Organization of Standardization, which coordinates country and industry-specific standards all over the world. ISO 9001 is one of the most important – it defines the requirements for structuring and controlling processes within a company. A new edition with revised content is published roughly every seven years. The latest, most up-to-date version is: ISO 9001:2015

ISO 9001:2015

Same highest-level quality – worldwide

Since the middle of the year, all manufacturing locations of the WITTENSTEIN Group have been certified to ISO 9001 – the North American and Swiss subsidiaries in accordance with the standard’s latest revision, namely ISO 9001:2015. “We’re certainly not resting on our laurels, though”, says Dirk Barth, Director Quality Management Worldwide at WITTENSTEIN SE. Preparations are currently under way for the next scheduled audit at our Romanian facility in December – where we are likewise hoping to obtain the newest version of the certification. “Our German plants will follow suit next year. WITTENSTEIN will then meet uniformly high QM standards worldwide.”

Constantly searching for ways to improve

Quality management has long been a vital precondition of success in the international markets. Mark Farny sums up what his work is all about: “Customers don’t want a piece of paper, nor do they want a logo or a stamp – they want quality”. He is responsible for the quality management system within the WITTENSTEIN Group. He and his team use this system to constantly review and scrutinize the quality of all products, processes and services with the help of audits, many of them internal: “All departments are up for one about once every two years. We take a look together to see exactly where the strengths and weaknesses lie and where there is cause for criticism. And above all, we identify potential areas for improvement.” Customer complaints are also a useful source of ideas, of course. In the end, the old adage still applies: it’s better if the customer comes back than the product. Barth: “In short, the ISO certification tells customers that a solid foundation exists. That they can rely on a particular manufacturer or a particular supplier.”

ISO is a given today

“QM certification plays an absolutely decisive role in the States. It enables us to prove our quality, our efficiency and our reliability to our customers.” Peter Riehle, CEO WITTENSTEIN North America, and Jim Fanning, his Quality Manager, speak with one voice: “An aerospace company like Boeing would never have selected us as a supplier without that certification”. And Andreas Tinner, Managing Director of WITTENSTEIN Switzerland, adds:

“The successful certification of our rack manufacturing line testifies to our quality – and that’s exactly where the biggest benefit for our customers lies.”

Representatives from the WITTENSTEIN Headquarters and the management of our Romanian subsidiary spent three days reviewing the production and assembly processes in Sura Mica, a short distance from Sibiu, and identifying, documenting and optimizing potential areas for improvement, to ensure that the facility there is optimally prepared for this December’s ISO 9001:2015 pre-certification audit.

Trade fair calendar 2017/18

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

SPS IPC Drives
Nuremberg, Germany
WITTENSTEIN alpha GmbH,
WITTENSTEIN cyber motor GmbH
November 28 to 30, 2017

SCF System Control Fair
Tokyo, Japan
WITTENSTEIN Ltd.
November 29 to December 1, 2017

ESE Kongress
Sindelfingen, Germany
WITTENSTEIN high integrity systems
December 4 to 8, 2017

ATX West
Anaheim (CA), USA
WITTENSTEIN holding, Corp.
February 6 to 8, 2018

Indumation Network Event
Brabanthal-Leuven, Belgium
WITTENSTEIN BVBA
February 22, 2018

LogiMAT
Stuttgart, Germany
WITTENSTEIN cyber motor GmbH
March 13 to 15, 2018

Shenzhen international machinery manufacturing exhibition (SIMM)
Shenzhen, China
WITTENSTEIN (Hangzhou) Co., Ltd.
April 9 to 13, 2018

China CNC machine tool fair (CCMT)
Shanghai, China
WITTENSTEIN (Hangzhou) Co., Ltd.
April 9 to 13, 2018

Drives & Controls Exhibition
Birmingham, UK
WITTENSTEIN Ltd.
April 10 to 12, 2018

Hannover Messe
Hannover, Germany
WITTENSTEIN Group
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