

motion

01.2015

THE MAGAZINE WITH DRIVE



Light AS
AIR



WATCHMAKING INDUSTRY

- 04** Fascination of movement
FAULHABER motors ensure gentle movement of the finest luxury watches

WATCHMAKING INDUSTRY

- 08** Smooth operation
FAULHABER subsidiary MPS produces miniature ball bearings

AEROSPACE

- 10** Light as air
Drive Systems are taking off in cabin equipment

MEDICAL SCIENCES AND LABORATORY DEVICES

- 14** Root canal treatment without stress
Quiet FAULHABER drive solutions that won't get on your nerves

ENVIRONMENTAL AND PERSONAL PROTECTION

- 18** The enclosure makes it possible
Pump drive in EX-protected housing

AEROSPACE

- 22** Historic milestone in space flight
Interview with Dr. Stephan Ulamec, project manager for the Philae lander, Deutsches Zentrum für Luft- und Raumfahrt e. V. (DLR)

SUSTAINABILITY

- 26** Self-sustaining knowledge for the future
Series of FAULHABER events in 2015

NEWS

- 27** Infotainment
New FAULHABER website with multimedia elements and responsive design



Dear readers,

When flying above the clouds, comfort and its associated technology need to be as light as possible: Airline passengers desire ever more convenience at the push of a button, whereas the airlines themselves would like to and must save fuel. These conflicting priorities give rise to a huge sphere of activity for FAULHABER drive systems, especially in view of the rapidly growing number of passengers. Thanks to our decades of experience, we have a significant advantage over our competitors, particularly when it comes to increasing demands with regard to reliability, weight and power density. In our title story, we explain current developments, who the trendsetters are, how FAULHABER delivers the desired comfort while remaining "Light as air" – and why our motors were previously "too good" for many of these applications.

You will also find out how filigree craftsmanship in the watchmaking industry meets modern drive technology, why DC microdrives make root canal treatment a more relaxed affair, what is currently happening on the comet 67P/Churyumov-Gerasimenko, who ERWIN is – and lots of other fascinating news and information from the high-tech world of FAULHABER. We hope you enjoy reading this edition!

With very best regards,

Dr. Fritz Faulhaber
Managing Partner

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Publisher/Editor:

DR. FRITZ FAULHABER
GMBH & CO. KG
Schönaich · Germany
Phone: +49(0)7031/638-0
Fax: +49(0)7031/638-100
Email: info@faulhaber.de
www.faulhaber.com

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WATCHMAKING INDUSTRY

Fascination of **MOVEMENT**





FAULHABER provides gentle motion for the finest watches

The object wouldn't be out of place in a gallery or museum. There the constant and interlocking movement of the watches would be interpreted as a three-dimensional metaphor for the eternal mystery of time. In actual fact, the sight of a rotating and revolving sculpture at an art exhibition was the "big bang" for M&E. Its founders took the fascination evoked by this work of art back to the development workshop. They combined it with sophisticated technology and exquisite details to create a luxurious product in every sense. At its heart is a motor from FAULHABER which provides gentle motion for the finest watches in the world.



Alexander Merklinger is a passionate unorthodox thinker and inventor. His passion for tricky mechanical tasks pursues him even in his spare time. It's no wonder that he is also a keen enthusiast and collector of high-quality mechanical watches. These mostly have automatic movements which wind up the watch normally as a result of motion by the wearer. Of course, this won't work if a watch is lying motionless in a cabinet, which is unavoidable if you happen to have several watches in your collection.

Motion instead of setting

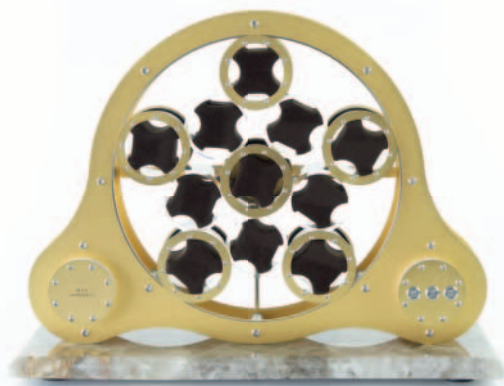
If the watch stops, winding up and setting by hand can be quite time-consuming, especially if the timepiece has additional complications such as the display of date, day of the week, moon phase and so on. Merklinger had already planned to purchase a watch winder to keep in motion those timepieces that he wasn't currently wearing. After he had visited the above-mentioned exhibition, he decided to build such a device himself.

And so began the development of a new type of watch winder that not only keeps the little mechanical works of art in gentle motion but also forms part of an aesthetically appealing all-embracing objet d'art.

The basic mechanical concept of the LumiSidus is characterised by its simplicity: The cylinders in which the watches are attached roll over each other and in this way keep each other in motion. Only the central cylinder has to be driven. The technical implementation of the idea also follows the principle of simplicity and clear lines. "The term "non-positive connection"



Technology meets simple elegance



LumiSidus 11
24-carat gold



LumiSidus 11
platinum ruthenium

is often used in technology", explains Alexander Merklinger, "this means that the rollers are in no way linked to one another, they simply touch each other at their outer surfaces. The motion is transmitted only as a result of the cylinders rolling off each other." For the entire device to function, these cylinders as well as the two outer retaining rings must be made with extreme precision. To assemble the watch winder, nine cylinders made of metal and perspex are simply placed in the frame around the driven central cylinder; stable connection of all elements in the system is not established until the eleventh cylinder is mounted.

No noise to disturb the meditative calm

Its counter-rotating motion emanates a meditative calm as the cylinders appear to float without the aid of gearwheels, belts or other means. Ten cylinders rotate not only about their own axis, but – like planets around their central star – also about the central cylinder. Of course, no drive noise is allowed to disturb this majestic performance. "One reason why we opted for the FAULHABER motor was because it doesn't make a sound when in operation", says Merklinger. "The extreme quietness of this motor clearly distinguishes it from all other motors available on the market."

The silent operation was an important factor but not the only requirement that M&E placed on the motor, recalls Hendrik Stockhaus, sales expert at FAULHABER: "It also had to be invisible, that is to say small enough to disappear in the largely transparent structure. However, it also has to deliver a high torque in order to keep the eleven cylinders in constant motion while moving at a very low speed. And, of course, it had to achieve all this reliably over a long period of time without maintenance."

After detailed consultation with the customer, the most suitable gear motor was selected. Thanks to its extreme reduction ratio, it can even operate at one tenth of a revolution per minute (0.1 rpm) – the actual speed of the LumiSidus watch winder is between 1 and 2 rpm. In keeping with the most Swiss watches circling in a LumiSidus winder, the little powerhouse is made at FAULHABER Minimotor in Croglio (Switzerland).

The motor is the central element of an all-embracing work of art and is made only from the highest quality components. For example, the stainless steel frame can also be supplied with a gold or platinum coating. The pedestal is made of either black granite or precious crystals (smoky quartz or agate). In their natural form, the latter do not reach the size needed to supply a plate of adequate size. For this reason, individual pieces of crystal are joined together in an

DC MOTORS

- Smooth running operation and smooth movement
- High torque in small dimensions



CYCLE OF THE TIMEPIECE

elaborate process to form a seamless plate that looks as if it has grown naturally and is a work of art in itself.

App controls light and motion

An integrated lighting system using LEDs that are set in a groove in the stone give these crystal pedestals a mysterious lustre. Using the LumiSidus app, the owner can have the device light up in every imaginable colour. Incidentally, the watch winder derives its name from the idea of planetary motion and light: LumiSidus is a combination of the Latin words for light (lux, lumen) and orbiting celestial body (sidus).

Whoever entrusts their watches to a LumiSidus winder will be sure to enjoy the splendid brilliance and majestic circling motion of their prized posses-

sions. The interval between changes in rotation direction can also be set using the app. "In some watches, the rotor which is responsible for automatic winding only runs in one direction", explains Alexander Merklinger. "This is why the direction of rotation must change at regular intervals so that every watch is wound up reliably."

The LumiSidus watch winders made their début at the Munich Time trade show last autumn after full-capacity production began in the summer. "We source all components and materials from Germany and Switzerland", emphasises Merklinger. Although still new on this exclusive market, the newcomer from Mannheim has already found a number of prospective customers and partners. Just a few years after their "big bang", the heavenly bodies of LumiSidus are already circling in a steady orbit.

Integrated lighting system using LEDs



FURTHER INFORMATION

M&E Uhrenbeweger Manufaktur GmbH,
Weisenheim am Berg
www.lumisidus.com

FAULHABER Germany
www.faulhaber.com

SMOOTH operation

FAULHABER subsidiary MPS produces miniature ball bearings

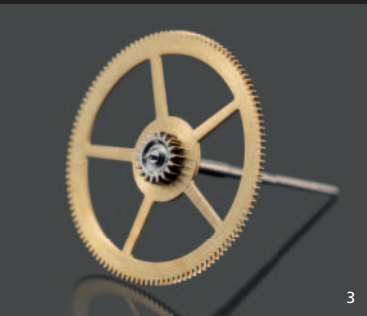
High-quality wristwatches are manufactured in several countries. However, the "Swiss watch" is and remains the byword for mechanical time measurement all over the world. Switzerland's edge over its rivals is based on long tradition, a unique accumulation of know-how as well as a broad infrastructure of top-class supplier companies. These companies manufacture the high-quality parts from which the coveted chronographs are made and which are often miniature marvels in themselves. For example, the almost microscopic miniature ball bearings from MPS.



1



2



3



4

- 1 | Due to the combination of maximum dimensional stability and minimum friction, the four-point contact ball bearing from MPS is used in many precision applications in addition to the watchmaking industry.
- 2 | Sunburst finish – MPS uses an innovative technique to give the visible components a resistant surface decoration.
- 3 | The MPS department for assembly technology specialises in the manufacture and assembly of gear train elements like this one.
- 4 | The Myrox ball bearing for watches is made completely of ceramic.





Almost 30 million wristwatches are manufactured in Switzerland every year – that's only one fortieth of total worldwide production. With this modest share, however, the Swiss watchmakers generate 54 percent of the global turnover in this branch. At over 700 US dollars, the average price of a Swiss watch is more than two hundred and forty times higher than that of a watch produced in China. This difference certainly also has a little bit to do with the prestigious names such as Rolex, Omega, Patek Philippe and IWC. However, it is mainly attributable to the intricate precision engineering that characterises the exquisite Swiss timepieces and that transforms them into miniature high-performance machines.

Compensation of earth's gravitational pull

In these watches, complications such as a stop-watch with split-time measurement or a perpetual calendar are housed in a watchcase measuring just a few centimetres – together with the "normal" watch movement and, of course, without impairing the accuracy of the watch. In particularly high-quality models, accuracy is further increased by means of a so-called tourbillon which is an elaborate mechanism that counters the effect of the earth's gravitational pull. Hundreds of moving parts must interact perfectly and reliably so that such watches can be produced and function continuously and precisely.

One of the biggest enemies of accuracy and durability is friction. To minimise friction, miniature ball bearing are used in high-quality mechanical watches. These mostly come from MPS. "A ball is at the core of all our products. We build a wide range of different bearings and systems around it", explains Véronique Athané Ryser, production manager at the Biel/Bienne site (Switzerland). "Apart from the watchmaking industry, we also supply products to other branches such as the medical technology sector and the aerospace industry, where maximum precision and reliability are of prime importance. And this is closely linked to the quality of the balls."

Weeks of grinding

The balls are made from sections of drawn stainless-steel wire or from ceramic zirconium oxide granulate. In both cases, processing can take up to several weeks. In a multistage process, the tiny raw components are first formed into balls on grinding discs with precisely shaped grooves, ground finer and finer on numerous discs and finally polished. When they are ready, the maximum deviation in diameter, roundness and surface roughness is in the nanometre range. All balls – 35 to 40 million leave the factory

every year – undergo several final checks, including visual inspection under the microscope. Here skilled employees roll a batch of balls, of which the smallest have a diameter of just 0.14 millimetres, backwards and forwards in a kind of pill box. Their trained eyes pick up any remaining deviations and anomalies – after the balls have already been examined and measured by machine.

On the other side of the highlands, directly on the French border, in Bonfol, MPS Watch resides and builds probably the tiniest ball bearings available in the market. The smallest have an outer diameter of just 1.28 millimetres.

Pioneer in ball bearings

"In 2004 we were the first manufacturer to use ceramic balls in clockwork bearings. Since last year we have offered Myrox, the first fully ceramic ball bearing", says Frédéric Chautems, factory manager in Bonfol. "Ceramic is considerably harder than metal and is practically indestructible. It does not need lubrication and still achieves extremely low friction coefficients." MPS also manufactures the components of the bearing housing – ring, core, cone and cage – itself because here too the utmost precision and reliable quality is crucial. Assembling the balls and housing into a functioning bearing is an art in itself and is performed by hand by highly specialised, mostly female employees.

Apart from the ball bearings, other watchmaking elements are also produced in Bonfol, e.g. turned parts, rotors or a mounting kit for the tourbillon that makes the installation and removal of this ingenious complication easier. Thanks to an extremely innovative development department, MPS has registered many patents and, technologically, has a considerable edge over its competitors – and not only in the case of ceramic bearings.

FURTHER INFORMATION

MPS Micro Precision Systems SA,
Biel/Bienne, Switzerland
www.mpsag.com

FAULHABER Germany
www.faulhaber.com



ROBERT VARONIER

Area Sales Manager
FAULHABER International Sales

Light A S

AIR

Drive Systems are taking off in cabin equipment

In 2011 there were 15,556 passenger planes and almost as many private jets in operation worldwide. If predictions prove correct, this figure is set to double in the next fifteen years. At the same time there is a marked trend towards equipping aircraft cabins with additional features that provide comfort at the push of a button. This will require an increasing number of small electric motors which, of course, must be as reliable, light and powerful as possible. Drives from FAULHABER are predestined for this area of application – and this is not only the opinion of Robert Varonier who coordinates activities in this market segment for FAULHABER. We spoke to him about the present and future of the motorised flying experience.



Who needs a motorised touchless toilet seat?

Some passengers in business jets or flying first class place particular importance on not having to touch the seat. This is why an automated toilet seat with sensor and motor was presented at the air trade show in Hamburg last year. This may be a somewhat unusual example of the constantly increasing range of comfort features, but it clearly demonstrates the underlying trend.

How would you characterise this trend?

The trendsetters can be found in private and business jets where there is virtually no financial limit to equipment and features. Here tables and holders for tablet computer are raised and lowered at the push of a button, and window blind systems are automated. Equipment and features that prove successful in this segment are often adapted for use in first class and then later in business class. For example, we saw these years ago when motorised seat adjustment was first introduced. Premium economy class, which is now offered more and more frequently, is likely to be next to adopt a number of comfort technology features.

Which requirements must motors used in aircraft cabins fulfil?

The most important requirement is reliability. Nothing must fail or break during a flight. And, of course, this also means that the maintenance intervals should be as long as possible. Weight is the second most important requirement. Every kilo increases fuel consumption, which is why airlines demand equipment that weighs as little as possible. Electricity consumption is not really an issue for airlines – the fans of the air-conditioning system alone probably use more electrical power than all of the motors in the cabin put together. However, a high power density, i.e. a lot of power from a small mass and therefore also from a small amount of electricity, is of course very important.

Reliable and convenient seat adjustment all the way to the "lie-flat" position thanks to lightweight and high-performance FAULHABER drive systems

What does this mean for FAULHABER?

When it comes to drive solutions, the lists of requirements from airlines and cabin outfitters could almost be mistaken for our product brochures. They put in a nutshell how our products stand above those of our rivals, especially with regard to power density, reliability and maintenance intervals. In fact, you could say that normally an aircraft will have been taken out of service long before a FAULHABER drive needs to be replaced. Recently, airlines have tightened their specifications considerably, and that throws open new opportunities for us.

Can you explain that in more detail?

Today, the majority of motors in aircraft cabins are found in the first-class and business-class seats. Originally, the manufacturers of the seats were primarily automotive suppliers. In this branch, the motors used are for the most part mass-produced items that, however, no longer satisfy the new requirements. This is where our motors, which were previously "too good" for this application, come into play. We can deliver precisely that what customers need – particularly as we offer functional drive systems consisting of motor, gearhead, brake and encoder.



BRUSHLESS DC-MOTOR

Ø 32 mm, length 42 mm
Torque 53 mNm



THE MOTOR WEIGHS JUST 192 GRAMS

What are the benefits for the customer?

The individual drive components are optimally matched to one another, work perfectly together and thus achieve a very high level of efficiency. We use, for example, extremely high-quality planetary gearheads. The encoders detect the movement of the shafts in high resolution and therefore allow very precisely regulated and smooth adjustment. The brakes are particularly important in cases where locking is required. And, of course, all components meet our high quality standards. We have 60 years of experience in maintaining a leading position in our particular field of technology.

What experience has FAULHABER so far had in the aviation industry?

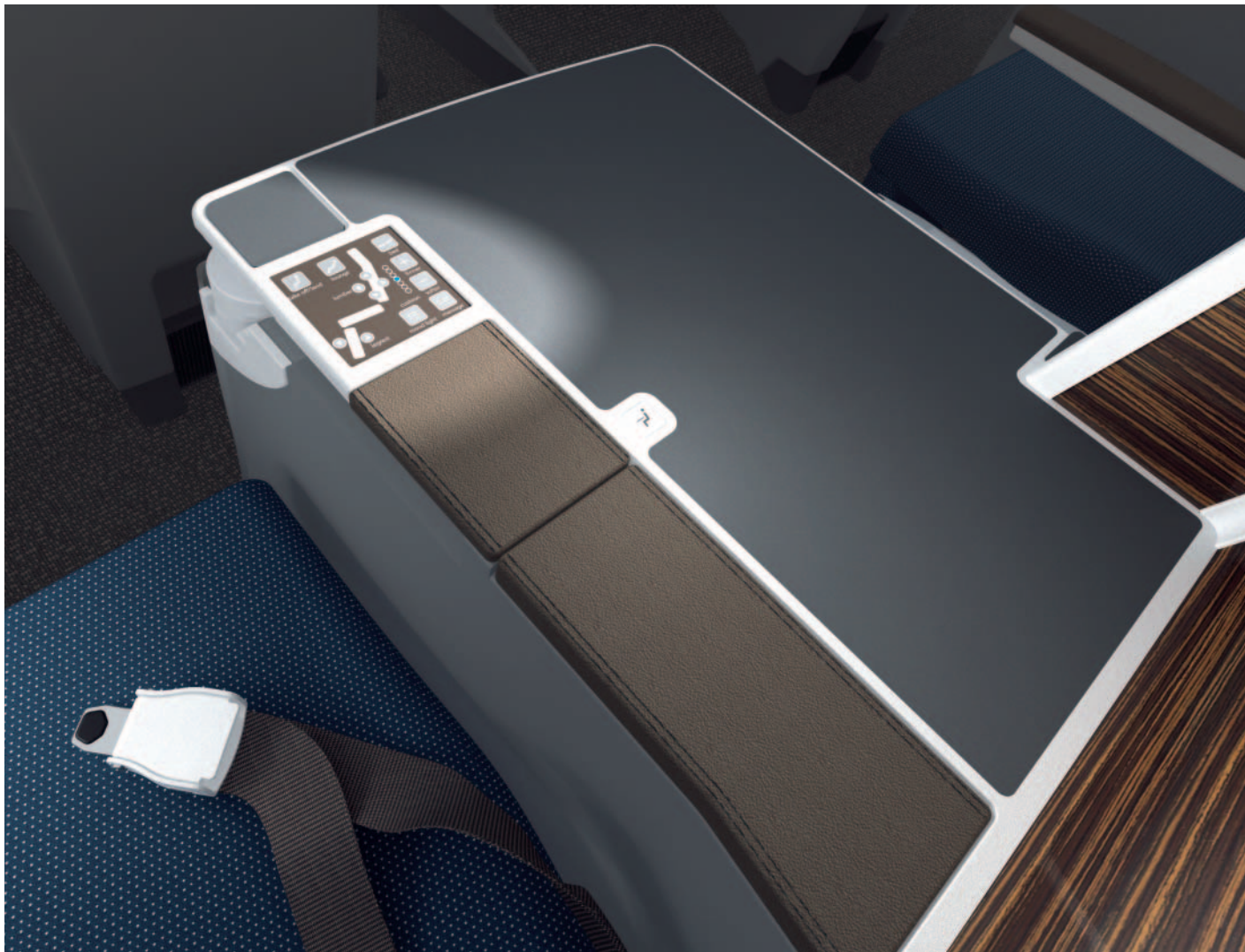
We have, for example, been supplying drives used for adjusting first-class seats for more than fifteen years. The window shutter in the business class of the Airbus A 319 is powered by a brushless motor that weighs just 192 grams – our 3242 BX4 model. FAULHABER motors can also be found in many safety-critical applications, such as in the locking mechanisms for cabin doors, for emergency exits or for the pilot's seat which must be fixed at a certain position during take-off and landing. Another application is the adjustment of valves which regulate the pressure in the air-conditioning system.

Where do you see potential for additional motorisation?

The onboard entertainment systems of the business class – individual, fold-down screens – are increasingly becoming motorised, and something similar may also be in the pipeline for the economy class. In addition, more and more passengers want to use their own tablet for which there are now also motorised holders. In the higher-class area, tables and partition walls, which are being installed more and more, are equipped with motor drives. Lowerable armrests to allow unobstructed access to the seat are also increasingly used. Last but not least: Manufacturers of business jets and especially Arabian airlines are most definitely interested in the motorised toilet seat mentioned previously.



Simple and precise operation
of passenger window blinds: quiet
and smooth



Top:
Maximum comfort with electric
seat adjustment, motor-operated
extendible table or tablet holder

Left:
Always "online" – Internet
access at your own seat thanks
to optimum on-board antenna
positioning in real time during
the entire flight

FURTHER INFORMATION

FAULHABER Germany
www.faulhaber.com

MEDICAL SCIENCES AND LABORATORY DEVICES

ROOT CANAL TREATMENT

without **STRESS**



Quiet FAULHABER drive solutions that won't get on your nerves

Endodontics or endodontology is a specialist area of dentistry. The most common procedure is the root canal treatment that a tooth receives in the case of inflamed pulp (also known as the "dental nerve"). Many of you will have experienced this procedure at first hand: The dentist removes the "nerve", cleans the root canal and then fills it. This treatment requires extreme care and is by no means simple because the tooth is to be preserved and the patient must then remain free of pain for as long as possible. New knowledge, methods and systems now ensure that difficult root canal treatment procedures can today be performed successfully and with minimal discomfort for the patient. Modern drive technology has made a significant contribution to this. FAULHABER DC-microdrives are the driving force of new endodontics systems that are today becoming more common in dental practices.



The TCM Endo is an extremely compact and user-friendly endodontics instrument.



Successful treatment of the dental root requires great expertise, special technical equipment, special instruments and materials, a great deal of time and a high degree of manual dexterity from the treating dentist. The pulp tissue has to be completely removed from the root canal, together with any bacteria and necrotic material. The canal walls must be treated uniformly without changing their shape and form and without excessive weakening of the root so that the filling remains in place for as long as possible. If these steps are performed to optimum effect, teeth which not long ago would otherwise have to be removed can today be saved.

Quiet technology that fits well in the hand

Modern automation technology has also contributed to progress made in endodontics. A good example of this is the endo motor system TCM Endo R11 that has been developed by Novag AG based in Goldach (CH) on Lake Constance. The elegant, extremely compact and user-friendly instrument makes the careful cleaning and treatment of the root canal easier for the dentist and therefore makes a decisive contribution to the success of the procedure.



Essentially, the new system consists of three components: the controller unit which has a clearly structured display that shows the treating dentist all the important information, a foot pedal that functions as the ON and OFF switch, and the hand unit. The latter comprises the handpiece with drive unit and an angled section with replaceable dental mills which is driven by the drive unit and allows ergonomic work even in inaccessible places.

THE MOTORS PROVIDE A HIGH DYNAMIC PERFORMANCE AND PRECISE SPEED CONTROL



DC-MICROMOTOR

Ø 15 mm, length 24 mm
Torque 2.9 mNm



The perfect drive: small, powerful and quiet

Finding a suitable drive for the handpiece proved to be quite difficult. Principal requirements were not only compact dimensions but also a torque of 1 to 5 mNm in the speed range from 60 to 500 rpm. Low-vibration and quiet operation were of course also desirable in order to permit precise and concentrated work and to eliminate any unpleasant noise for the dentist and patient during treatment. Gearhead noises were therefore also to be avoided. Since the dentist works in the oral cavity, noise and vibrations are transmitted directly into the auditory canal, can therefore be heard very clearly by the patient and often evoke negative associations.

It's no wonder therefore that DC-micromotors from the FAULHABER range with their smooth-running and low-noise operating characteristics have proven to be particularly suitable for this field of application. With a diameter of 15 mm and a length of just 24 mm, the 1524 series DC-microdrives used in the handpieces of the endo system were easy to integrate. Thanks to their high power density, the motors are not only compact but also light. They weigh just 18 g, which is another positive feature for this particular application. After all, the system is to ensure precise, fatigue-free operation even in the case of prolonged treatment periods or if a large number of patients are treated during the course of one day. The motor is combined with a two-stage and extremely quiet spur gearhead which has a reduction ratio of 11.9:1. Together with the motor, the drive unit measures just 33 mm in length.

Low inertia and cogging-free operation

FAULHABER DC-microdrives differ from other types mainly with regard to their design: Their rotor does not consist of a laminated sheet package but instead of a self-supporting, skew-wound copper coil. This rotor, which is referred to as a bell-type armature, therefore has a very low weight and boasts an extremely low inertia and cogging-free movement. As a result, the motors provide a high dynamic performance and precise speed control. Owing to their low contact resistance, the precious-metal commutation systems have also proven ideal for low-power motors. Furthermore, thanks to their linear characteristics, the DC-micromotors are easy to control. It was possible to integrate the corresponding actuation unit easily in the drive electronics of the endodontics system.

FAULHABER DC-microdrives have in the meantime been tried and tested in the new endodontics systems. Since the middle of 2014, both dentists and patients have benefited from this effective treatment of dental root disease.



Compact combination of DC-micromotor and spur gearhead. The slimline drive unit can be incorporated easily in the handpiece of the treatment instrument.

FURTHER INFORMATION

NOUVAG AG, Goldach
www.nouvag.com

FAULHABER Switzerland
www.faulhaber.ch



ENVIRONMENTAL AND PERSONAL PROTECTION

THE **ENCLOSURE** is the --- DISTINCTIVE FEATURE

When a customer-specific development is needed, reliable DC motors and controllers are a good basis. In a flameproof casing, the duo consisting of motor and Motion Controller can perform tasks even in potentially explosive atmospheres. A masterpiece in terms of development that proves itself not least of all on critical ground – and that's what systems in chemical engineering are.



Systems used in chemical engineering applications require certified explosion protection



The enclosure establishes the basis for ATEX and EX certification



As with so many good projects, it began with the cooperation of competent partners. Here, the mechatronic experts from the Mattke company in Freiburg and the drive technology engineers from FAULHABER make a good team. Last but not least, good and solid drive technology from Schönaich serves as the ignition spark for creative ideas.

The task of the specialists from Freiburg was to use a brushless FAULHABER motor with Hall sensors and a Motion Controller with RS232 interface to construct an explosion-proof system. The fact that Mattke is well versed in the world of movement is apparent in motto of the firm's 50th anniversary: "Mattke moves", to be celebrated later in 2015.

The development goal of the collaboration between Mattke and FAULHABER was to create a suitable drive for a micro annular gear pump (mzr® pump). This is where the third partner came into play, the pump specialist HNP Mikrosysteme from Schwerin. The design of the pump was already specified, as the pumps are successfully used in numerous customer systems. The possibility of obtaining an ATEX motor with integrated control would allow additional customer requests to be satisfied that could not

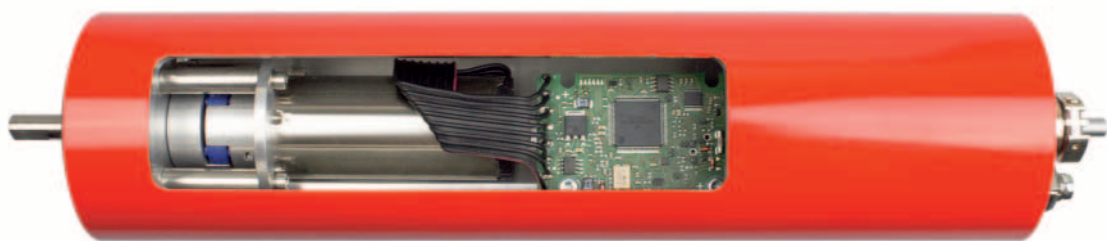
previously be met. There was a discussion early on with Faulhaber and Mattke about desires regarding function and design; the two motor specialists realized the technical implementation. Just finished and sufficiently tested, the motor is already used as the drive of a hermetic inert micro annular gear pump in a drinking water treatment plant in a chemical engineering application.

"Our partner for motors and controllers"

"What is special about the pump drive is the integrated Motion Controller, which is located with the motor in an explosion-proof housing", says Werner Böhringer. As director of Mattke AG, he is responsible for this project. Previously, DC motors were combined in a flameproof casing with micro annular gear pumps.

Today, integration is called for. "To make the pumps efficient and more controllable and to reduce the installation space, HNP Mikrosysteme uses micro annular gear pumps for both: brushless motors and Motion Controllers from our partner FAULHABER", declares Böhringer.

CLEAN WATER THANKS TO INTELLIGENT SOLUTIONS



Integrated in the flameproof enclosure according to ATEX is a Motion Controller that can be controlled via CANopen or RS232

The Mattke engineers developed a flameproof, enclosed housing for the drive pair "that did not exist previously on the market, even though it is exceptionally effective", notes Böhringer. By enclosing the Motion Controller in a capsule together with the motor, cumbersome precautions for the sensitive electronics of the servo controller can be dispensed with. In addition, signal losses that arise due to long supply lines if the electronics are placed outside of the potentially explosive area are avoided.

"The integration of all components in a flameproof casing makes life easier for the pump manufacturer and his customers", finds Werner Böhringer, making reference to the certification without which nothing happens in most of the places where the pumps are used. It is the reward for good development work. "By enclosing the electronics, we were able to clear the hurdle for ATEX certification for motor plus servo controller."

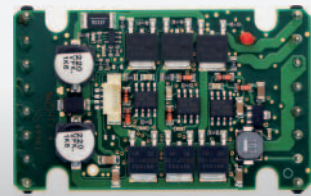
BRUSHLESS DC-SERVOMOTORS SERIES 3268...BX4

Ø 32 mm, length 68 mm
Torque 96 mNm



MOTION CONTROLLER SERIES MCBL 3003

V2.5, 4-Quadrant PWM with RS232 or CAN interface





Integration of the electronics – a logical development step

A glance at the requirements profile of the pump shows the high demands on this technology. This is due to the fact the micro annular gear pumps deliver and dose low-to-medium viscosity media with high precision. The profile of such pumps therefore includes attributes such as low pulsation, low dead volume, low shear stress, long service life, low weight and a compact design. And because micro annular gear pumps seem destined for applications in potentially explosive atmospheres, the servo-controlled motors with ATEX certification are a must today at HNP Mikrosysteme. Serving as the basis of this Mattke solution are the brushless FAULHABER 3268 ... BX4 series DC-motor with Hall sensors and the FAULHABER MCBL 3003 series Motion Controller, which can be controlled via CANopen or via the RS232 interface.

ic inert series from HNP Mikrosysteme enables flow rates from 0.048 ml/min to 240 ml/min as well as differential pressures from 0 to 10 bar.

"The pump is driven by Mattke motor EXR-32.24-MC3-L10, which is based on a solution from FAULHABER", explains Dr. Carsten Damerau from HNP Mikrosysteme. "It is the special characteristics of pump and drive as well as the excellent interplay that enable use for extremely demanding delivery tasks, such as those required in the treatment of drinking water."

When used for treating water

In a customer project for water treatment, the mzs-7259X2S Ex pump delivers the so-called bleaching lye, a concentrated, aqueous solution of NaOCl. Bleaching lye acts, for example, as a selective oxidant or disinfectant in water treatment processes.

A word on the process-engineering performance data: the micro annular gear pump of the hermet-

FURTHER INFORMATION

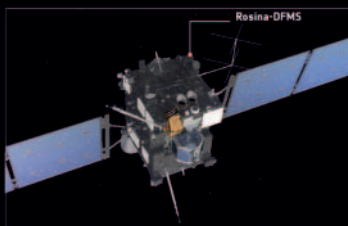
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HISTORIC MILESTONE in SPACE FLIGHT

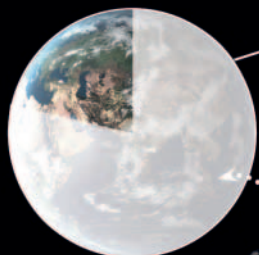
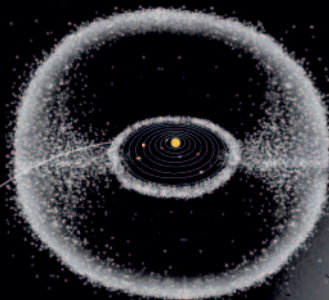
In mid-November 2014, Philae (the ballistic lander of the Rosetta space probe) touched down on the comet 67P/Churyumov-Gerasimenko and began experiments intended to provide information about its composition and so to deliver valuable insights into the creation and history of our solar system. We spoke to Dr. Stephan Ulamec (project manager for the Philae lander) about the current status of the mission.

Rosetta has made the first detection of molecular nitrogen at a comet



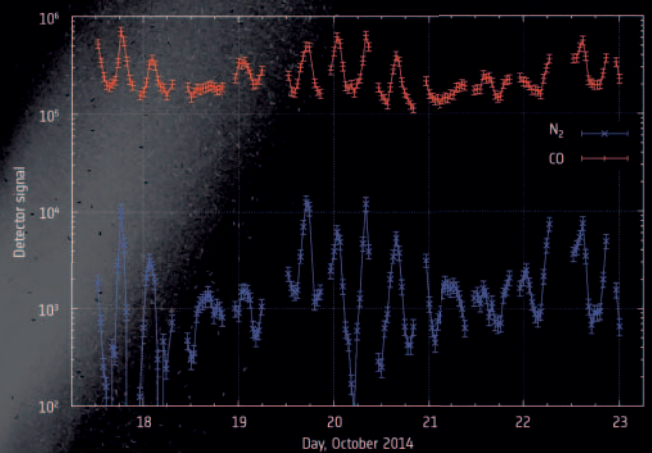
The measurements were taken 17–23 October 2014

By comparing the ratio of N_2 to CO at the comet with that of the protosolar nebula, it was discovered the comet must have formed at low temperatures, consistent with the Kuiper Belt.



78%
of Earth's atmosphere is
molecular nitrogen, N_2

Although comets could have delivered some nitrogen to Earth, the new study suggests that Jupiter-family comets like 67P/C-G are not the major source.



ROSINA recorded variations in the amount of molecular nitrogen (N_2) and carbon monoxide (CO) detected as a function of time, comet rotation and position of the spacecraft above the comet. An average ratio of N_2/CO of $(5.70 \pm 0.66) \times 10^{-3}$ was determined, with minimum and maximum values of 1.7×10^{-3} and 1.6×10^{-2} , respectively.

The detector signal is integrated over 20 seconds. A correction factor accounting for the instrument sensitivity is applied in order to derive the ratio.



Dr. Ulamec, last year was certainly very eventful and interesting for you, especially in November with the landing of the Philae space laboratory on the comet 67P/Churyumov-Gerasimenko, a unique achievement in the history of aerospace. Has the great flurry of excitement now died down or are the Rosetta mission and Philae still keeping you on the edge of your seat? What's happening at the moment?

At the moment, the data that we have received from Philae is being interpreted and specialist articles are being written, e.g. for the magazine "Science". The excitement about the landing itself may be over, but the scientific work has only just begun. Rosetta is also sending us new and exciting data every day from its orbit. As far as the lander is concerned, we are currently getting ready for it to wake up. That is sure to be another very exciting moment.



DR. STEPHAN ULAMEC

Project manager for the Philae lander
Deutsches Zentrum für Luft- und Raumfahrt e. V.
(DLR)

The graph shows the variation in the signals measured for molecular nitrogen (N₂) and carbon monoxide (CO) by Rosetta's ROSINA instrument. The signals vary as a function of time, comet rotation and position of the spacecraft above the comet. An average ratio of $N_2/CO = (5.70 \pm 0.66) \times 10^{-3}$ was determined for the period 17–23 October 2014. The minimum and maximum values measured were 1.7×10^{-3} and 1.6×10^{-2} , respectively (note that the ratio cannot be derived directly from this graph – a correction factor accounting for the instrument sensitivity is applied).

The landing of Philae was followed with great interest – our eyes were also glued to the monitors on 12th November. We now know that Philae actually landed three times. According to the latest information we received, the rewinding mechanism with the FAULHABER motors in the anchor harpoons was ready for operation. Has it become clear why the harpoons failed to deploy?

Unfortunately it hasn't yet been established whether the harpoons failed to fire because the pyros didn't react or whether the ignition filaments were not energised. However, it is correct that the FAULHABER motors were ready for operation.

Is there still a possibility of deploying the harpoons and what could happen as a result?

We're checking that. If the problem was caused by ignition failure or the filaments are burnt through, then ignition is of course no longer possible. If, however, the reason was because there was no flow of current, then there might still be a possibility for a second attempt.

Rosetta's and Philae's journey through space to 67P/Churyumov-Gerasimenko took over 10 years. How did the technology on board generally cope with these extreme conditions?

Astonishingly well. The mechanisms such as the launching mechanism, extension of the legs, activation of the drill, etc. for the most part functioned perfectly. The electronics also functioned well and didn't suffer any radiation damage, for example.

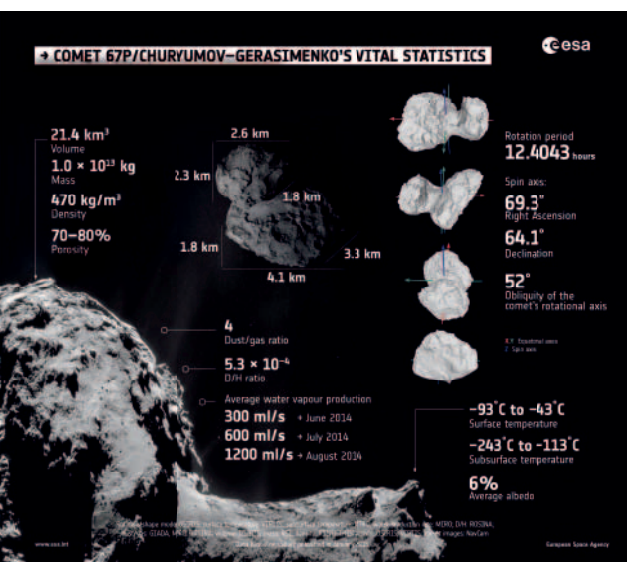
In the days after the landing, there were reports about the experiments conducted by Philae in the first 60 hours or so before the probe entered a state of "hibernation". FAULHABER drives are used in many of these measuring and sampling devices. A few initial results have also already been published. Which scientific results have impressed you most?

The concrete results are now all being prepared for the special edition of "Science". What was astonishing was the fact that the comet surface is extremely hard, at least at the location where we were able to examine it. The images show a unique and bizarre



Top:
Comet 67P/Churyumov-Gerasimenko on 31 January 2015 from a distance of 28.0 km

Below:
Summary of properties of Comet 67P/Churyumov-Gerasimenko, as determined by Rosetta's instruments during the first few months of its comet encounter. The full range of values are presented and discussed in a series of papers published in the 23 January 2015 issue of the journal Science.



Pictures: ESA-C.

landscape. The analytical instruments were able to identify organic substances.

Why is it that so little has so far been published about these analyses?

You will find quite a lot of information on the ESA and DLR websites. As mentioned before, the detailed results will be published in the coming weeks. It is important to perform analyses thoroughly to avoid having to later withdraw "prematurely announced" results. The evaluation of, for example, mass spectra can be very challenging if you don't know which molecules you are actually looking for.

Philae is at a different landing site to that originally planned, but the exact location is as yet unknown. Why is it so difficult to precisely locate the probe?

The position of the lander has been located with relative accuracy ($200 \times 20 \text{ m}^2$). However, it has so far not been possible to see the lander on the OSIRIS image from the orbiter. The lander would be just a few pixels in size and can easily be confused with natural features. In addition, it is usually not well lit by the sun.

The new landing site initially proved to be unfavourable because not much light is available for the probe to generate energy. There is now the hope that as the comet approaches the sun, Philae will again receive adequate sunlight and still remain protected against excessive heat. Question: When do you expect to receive signals again from the probe?

Since the middle of March we are trying to make contact with the lander. However, we probably won't be successful until May when we are closer to the sun.

What possibilities will there then be to continue work with Philae?

If the battery can be successfully charged again, it would then be possible to execute complicated scientific routines, for example a further attempt at drilling or another radar scan.

The Rosetta mission is so far completely unique. After 10 years in space and a "commute" of 6.5 billion kilometres, successfully rendezvousing with an object as small as the comet with such accuracy and then scientifically examining and escorting it is without doubt a milestone in space flight. How do you rate the findings of this mission? What has significantly changed with regard to our perception of comets and similar celestial objects?

Rosetta is a historic mission, comparable to the "greats" like Voyager or Viking. It has already provided us with many new insights into comets. However, it will take years to really understand all of the data and to establish connections that will enable us to answer questions with regard to the creation of the solar system or what made life on earth possible.

The mission is continuing further. Rosetta is now accompanying Chury on its journey to the perihelion (the shortest distance from the sun) and beyond and will continue to observe the comet and its activities. What additional information do you expect to obtain?

The comet is becoming increasingly active. Data about the coma, gas and dust can then be obtained even better.

When will the mission end and what will then happen to Rosetta and Philae?

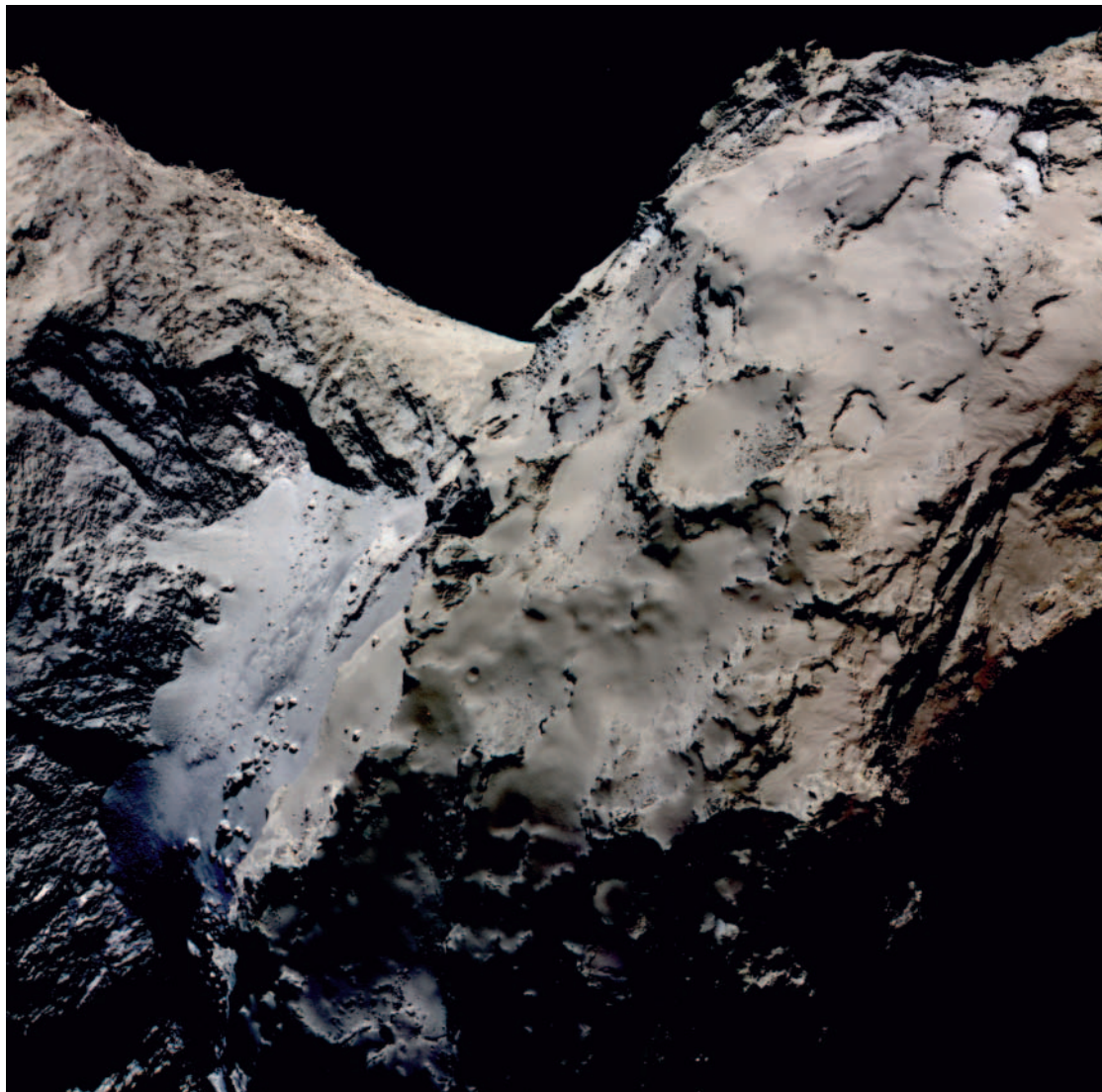
Rosetta officially ends in 2015 but will probably be extended until the fuel runs out. One possible option at the end of the mission would be to "land", or rather "strand", Rosetta on the comet.

Are other missions of this type planned?

NASA, for example, is considering bringing cometary material back to earth. That would be the next great step in cometary research.

Dr. Ulamec, many thanks for talking to us.

False-colour image showing the smooth Hapi region connecting the head and body of comet 67P/Churyumov-Gerasimenko. Differences in reflectivity have been enhanced in this image to emphasise the blueish colour of the Hapi region. By studying the reflectivity, clues to the local composition of the comet are revealed. Here, the blue colouring might point to the presence of frozen water ice at or just below the dusty surface.



Pictures: ESA-C.

SELF-SUSTAINING KNOWLEDGE FOR THE FUTURE

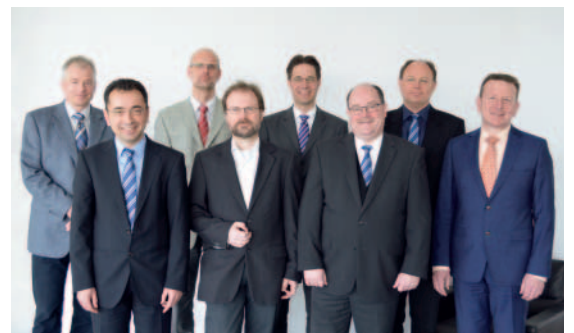
In 2015, the focus of ERWIN – the series of internal FAULHABER events – will be two truly forward-looking topics: knowledge management and sustainability. The keynote lecture given by Prof. Dr. Günther Seliger from the technical University (TU) Berlin attracted much interest.



Factory Management (IWF) at the TU Berlin) kindly accepted FAULHABER's invitation to give the opening lecture. By way of an introduction, the managing director Dr. Thomas Bertolini and the organiser of the ERWIN lecture series Dr. Nayim Bayat explained the term "sustainability" as well as its significance for FAULHABER, after which Prof. Seliger took the podium. He captivated the audience with his lively and entertaining delivery which allowed him to convey a wealth of interesting information which included methods of assessing environmental justice, the recirculation of raw materials, the sale of benefits instead of products, education and international perspectives of sustainability. Using numerous concrete examples, he presented his lecture in a truly "self-sustaining" fashion.

➔ ERWIN is female and it is a name that many FAULHABER employees will already be very familiar with. ERWIN is actually an acronym and stands for "ERfahrung", "Wissen" and "INformation" (experience, knowledge and information) which are the focus of a series of internal events at FAULHABER. Considering the rapid development of knowledge-based society, it is no surprise that the success of FAULHABER will depend increasingly on knowledge management and transfer. Around 90 ERWIN lectures on a broad range of topics by internal and external speakers have already taken place.

The main theme of ERWIN 2015 is quite literally "self-sustaining". Prof. Dr. Günther Seliger (who holds the Chair of Assembly Technology and Factory Operation at the Institute for Machine Tools and



From left to right: Benno Blase, Dr. Nayim Bayat, Jörg Rittker, Dr. Andreas Wagener, Markus Dietz, Hubert Renner, Herbert Wallner and Dr. Thomas Bertolini

INFOTAINMENT

Thanks to a multitude of multimedia elements and a responsive design, "WE CREATE MOTION" is now also a digital philosophy on the new FAULHABER website.



Design optimised for smartphones and tablets

➔ The introduction of the product selector last year clearly demonstrated that FAULHABER had begun to explore new avenues online. This has also recently been the case for the corporate homepage which has had an enthusiastic reception thanks to its attractive design, clearly structured layout and high level of user-friendliness.

The focus of the relaunch was to provide every visitor with more up-to-date information in a simpler and more stimulating way. The first glimpse of the homepage should immediately show visitors what FAULHABER has to offer and enable them to access the desired contents quickly by means of simple and intuitive navigation. Furthermore, the new web design is such that contents and navigation adapt to all commonly used end devices, e.g. desktop computers, tablets or smartphones.



All information and downloads for the product can be called up in a clearly structured way via tabs.

www.faulhaber.com

PREVIEW

TESTING movements. MOVING INNOVATIONS.



Product life cycles are getting shorter in all areas of industry. New products appear on the market faster and faster. This trend has increased dramatically, particularly in the automotive sector. While not so long ago it still took seven to eight years before a vehicle was ready for production, today it is just two-

and-a-half to three years. This places high demands on the development team. Vehicle functions, such as the frequent opening and closing of the door, must be tested quickly and precisely so that any necessary optimisations can be performed on short order. In the next issue of our FAULHABER motion magazine, you will learn how high-performance FAULHABER drives can be integrated in such test systems thanks to their compact design and simple handling.



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