

motion

02.2015

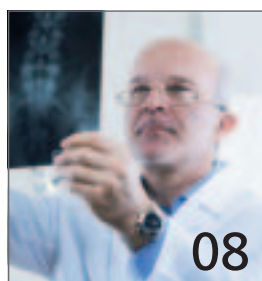
THE MAGAZINE WITH DRIVE



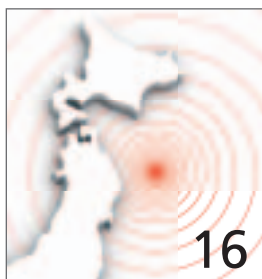
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TOUGH JOBS



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Dear readers,

"Repetitive motion injuries are posing a major risk of injury in our working world today." One manifestation of this is RSI syndrome with which highly repetitive movement sequences can lead to painful and chronic damage to the muscles, tendons and joints of the hand and arm. Movements, such as the ones described in our title story, the cutting of countless vines in a vineyard. In order to counteract the risk of RSI, electric pruning shears are therefore often used in wine and fruit growing. An area of application where FAULHABER drive systems are setting the standard in terms of performance, lightweight construction and reliability.

The Swiss start-up company Noonee is also working on an inventive idea for minimising extreme physical strain for skilled workers with its chairless chair. We support the development team with our expertise and technology.

In this issue you can also read about how FAULHABER drives influence innovations in the automotive industry, make seismological activities measureable in the nano-range or bundle extremely small quantities of X-rays into meaningful images.

Look forward to these and many other exciting topics.

Sincerely

Dr. Fritz Faulhaber
Managing Partner



FAULHABER motion is now available as an app.

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PRECISION MONITORING & MEASURING

TESTING movements. INNOVATIONS MOVE.

Product life cycles are becoming shorter in all areas of industry. New products appear on the market faster and faster. This trend is particularly evident 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. Powerful drive solutions are required that can be integrated into test systems easily, work reliably and are easy to operate.





Left:
Micro-actuator for testing car doors
(image: Kübrich)

Top:
Up to one million test cycles may be necessary depending on the application; this means that reliable functionality in continuous operation over several weeks is mandatory.
(Image: Kübrich)



Kübrich Ingenieurgesellschaft GmbH & Co. KG develops and manufactures test systems for checking and ensuring the functionality and quality of complex mechatronic units. Together with intelligent software, well-tried hardware and high-precision mechanical components, automatically operating test systems for different tasks are created at the company headquarters in Priesendorf, starting with the testing of electric power windows to automatic mirror adjustment, entire car seats or the like. The new μ Act actuator is a typical example, and is used in the testing of sun visors, door handles, various unlocking devices, actuators elements etc..

Micro actuator with a wide performance spectrum

The compact combination of a complete drive in a robust housing, a flexible mechanical interface for coupling, control electronics, bus interface and a hub for connection additional sensor systems is vibration and moisture resistant, which is important for dynamic component testing under climatic conditions. The actuator is available in two versions, because differ-

ent applications require different forces. Because of the integrated processor, the systems can carry out the movement processes independently in combination with the relevant test software (TiS). Considerable demands are made of the actuator when this takes place. Up to one million test cycles may be necessary depending on the application; this means that reliable functionality in continuous operation over several weeks is mandatory. The components that are used must therefore meet high expectations, be as durable as possible, reliable, and do their job without needing maintenance.

The driving force

Brushless DC-servomotors are therefore the driving force behind the micro-actuator. Quality "made in Germany" was important to the developers at Kübrich, and it is hardly surprising that the choice ultimately fell on microdrives from the FAULHABER product range. They are the right choice for use in testing and test systems, particularly since they are provided as functional drive systems consisting of a motor, gearhead, brake and encoder. The individ-

ual drive components are optimally matched to one another, work perfectly together and thus achieve a very high level of efficiency.

A brushless DC-servomotor lasts significantly longer in comparison to mechanically commutated electric motors. It consists of fewer individual components, essentially consisting of a three-phase winding (stator) and a four-pole permanent magnet (rotor) as well as the electronic commutation system. The dynamically balanced rotor provides quiet, cogging-free operation.

Compact motor / gearhead combination

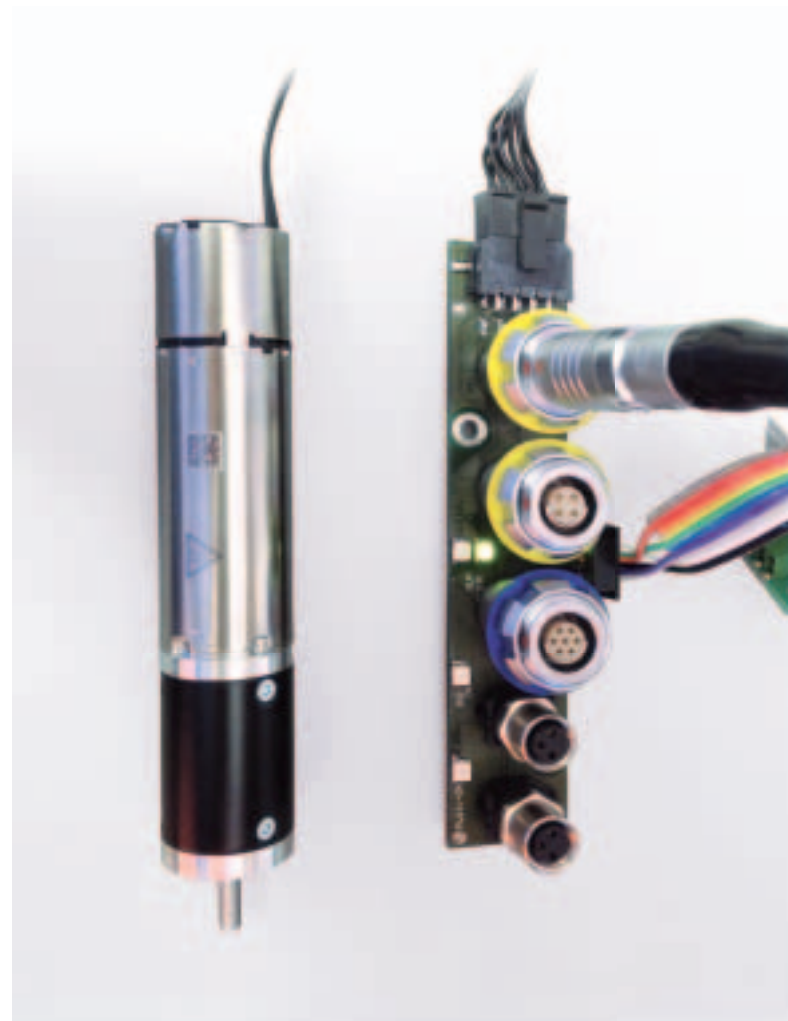
In the described application, there are two different types of use for these servomotors depending on the purpose of the test and the torque that is required: For the smaller version of the μ Act, the choice fell on the brushless DC-servomotor of model series 2250 BX4. It has a diameter of 22 mm and is

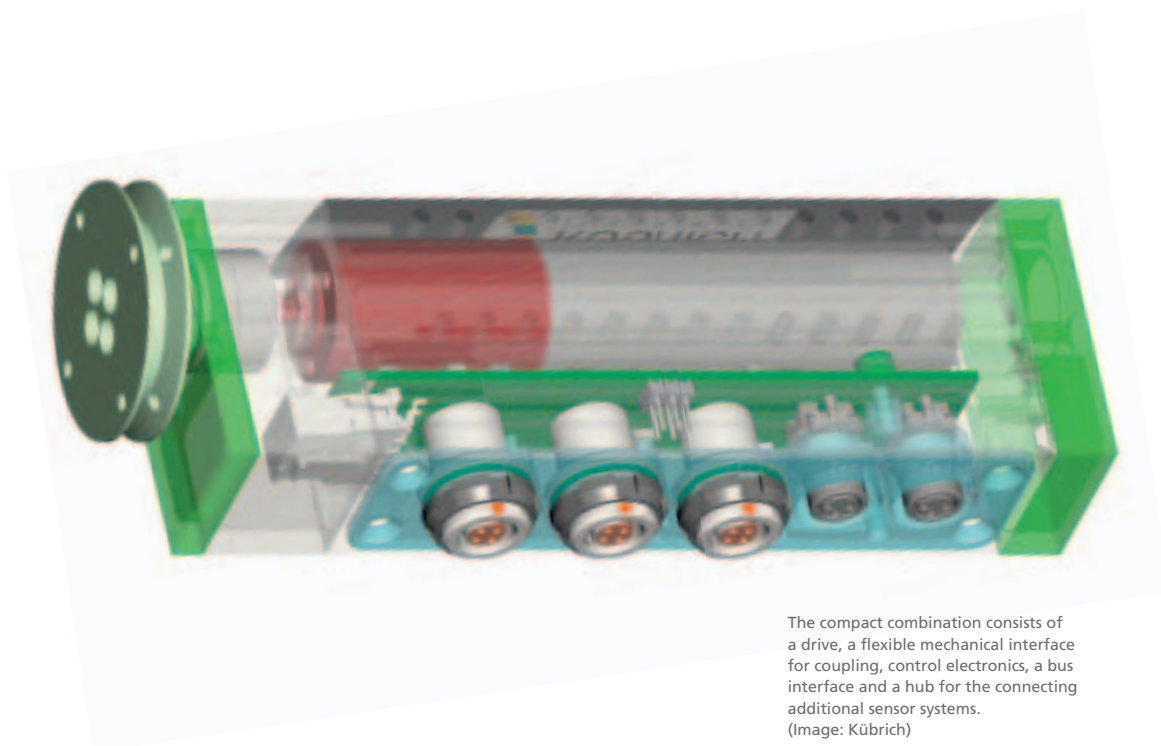
a mere 52 mm in length. The four-pole technology gives it a high level of continuous torque of up to 32 mNm despite these compact dimensions, and also has quiet running characteristics and a low noise level. The bigger testing device is also equipped with a four-pole DC-servomotor from model series 3268 BX4 or 3242 BX4. With a diameter of 32 mm and length of 68 mm or 42 mm, these motors achieve torque of 96 mNm or 53 mNm.

Depending on the purpose of the test, the brushless DC-servomotors are combined with a planetary gearhead (model series 22F) that operates with a reduction of 1:25 or 1:51. All parts of these precision planetary gearheads are made from metal, making them ideally suitable for combining with DC-micro-motors for applications such as this one that require high output torque. They are simply attached to the motor using a flange that can be screwed onto the front. This creates a compact drive unit which can be easily integrated into the application and requires

The brushless DC servo motors are combined with a planetary gearhead depending on the purpose of the test.

RELIABLE FUNCTIONALITY DURING CONTINUOUS OPERATION





The compact combination consists of a drive, a flexible mechanical interface for coupling, control electronics, a bus interface and a hub for the connecting additional sensor systems.
(Image: Kübrich)

less space. For tasks which require lower output torque, there is also the option of a plastic version of the planetary gearhead.

The brushless DC-servomotors also demonstrate their reliability in the new micro-actuators for tests in the automotive sector. After all, they have proven themselves in many other applications, starting with medical engineering and camera technology to any kind of automation task, robotics and even in test systems. They cover torques from 0.1 to 217 mNm in different sizes, can be combined with different gearheads, encoders and drive electronics and can also be modified for special requirements. The most frequent adaptations are, for example, vacuum compatibility, extension of the temperature range, modified shafts, other voltage types as well as customer-specific connections or plugs.

BRUSHLESS DC-SERVOMOTORS SERIES 3268...BX4

Ø 32 mm, length 68 mm
Torque 96 mNm



FURTHER INFORMATION

Kübrich Ingenieurgesellschaft GmbH & Co. KG,
Priesendorf
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www.faulhaber.de

OPTICS & PHOTONICS

X-RAY OPTICS

FOR MINIMAL
radiation dose



When Wilhelm Röntgen discovered and investigated the X-ray in the late 19th century, he was one of the few pioneers in the field who routinely used protective lead shields. He may not have known the precise reasons why, but he suspected that this kind of radiation was not good for human health – and his suspicions were well founded. Despite this, X-rays help to restore health as they are one of the most powerful instruments in medical diagnostics and, in many cases, are crucial for identifying the right course of treatment. When it comes to achieving the best imaging with the lowest possible X-ray dose, lenses made by Italian company Optec are almost inevitably involved. Their aperture, focus, filters and zoom are moved by FAULHABER motors.



X-ray optics is somewhat different to the optics of visible light, the first difference being that X-rays are generated by an X-ray tube. This uses high voltage to make electrons collide with a metal target, which in turn releases high-energy, low-wavelength radiation. X-rays can penetrate most materials, but the denser the material, the more they are attenuated. This difference in penetration intensity is what we see on an X-ray image. Before the image can appear to the eye, the invisible X-rays have to be “converted” into the visible spectrum. Today, this is mostly done by flat panel detectors which produce digital images, similar to the optical sensors of common digital cameras.

A bulky past

Standard optical lenses, however, cannot be used to direct rays to the detector. As the refraction index of X-rays is very close to 1, optical glass barely changes their direction. This is why X-ray lenses were traditionally very bulky and difficult to handle, remembers Giuseppe Cilia, General Manager of Optec: “When our company was founded in 1985, two big lenses were necessary to transfer the X-ray image to the camera. They had a very long focal length, and the focus had to be adapted manually. They needed a clumsy lead aperture and a high level of radiation energy to produce acceptable pictures. And the patient, of course, was exposed to this radiation.” That year, Optec devised an optic relay, doubling radiation transmission through the lens and improv-



Their aperture, focus, filters and zoom are moved by FAULHABER motors.



DC-MICROMOTOR

0816 ... SR series
 Ø 8 mm, length 16 mm
 Torque 0.7 mNm



ing image quality while significantly reducing radiation levels at the same time. Now only one lens was needed instead of two.

This breakthrough formed the basis for Optec's success in X-ray optics. About 70% of the lenses now used in medical radiography are manufactured by the company based in Parabiago, in the north-west of Milan's metropolitan area. Today, these lenses are even smaller and optically more powerful. "The latest digital image processing techniques have markedly improved the perception of anatomical details, but, at the same time, impose new requirements on the performance of the X-ray imaging system as a whole," says Giuseppe Cilia. "The dynamic range of the lens plays a crucial role here."

Compact flexibility

In photography, the dynamic range describes the limits for the amount of luminance that can be recorded, or, as you could also say, the spectrum between overexposure and underexposure. The greater this range, the more details doctors are able to see on X-ray images. The technology developed by Optec has allowed the dynamic range of the lenses to be extended tenfold, from 300:1 to 3000:1. Thanks to this optical flexibility, Optec's compact lenses can be used for both high and low sensitivity capture. Fluoroscopy is an example of the latter and is used for real-time imaging during surgical interventions, e.g. during critical operations close to the spinal cord or on the heart. Since exposure to X-rays can last for many seconds or even some minutes here, the radiation dose must be reduced to the absolute minimum.

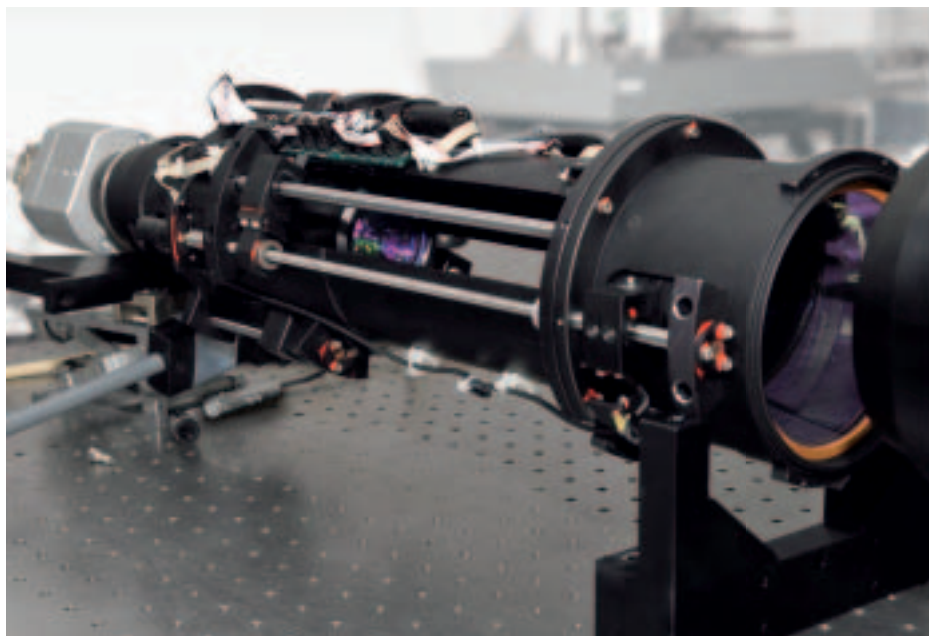
"You can open the aperture of our lenses very wide to get a clear picture of the procedure," explains Giuseppe Cilia. "When you need a static picture, for example of a knee joint exposition, this takes just a few milliseconds. However, the radiation dose can and must be higher to obtain a more detailed image. By combining aperture, focus and filters, we get a very high transmission and therefore expose patients to as little radiation as is technically possible. The resolution is also extremely high, and is close to the diffraction limit. With the FAULHABER motors moving the parts no manual handling or adjustment is necessary."

Power for medicine and space

One of the biggest advantages of the lenses is their compact size which requires the motors to be very small, too. Optec uses DC-Micromotors from the 0816 SR series for its X-ray lenses, which have precious metal commutation, a diameter of just 8 mm and a length of 15.9 mm. A planetary gearhead from the 08/1 series, which also only has a diameter of 8 mm, transfers the drive energy to the optomechanics. This combination delivers the power, speed and accuracy that is required for Optec's X-ray optics. "We produce lenses of the highest quality for the most sophisticated applications. FAULHABER motors are the best fit for our products because they have the same levels of quality and engineering," says the General Manager.

Apart from the motors, Optec purchases very little other than glass from external suppliers. From polishing and coating the optical lenses to assembling the units, all manufacturing steps are performed in Parabiago. There is no mass fabrication: Depending on a client's needs, Optec can even develop and produce one-off pieces. The product range includes short-wave infrared lenses, micro-lenses for endoscopes and lenses for optical applications in space. Giuseppe Cilia is especially proud that Optec will be the first

company to supply a zoom lens to be mounted on a satellite. "The lens and the zoom's motor need to work reliably for many years under the extreme conditions in space. At the same time, every gram counts and the equipment needs to be as light as possible. Our product was the one to meet all requirements." As with all Optec lenses, the first zoom lens in space will also be powered by a FAULHABER motor.



Depending on a client's needs, Optec can even develop and produce one-off pieces.

OPTEC LENSES GET THE MOST OUT OF X-RAYS



Each lens can be developed and manufactured in accordance with individual customer requirements.

FURTHER INFORMATION

OPTEC spa,
Parabiago (Milano), Italy
www.optec.eu

FAULHABER Switzerland
www.faulhaber.ch

MEDICAL SCIENCES

CHAIRLESS **CHAIR** for **PEOPLE** WHO ARE ON **FEET** ALL DAY.





Test run at Audi: The specialist has fetched the speedometer element and is sitting comfortably on the chairless chair from Noonee during installation.



"Oh, my legs! Aargh, my back!" Complaints like this are not uncommon when people have to spend a long day standing up. In many cases it is not possible to sit down at work because there must not be any chairs in the way. You are therefore on your feet all day, which can be quite uncomfortable. This can have a detrimental effect on concentration and performance. It can also result in physical complaints and more time taken off work, especially amongst older employees. Swiss start-up company Noonee has now developed a solution for relieving the strain on legs and backs that is both imaginative and simple – the chairless chair. Unlike other exo-skeleton concepts, the "Chairless Chair" batteries don't just last for several hours, but several days. Motors from FAULHABER also play their part.





Substantial support with stamina

An exo-skeleton (exo = outer) is a supporting apparatus which is on the outside of the body, in contrast to our bones. We know of the natural version from insects and the artificial exo-skeletons in science fiction films. In these films, exo-skeletons are imagined to be fighting machines that turn ordinary beings into invincible warriors. However, artificial exo-skeletons have long since existed in reality, in different forms and for different purposes. They provide assistance in cases where muscle power is inadequate, e.g. for lifting lift heavy components or working overhead with a bulky grinding machine for long periods. People with paraplegia can walk again with an exo-skeleton, as was shown in 2014 in Brazil at the kick-off to the opening game of the football World Cup.

These real exo-skeletons have two serious disadvantages: they are fairly heavy, usually significantly more than 20 kilograms, and their batteries last for little more than two hours. For these reasons alone, they are therefore far from capable of being generally used in everyday life. Keith Gunura, CEO of Noonee, had researched into exo-skeletons before he set established the start-up enterprise together with Olga Motovilova in Rüti, near Zürich: "We wanted to construct a supporting system that was extremely light and simple, did not run out of power during continuous operation and provided a solution to a wide range of everyday problems", he explains.

Holding on to experts by means of relief

He had his own experience of complaints caused by standing for long periods during a student job at a packing service provider in England. "Particularly older co-workers had problems, and I heard the cry 'oh my legs' every evening", he remembers. The two founders discovered that the management of major companies were also concerned about this problem by jumping into the deep end. During a workshop for start-up entrepreneurs at the Swiss Technical University in Zurich (ETH), one of the exercises involved calling potential customers and asking about their interest in a product. "The workshop leader dialled a number and handed us the receiver, saying that someone from one of the biggest car manufacturers in the world would answer the phone", explains Keith Gunura.

To the surprise of both founders they were not met with scepticism but wide open doors, even though they didn't even have a prototype yet. And in spite of the fact that the first prototype failed during the demonstration, the automotive industry managers just wanted to know when the next attempt was taking place. "German companies in particular view demographic development and the increasing shortage of experts as a major strategic challenge", explains Keith Gunura about the major interest shown by potential customers. "They desperately wanted to do something to relieve the strain on their experts during production, and make it possible for employees to remain active for longer."



The founders of Noonee, Keith Gunura and Olga Motovilova, got to know each other at the ETH Zurich.



In order to sit, the shock absorber element is locked by the FAULHABER motor, and the lock is released when walking. The seat inclination is infinitely variable.

Proven in practice

A practical test was carried out at the Audi plant in Neckarsulm, which provided some important tips for optimising the first prototype generation. A second series of tests were carried out a few weeks later in three-shift operation at the Ingolstadt plant. "The managers thought that the employees would be sceptical. Instead, they contacted the management and volunteered to take part in the experiment. It only took a few minutes to learn how to use the equipment."

Noonee has actually succeeded in keeping the concept and the technology extremely simple. A supporting strut, which also serves as the seat, is fastened to the back of the legs. The prototypes were made from titanium, but could be also made from carbon fibre in future, which would make them even lighter. A joint at knee height provides flexibility, and the shock absorber element behind the lower leg can be locked in stages if the user wishes to sit down. The entire Chairless Chair is attached using straps at the hip, knees and ankles. When sitting, the weight is led directly into the ground, therefore relieving the legs and the lower back. The entire construct only weighs a few kilograms, is easy to put on and is hardly noticeable when walking.

The human legs are still responsible for movement – which is an advantage compared to active exo-skeletons, which can result in muscle wastage due to "over relief". The users can sit down anytime, anywhere, while attaching parts to a vehicle chassis, for example. They have freedom of movement and their seating facility is always available.

Car manufacturers, surgeons and priests

To turn the flexible construct into a stable seat, all you have to do is operate a switch that is attached to the strap. Two FAULHABER motors activate the stop valve in the hydraulic elements of the shock absorbers, and the support locks in the required position. The lock releases again when the user stands up.

"We required an extremely flat motor with high torque and steps that were as small as possible for this application", explains Keith Gunura. "Of course, it had to be as light as possible and have minimal power consumption." The cogging-free DC flat motor

with gearhead was just the job for these requirements. As well as its small dimensions (26 millimetres in diameter x 19 millimetres in length), its strengths include extremely low current consumption with a low starting voltage, and high dynamics thanks to the minimal inertia of the rotor. The small 6 Volt battery still did not require recharging during the practical test, even after a week of continuous operation. The motorised lock also passed the stress test (two full shifts in succession) with flying colours.

The product is not yet ready to go into production, but development is continuing at full throttle with active support from potential customers and (as far as the motor and its functionality are concerned) FAULHABER. Meanwhile, the fledgling company's inbox has already received a flood of inquiries. "We receive multiple emails every day from people who are interested in our seat support", says Olga Motovilova, who is now responsible for operational business as COO. "They come from people such as surgeons, priests, film crews, hunters and anglers from all over the world." The plan is for the first chairless chairs to be delivered in mid-2016.

FURTHER INFORMATION

noonee AG
Rüti, Switzerland
www.noonee.com

FAULHABER Switzerland
www.faulhaber.ch



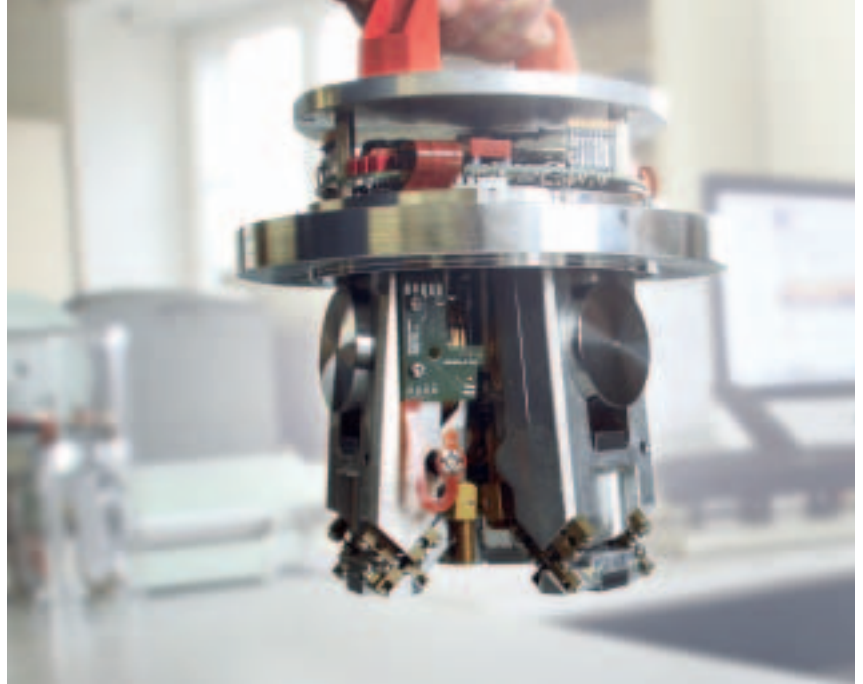
Broadband seismometers

DETECT **NANO-
MOVEMENTS**



Imagine a bar that extends from Zurich to Tokyo, more than 10,000 kilometres. Now someone in Tokyo slides a piece of paper beneath it. The seismometer at the Zurich end then reacts and precisely indicates the minimal change to the inclination angle. This unbelievable precision is achieved by devices from Swiss company Streckeisen, whose name is synonymous with high-performance seismometers within expert groups. Four FAULHABER motors contribute to making the highly sensitive sensors carry out their work reliably.

The pendulum remains in the balanced equilibrium position



Man flies to the moon and sends probes to the edge of the solar system and beyond. However, man can only penetrate a few thousand metres into the earth. In order to explore the interior of the planet, we are therefore dependent on indirect methods. Seismology – from the Greek *seismós*, meaning earth tremors – researches the vibrations which are caused by the movements of the continental plates. Conclusions are drawn about what is happening in the earth's interior from their spread, just like using ultrasound to view a baby. A "proper" earthquake that can be felt without instruments is relatively easy to measure. The vibrations are intense and the signal is appropriately clear and can also be recorded by less sensitive sensors.

It is more difficult when the movements are very small, such as the washing of the ocean waves, which is present as micro-seismatics all over the world. The simple traditional seismometer has no chance in this case. It basically consists of a weight – the pendulum –, which is suspended from a spring. A pin is attached onto the weight which draws curves onto a continuous roll of paper when the vibrations occur. The deflection indicates the strength of the vibrations – but only as far as edges of the paper roll. At the other end, the sensitivity is limited by the thickness of the pin: minimal deflection of less than the line width is no longer clearly recognisable. This corresponds to dynamics of approx. 60 dB.

A sheet of paper 18 kilometres wide

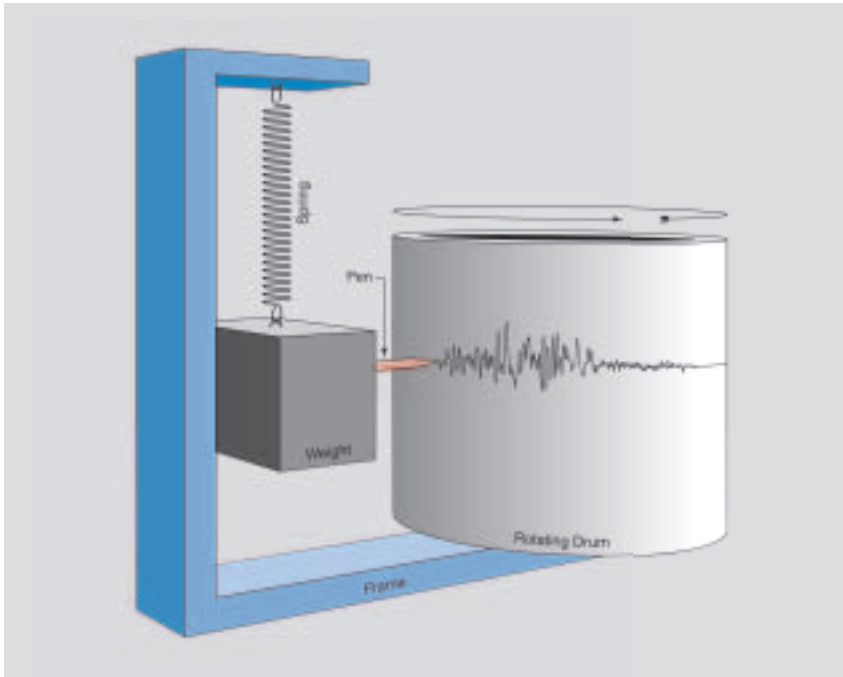
In order to overcome such limitations, prospective geophysicist Gunar Streckeisen developed the so-called STS-1 broadband seismometer at the ETH in Zurich during the course of his dissertation and

under the guidance of Erhard Wielandt about 35 years ago. He later founded Streckeisen AG in Winterthur in order to manufacture these devices and distribute them all over the world. This meant the end of road for classic seismometers. Erhard Wielandt was the driving force in the development of modern seismic measuring technology at this time.

The pendulum remains in the balanced equilibrium position

The only thing that a broadband seismometer has in common with its classic predecessor is the moving pendulum, which reacts to outside forces. A pin is no longer needed, particularly since a straight line would always be drawn. The trick with which the Streckeisen seismometer achieves its extremely large dynamics lies in the tracking: an electromagnetic feedback system ensures that the pendulum always remains in the established, balanced equilibrium position. "It works like an electronic balance", explains Robert Freudenmann, managing director of Streckeisen. "The correction signal that is needed for tracking is also the output signal at the same time. The more powerful the movement acting upon the device the greater the signal, and the pendulum therefore always remains in the middle." 145 dB can be achieved using a measuring principle such as this, which corresponds to an 18 km wide sheet.

In order to record the movements of the earth in all three dimensions; each seismometer has three pendulums. They are in a slightly tilted position, arranged in a circle, each offset by 120 degrees. They react differently depending on the direction of the force, and the three-dimensional image of the spacial variations can be calculated from the differences.



Schematic diagram of an old, classic seismometer

Balancing once in ten years

Once installed, the high-precision electromechanics work automatically and can go without human intervention for a long period. Exact alignment of the seismometer and balancing of the pendulum are crucial before starting operation. "Traditionally, seismometers have always been aligned eastwards", explains Robert Freudenmann. "In order to balance the pendulums, a moving mass on the pendulums is moved until they are perfectly balanced. The mass is a toothed ring, which is moved to and fro by rotating on an axis. It is driven by a screw that is positioned at right angles to it. There is a small amount of play in the toothed ring and the screw. When perfect equilibrium is reached, the tooth of the adjusting weight remains between the tooth flanks of the screw, i.e. the pendulum can be moved freely."

Long-term reliability

This process, which is known as "centring" within expert groups, is carried out by an AM0820 stepper motor with 16:1 planetary gearheads from FAULHABER. It must fulfil a wide range of requirements of the high-quality application: small dimensions and current consumption; precise movement and insensitivity to low temperatures, since Streckeisen devices are also used in Northern Alaska and near the South Pole. But the most important thing is long-term reliability: "For long-term measurements, a location is chosen which the ambient conditions are very stable", explains Robert Freudenmann. "In extreme cases, the pendulum is balanced for the first time before being put into operation, and the second time may only occur ten years later. Then the motor immediately has to perform its task again with precision, even after a long period of inactivity. We know that FAULHABER motors are capable of this."

Inflated concrete chamber

Not all devices are used for long-term measurements. In so-called array measurements, a large number of seismometers are arranged in a grid formation in a certain area in order to record the special features of the subsoil in this location. Once the measurements are complete after several months or a few years, the grid is moved and the devices travel to their next location. For example, the states of the USA are measured one after the other in this way. However, the unavoidable movement that takes place during transport is not good for the sensitive sensors. In order to prevent damage, the moving parts are therefore secured with a transportation lock. This is carried out by the fourth motor in the Streckeisen seismometer, a 0816P006S DC-micromotor. "FAULHABER can provide us with both stepper

STEPPER MOTOR
AM 0820
PRECiStep®-technology



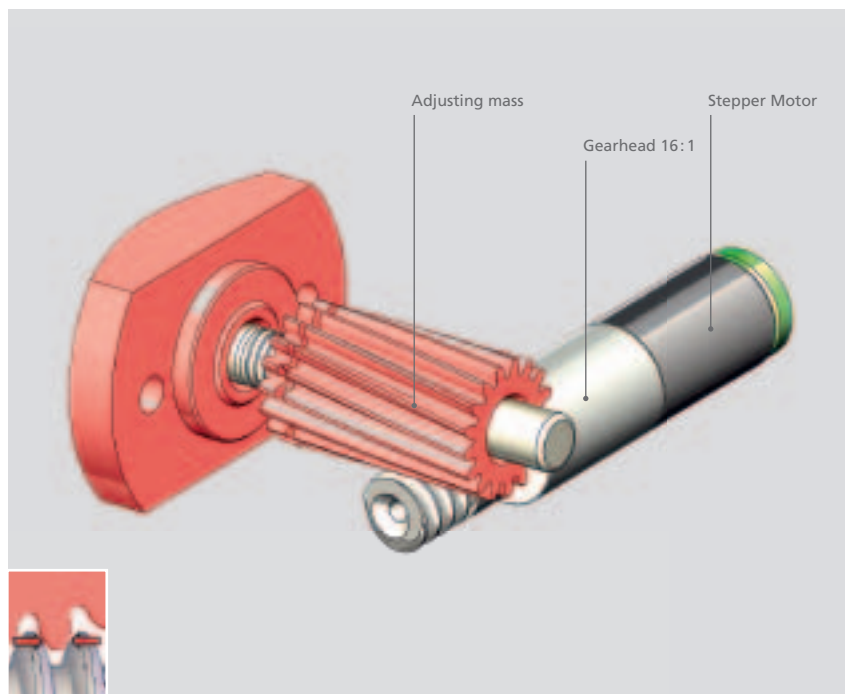
DC-MICROMOTOR
0816 ... SR series
Ø 8 mm, length 16 mm
Torque 0.7 mNm



motors and also micromotors with the right and with outstanding quality in a practical way", emphasises Robert Freudenmann.

Modern seismometers from Streckeisen are smaller and easier to set up than the first generation. A new variant with a tubular housing can be lowered into boreholes. The installation is still carried out by means of delicate manual work. It cannot be checked whether the components interact with the necessary accuracy until right at the end. Every sensor is therefore subjected to extensive testing in an air-raid shelter for insensitivity to air pressure fluctuations, amongst other things. A ventilator blows air into the chamber, which is surrounded by thick concrete, and "inflates" it. "Its hard to believe, but the increased air pressure actually alters the room, even though it is only by a few nanometres", explains Robert Freudenmann. "Our devices can detect this change. If a device was not sealed, we would receive a deviating signal. Using tests such as this, we ensure that only perfectly functioning seismometers are delivered that precisely record what is going on in the earth's interior."

INSENSITIVITY TO LOW TEMPERATURES



At the end of the centring process, the tooth of the adjusting weight remains between the tooth flanks of the screw without touching them.



GSN seismic station QSPA at South Pole, Antarctica. The construction of this station required the drilling of boreholes in the ice to the depth of nearly 1000 feet. Photo shows the NSF contracted drillers operating the ice core drill at the QSPA site (~5 miles from the South Pole).

FURTHER INFORMATION

Streckeisen GmbH
Pfungen at Winterthur, Switzerland

FAULHABER Switzerland
www.faulhaber.ch

PROFESSIONAL TOOLS

➤ SHORTCUTS FOR TOUGH JOBS



DC-motors reduce the weight of electric pruning shears.

Anyone who has already suffered from mouse arm or tennis elbow knows exactly about the painful and persistent condition that is known in medicine as RSI (injuries due to frequently repeated movement sequences). Even the smallest movement can cause extreme and long-lasting damage to muscles, tendons and nerves, if it is repeated thousands of times. If mouse arm results from operating computers, the equivalent for wine and fruit growers, who must trim countless branches and shoots, is "shearing arm". In order to counter the risk of injuries due to repeated movement patterns and support the muscles, many people now use motorised shears. The Pony model from Italian manufacturer Campagnola is a particularly lightweight, low-power device that works with a FAULHABER DC-micromotor in order to offer the highest efficiency at the lowest weight.



Each vine can make dozen of shoots each year but only one or two are necessary for the production of wine. All redundant shoots are cut off directly at the roots and the remaining shoots are pruned which means at least one cut per shoot. Each hectare contains between 5,000 and 10,000 vines, which means that approx. 100,000 cuts per hectare must be done alone in wine growing. This applies to fruit growing. Even small trees, such as ones normally found in intensive farming, must be trimmed and pruned hundreds of times. The quality of the fruit and wine depends heavily on the correct cutting techniques.

Every cut, which is placed with simple pruning shears, requires considerable effort from the arms and hands and leads to symptoms of fatigue after a certain amount of time. The risk of contracting RSI is extremely high, particularly during the cutting phase. In order to prevent this, device manufacturers developed mechanical pruning shears as soon as the technical requirements were available. At the beginning, pneumatic systems were the only mechanical solution – even today you can hear the sound of compressors in vineyards in Autumn and Winter.

Electric shears are connected to the battery which is normally fastened onto the wine grower's belt with a short cable.





- Weight of handpiece: 770 g
- Weight of battery: 1.7 kg
- Maximum cutting capacity: 25 mm
- Battery voltage: 51 V
- Battery life: 10 hours
- Type of battery: Lithium-ion

Batteries replace compressors

A compressed air hose that can be more than 100 metres long under pressure is needed to transfer the force into the wine grower's shears. While pneumatic shears are still the optimal technology for cutting strong branches, handling is problematic particularly in wine growing. This is because wine growers must go down again to the compressor after they are finished pruning a row and it must be repositioned before they can continue with the next row.

It only became possible to replace compressed air with electrical energy by using lightweight lithium-ion batteries. This allows the wine growers to simply go round the corner and move up and down in the rows without limitation. Electric shears are connected to the battery which is normally fastened onto the wine growers belt with a short cable while the electrical motors are integrated into the shear's handles and apply the necessary force. "During the cutting season, the operator must often use the shears relentlessly for weeks", explains Patrizio Pellicanò, the Technical Director at Campagnola. "This means that the operator must hold the device for the entire day and every gram of weight counts."

Optimal motors for shears

The company based in Bologna in Northern Italy has therefore decided to develop a pair of shears that simplify the wine grower's work in every respect. The motor is the crucial component but not only in regards to its weight. "The drive must have high torque while the weight is reduced to a minimum", explains Christian Lucini of FAULHABER MINIMOTOR, who is responsible for the project. "It must also work at high speeds in order to make the cuts as quickly as possible. Due to the start-stop nature of this work with constant load changes, the shears must also provide force without warming-up while the energy consumption is minimised and the operating time maximised."

Campagnola has carried out a series of tests comparing the drives of different manufacturers based on these criteria. "The 2657 CR DC-micromotor from FAULHABER clearly won the comparisons", recalls Patrizio Pellicanò. "With just 156 grams for the motor, the entire drive system weights 80 grams less than other motor gearhead combinations. In addition to this, high efficiency in combination with low energy consumption provide a usage duration of ten hours per charge, which corresponds to 20% more battery life in comparison to rival products."

The lightest option

The Pony model is the lightest pair of shears that Campagnola offers and one of the lightest models on the market. It can perform up to 70 cuts per minute and can be operated both automatically and manually. In automatic mode, the cutting blades fully close as soon as the finger presses the trigger. In manual mode, the cutting blades conform to finger movements, which means that the motor reacts very precisely and the output power must be adjusted exactly to the movement. The DC-motor manages this fine coordination with flying colours. The shears also protect the drive-supporting wires. If wires are detected between the cutting blades, the shears stop cutting automatically.

A cutting counter, which also records the operating times, makes it possible to monitor the cutting movements in detail and allows the operator to comply with the service intervals. Campagnola recommends an overhaul of the shears after 400,000 cuts. "The devices run constantly when trimming vines and fruit trees particularly in large companies", explains Patrizio Pellicanò. "In addition to this constant load, the shears must be able to work for four or five years without any problems. The DC-micromotor from FAULHABER has proven itself with its characteristics and high reliability in continuous operation. We have definitely made the right choice here."

70 CUTS PER MINUTE



The drive must have high torque while the weight is reduced to a minimum. It must also work at high speeds in order to make the cuts as quickly as possible.

DC-MICROMOTORS SERIES 2657...CR

Ø 26 mm, length 57 mm
Output Power 47.9 W
Holding torque 286 mNm
Mass 156 g
Speed <7000 rpm



FURTHER INFORMATION

CAMPAGNOLA srl,
Bologna, Italy
www.campagnola.it

FAULHABER Switzerland
www.faulhaber.ch

IN ADDITION MORE BITE.

For HIGH POWER-
APPLICATIONS.

FAULHABER has expanded its product range with more power in a small place with the DC-motors of series 1727...CXR and 2668...CR as well as the new 20/1R planetary gearhead.



Series 1727...CXR DC-Motors

The CXR series combines power, robustness and control, is extremely compact with a particularly attractive price-performance ratio. FAULHABER expands this model series with the new series 1727 ... CXR with a powerful drive in the 17 mm diameter range. A more powerful neodymium magnet gives the graphite-commutated motor a continuous torque of 4.9 mNm. The operating temperature range is between -30 and +100 °C by default.

Like all drives in the model series, the 1727 ... CXR can be combined with different magnetic encoders. It can be optionally actuated with the SC 1801 speed controller or the MCDC 3002 motion controller for speed control or positioning. Different FAULHABER precision gearheads make it possible to coordinate performance to many different application areas in an optimum way.

Its high power density opens the 1727... CXR up to a large spectrum of possible applications, in tattooing devices, servo-drives in robotics or pump drives in medical technology, among others.

Series 2668...CR DC-Motors

Graphite commutation, a very powerful neodymium magnet and an extremely high copper content in the winding of the FAULHABER rotor provide the CR series compact drives with an enormous amount of power. The new series 2668 ... CR supplements the model series in the 26 mm diameter range. With a rated torque of 70 mNm and a weight of 189 g, this drive is the most powerful motor in its class on the market at the moment.

Due to its high pulse torque, the 2668 ... CR can achieve its full power within an extremely short time, which makes it particularly outstanding for use in professional high power tools, such as electric pruning shears or screwdrivers. In this respect, the high stability and low wear of its copper-graphite brushes and the robust steel housing also make a positive impression.

The standard drive can be combined with high resolution optical or magnetic encoders for applications with precise speed controllers or positioning tasks, as is often required in medical technology, robotics or aerospace.



MARIO WINTERER (LEFT)

Dipl.-Ing.
Project management and project
platform construction

HANS-CHRISTIAN SPRANGER (RIGHT)

Dipl.-Ing. (FH)
Product Manager

Series 20/1R Planetary Gearheads

Thanks to the sturdy construction, FAULHABER metal planetary gearheads are ideal for applications which demand the highest torque. FAULHABER is now launching the most powerful power transfer technology in the 20 mm diameter range on the market with the enhanced 20/1R planetary gearhead. The new 20/1R gearhead made from stainless steel makes it possible to achieve a continuous torque of 800 mNm and even up to 1100 mNm for short periods in interval operation. The gearhead is available with one to five stages, and the span of the 16 possible reduction gear ratios ranges from 3.71:1 to 1526:1. The input speed reaches 12,000 rpm. The operating temperature range is between -10 and $+125$ °C by default. The gearhead is also available as a low-temperature model for down to -45 °C. Numerous product variants, including an autoclavable version, makes it easy to adapt to the required application environment.



FURTHER INFORMATION

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Top of the class – MADE IN GERMANY

Youth development at FAULHABER. Young German engineers are the world's elite. This was proven at the international microsystem technology competition, iCan: German students took first, second and third place both in 2014 and 2015. They also implemented their innovative ideas with the support of FAULHABER.



Teams from the USA, Europe, New Zealand, Japan, Taiwan and China participate every year at iCan, which stands for "International Contest of Application in Nano-micro Technology". iCan's goal is to uncover practical uses for microsystem technology sensors and actuators in everyday applications. The intention is not just to introduce a new idea – the teams go into the competition with functional prototypes. Motion is introducing three particularly promising examples from this year and the previous year.

Intelligent goggles. A team from TU Darmstadt presented safety goggles which detect their proper use and react accordingly. Eye injuries are quite common despite safety goggles being compulsory in Germany. These enhanced safety goggles communicate between man and machine: sensors on the frame and the bridge register whether the goggles are being worn properly. The resulting signal reminds the user to wear safety goggles or switches off a machine if necessary. Thus, the user is protected from eye injuries and at the same time the goggles support employers who are required to comply with work

safety measures. The goggles could also be used to limit access to certain devices in a workshop to certain people. The student team, who were sponsored by FAULHABER for the competition, secured first place with this development in 2014.

Rollator with drive. Rollators are an indispensable walking aid for the elderly and handicapped: They provide support when walking and space for transporting shopping and have a mobile seat for taking short breaks. There are also situations where a Rollator is cumbersome, such as when the user is going uphill and the Rollator's load must be pushed as well. A team of students from TU Illmenau introduced their Roll-E at iCan in 2014 – and achieved second place. The prototype was based on a commercially available Rollator, which is also equipped with diverse sensors as well as motors from FAULHABER. Roll-E has intelligent, intuitively operating handles which register the pushing movements of the user. Sensors which detect the incline of the terrain and a microcontroller can drive or slow down the rear wheels via controlled DC motors accordingly. Active



Left:
The safety goggles team from
Darmstadt

Right:
The Rollator team from Illmenau



The safety goggles communicate between man and machine



support can therefore be provided, particularly when the Rollator is loaded and on slopes and inclines, therefore decoupling the additional load from the user.

Running shoe with app. The JointWatchR running shoe warns its user if the joints are under strain, which will please joggers in particular. The students of the Karlsruher Institute for Technology (KIT) developed this innovation, which was awarded second place at iCan in 2015. Sensors in the heel of the shoe measure data such as acceleration and incline, which is collected by a microchip and transmitted to the runner's Smartphone. The wearer can then adapt their running style accordingly. Furthermore, the cushioning of the shoe can also be adjusted using the associated Smartphone app, so that the runner will always be moving efficiently on different surfaces, e.g. on asphalt or dirt tracks. Technically speaking, the team equipped a conventional running shoe with sensors, microprocessors, batteries, a FAULHABER electric motor and an in-house developed mechanical solution for adjusting the cushion-

ing for the heel. In addition to the sport and fitness area, the working environment is also a possible area of use for the JointWatchR. Furthermore, the shoe could be useful for rehabilitation after sport injuries, as medical experts can analyse the sensor data collected after a training session and use it to decide on further action.

Initiative from Asia. The iCan competition is based on a Chinese initiative which has now become an international event. In Germany, the national competition COSIMA serves as a preliminary which is attended by the Association of Electrical, Electronic and Information Technology (VDE) with support from the Federal Ministry for Education and Research. FAULHABER supports the German teams which have qualified for iCan together with other sponsors.



The running shoe team from Karlsruhe

FURTHER INFORMATION

VDE Verband der Elektrotechnik Elektronik Informationstechnik e.V.
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