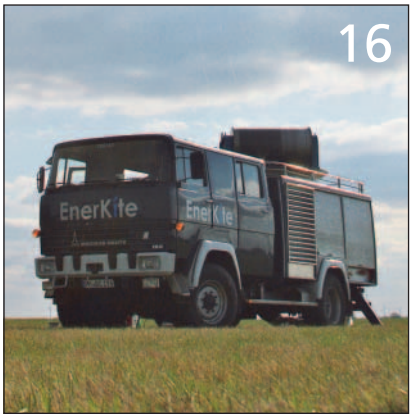
FAULHABER

motion

02.2013

THE MAGAZINE WITH DRIVE

TECHNOLOGY that gets under YOUR SKIN



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Dear readers,

What does high-developed drive technology from FAULHABER have to do with a century-old body art like tattooing? The answer is simple and leads us to the central concept of this edition of FAULHABER Motion: New ideas.

New ideas have always been the driving force for economic growth and prosperity in our civilisation. They set trends, generate new fields of business, create markets, shape generations and turn the old and well-known into history. For more than 60 years, we have not only been supporting our customers in realising their ideas of today with our expertise in the area of miniature and microdrive technology, but we have also been clearing new paths with the development of trendsetting products.

If tattoos were seen as biker gang clichés a few years ago, the idea of body art has since set a new trend which can now be found in all parts of our society. This has greatly stimulated and enhanced this market, in turn spawning new ideas for technical equipment for tattoo artists. In our report "Technology that gets under your skin", you will learn how compact DC-Micromotors make tattoo machines lighter as well as more versatile and manageable. In this edition of FAULHABER Motion, you can also read how our innovative drive solutions spur on bionics and how they are contributing to the development of sustainable concepts for the use of renewable energy.

Sincerely

Dr. Fritz Faulhaber
President

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TECHNOLOGY that gets under YOUR SKIN

The football players Lukas Podolski and Jerome Boateng have them. Former Olympic swimmer Franziska van Almsick has them. Pop stars such as Robbie Williams or Madonna also decorate their bodies with figures that go under the skin.

For some years now, tattoos have gained mainstream acceptance. Just in Germany there are about five million people who have a tattoo. Women are also now enhancing their beauty with "permanent make-up", whereby eyeliner or lip contours are permanently applied. What does this have to do with FAULHABER? In the handy machines used for tattoos and permanent make-up there are DC-Micromotors – made in Schönaich.

Whereas just a few years ago tattoos were primarily popular among motorcyclists, in the meantime it is completely commonplace that 16-year-olds ask to have a permanent body art piece for their birthday. The spectrum ranges from small dolphins on the ankle to fearsome skulls and crossbones, but also very personalised adornments: actress Angelina Jolie, for example, has a Buddhist prayer on her back.

The speed is dependent on the tattoo machine, the technology and the desired effect, e.g. lines or shading, but lies somewhere between approx. 800 to 7,500 movements a minute.

Body art with a historic background.

Actually, the application of figures to the skin has a tradition reaching back thousands of years in a multitude of cultures. With needles or other sharp implements, people have always sought to permanently apply colour pigments to the human body. For instance, numerous tattoos were found on the roughly 5,300 year-old Stone Age man "Ötzi". Tattoos have also been identified by archaeologists on the 4,000 year-old mummy of the Egyptian priestess Amunet. The archaic methods used for this tattooing were exceptionally painful, as the designs were carved into the skin using wooden implements, human bones, sharks' teeth or thorns. Nowadays, the procedures are much less painful, more hygienic and of the highest technical standards – especially if motors from FAULHABER are applied in the tattoo machines.

Requirements.

Tattoo professionals consider themselves to be artists; accordingly, their tattoo devices are the equipment with which they realise their art. They are occupied for many hours, without a break, when creating a large-scale tattoo. Modern tattoo machines are therefore characterised by a low intrinsic weight and the flexibility to adapt to individual movements. What is also desirable for the work procedures is that the device operates quietly and with low-vibration, and it fits the hand well.

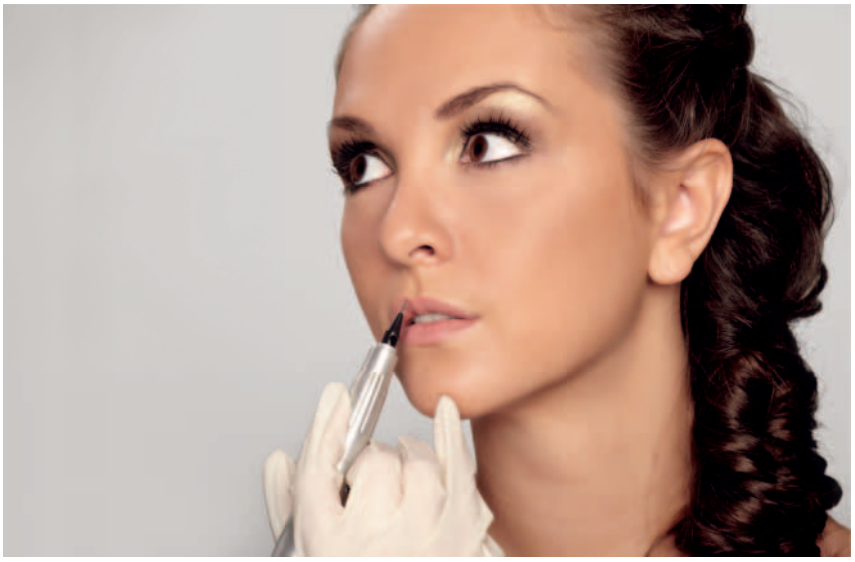
At first glance, a tattoo machine functions similarly to a sewing machine: one or more needles oscillate and thereby puncture the skin. The pigment is injected at the desired part of the body at a rate of several thousand pricks per minute. A seasoned tattoo artist neither punctures the skin too shallow nor too deep; ideally, he or she gets to the middle layer of skin. Because, if it is applied too superficially, the tattoo will not be permanent; if the punctures go too deep there will be bleeding, which would influence the dispersion of the injected pigment.

The underlying technology.

Essentially, tattoo artists can choose between two types of machines: coil-based machines and rotary machines. Coil-based machines belong to the older generation, and function somewhat like an old-fashioned doorbell in which a clapper strikes a little bell repeatedly in rapid sequence. These classic tattoo machines work with alternating current which constantly reverses the polarity of the magnetic coil, in turn moving the needle. This technology is currently used with increasing frequency in tattoo studios. However, the newest generation tattoo machines

800 TO 7,500 MOVEMENTS A MINUTE

Different needle modules for contours or surfaces



Very smooth-running operation is necessary for work on sensitive parts of the body.

Thanks to the use of compact DC-Micromotors with high power density, the tattoo machine has a low intrinsic weight as well as an easy-to-handle design.

work with high-performance electric motors. With them, the needle is no longer actuated by means of a coil but instead by a motor. The advantages are that these so-called rotary machines are especially smooth running and significantly quieter than the coil-based machines, and – thanks to their low intrinsic weight – fit much better in the hand. In these angular devices, the motor is located in a cross-piece and drives an eccentric mechanism in order to linearly oscillate the injection needle. This more likely requires thicker and shorter DC-Micromotors. These are available in FAULHABER's product range in various versions and technologies. Depending on the model, the drives just barely weigh 20 to 60 grammes, yet can nonetheless deliver the necessary performance – thanks to their high efficiency factors of up to 86 percent.

Enduring, but not everlasting.

Permanent make-up was developed from tattooing and refers to an enduring outlining of features, such as eyes or lips, by means of micro-fine colour pigments. In contrast to a tattoo, permanent make-up is not irreversible as modern technology makes it possible to colour just the uppermost layer of skin. The result lasts about five years long. The professionally and enduringly applied cosmetic art is viewed with increasing interest in our world, which places a great deal of value on beauty. Beyond the aesthetic aspects, permanent make-up can also cover up small imperfections and scars.

Precision in ballpoint pen format.

Like the tattoo artists, cosmeticians who apply permanent make-up also benefit from having a light, handy device that they can delicately operate. The colour pigments are injected in the surface of the skin with an oscillating needle, whereby – in contrast

Modern tattoo systems make it possible to create even the most complex motifs.

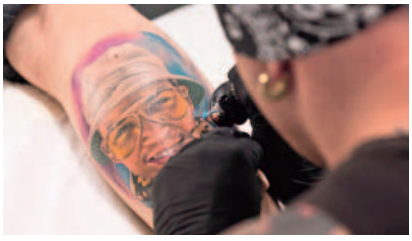
to tattooing – only the uppermost layers of skin are treated and the underlying tissue remains unscathed. The devices that are employed must meet the highest demands on technology and design, and moreover work precisely and reliably. As the most sensitive parts of the body – such as the eyes, for instance – are being treated, extremely smooth running is particularly necessary for this. Motors made by FAULHABER can also be successfully utilised in devices for applying permanent make-up. Because the devices are elongated and ideally have a format somewhat resembling a ballpoint pen, the slender models of the DC-Micromotors have proven themselves.

Unique solutions.

Based on their technology, FAULHABER motors are distinguished by a high efficiency, which is not only an advantage for battery-operated devices. As a result of the high power density, more compact, lighter drive solutions are possible, e.g. with a diameter of 13 millimetres for permanent make-up handpieces. FAULHABER models are differentiated from conventional DC motors by the rotor. It is not wound around an iron core, but instead consists of a copper coil manufactured with a self-supporting, skew-wound design. This provides for low rotor weights, very smooth-running operation and a highly dynamic cogging-free action without the usual magnetic hysteresis losses associated with other technologies.

More than just technology.

Of course, FAULHABER has more to offer than just technology. Apart from our drive systems, many customers appreciate our comprehensive product service, such as that customer-specific modifications can be made to the shaft or the connections and plug connectors, even for relatively small quantities. FAULHABER also scores when it comes to accessories: many components are combinable without any problems, which is not only important to the manufacturers of tattoo machines.



Top:
First, the contour is created - usually in black...

Bottom:
... then the surfaces are shaded and filled with colour.

FURTHER INFORMATION

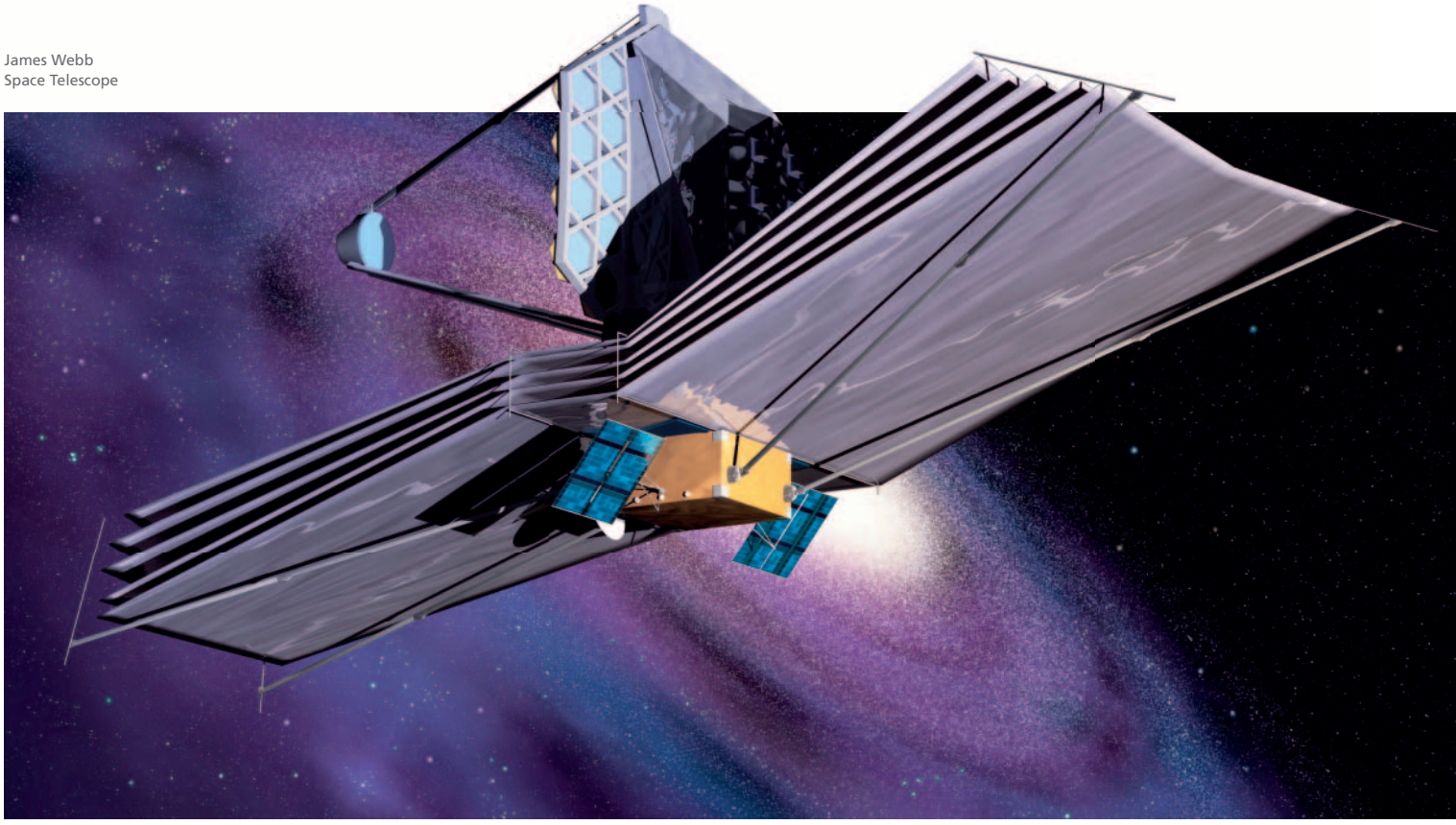
FAULHABER Germany
www.faulhaber.com

An almost INCREDIBLE DEGREE of accuracy

Exact positioning for astronomy and molecular research. Why is it much warmer one million kilometres away from the sun than on its surface? Even today, we still do not have a definitive answer to this seemingly simple astronomy question. Two satellites, set to go into orbit in 2017 in a formation accurate down to the last millimetre, may be able to help solve the mystery. One satellite will cover the sun, so that the other will be able to observe the hot solar corona undisturbed. In order to install the measuring instruments for this incredible feat of precision, the technicians at the European Space Agency (ESA) are using a hexapod. Manufactured by SYMETRIE, a high-tech company based in the South of France, the hexapod is powered by motors produced by FAULHABER.

Hexapod
BREVA from SYMETRIE

James Webb
Space Telescope



THE MILLION-DEGREE QUESTION

During a solar eclipse, it is possible to see the solar corona or aureole surrounding the darkened surface of the sun with the naked eye. Comprised almost entirely of ionised plasma, it extends into space to a distance of up to three solar radii. With a temperature of several million Kelvin, it is so hot that the 5778 Kelvin on the sun's surface almost seem cool in comparison. Up until now, the reason for this enormous difference could not be investigated in detail. On Earth, large parts of its radiation are swallowed up by the atmosphere, while in space, observation is subject to technological limitations: the surface of the sun must be covered so that it does not outshine the corona, however, with the equipment currently available, this means that the part of the solar corona that is close to the sun is also hidden.

A hair's breadth

For this reason, the ESA plans, as part of its Star-Tiger programme, to launch two satellites in 2017 that are set to travel in a unique formation. They will orbit the Earth at a distance of just 150 metres to each other – and at a speed of several kilometres per second, that is truly the proverbial hair's breadth. The shield of one of the satellites is set to cover the sun in such a way that the instruments on the other will be able to capture the radiation of the corona to a degree not previously possible.

To facilitate optimum alignment of both satellites as well as the instrumentation on board, the ESA technicians have simulated the conditions of space travel at the Laboratory of Astrophysics in Marseilles, France. A coronagraph, which is set to capture the radiation of the solar corona on the satellite that is in the shade, has been mounted on a BREVA hexapod (a "six-legged" robot) manufactured by SYMETRIE. In each leg, a brushless DC-Micromotor is installed with an integrated encoder. By extending and retracting the legs, the platform mounted on top can be adjusted freely in any direction. Thanks to the outstanding

BREVA

Travel range	± 75 mm / ± 30°
Resolution	0.5 µm / 2.5 µrad
Repeatability	± 1 µm / ± 5 µrad

Applications

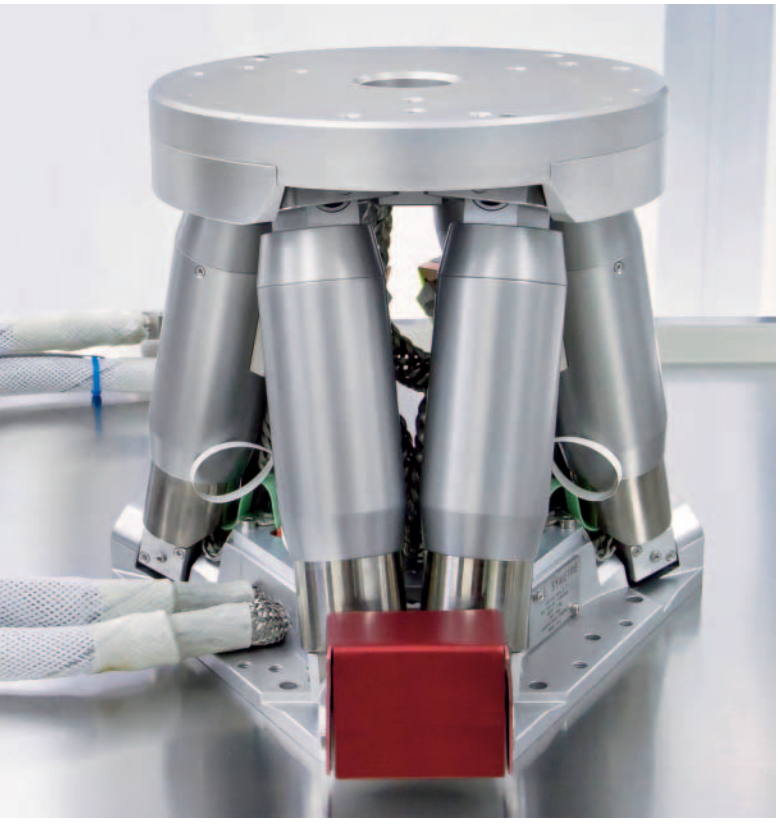
Instrumentation, Optics, Test laboratories, Aeronautics and spatial, Metrology, Synchrotrons

BORA

Travel range	± 20 mm / ± 15°
Resolution	0.1 µm / 2 µrad
Repeatability	± 1.5 µm / ± 6.5 µrad

Applications

Instrumentation, Optics, Test laboratories, Aeronautics and spatial, Metrology, Synchrotrons



BORA, vacuum-compatible version

dynamics and power density of FAULHABER drives even in the smallest spaces, as well as the high encoder resolution, even large masses can be positioned quickly, reliably and precisely.

A mirror for the next Hubble

Thanks to this freedom of movement, the ESA technicians have been able to simulate a variety of positions for the "flying machines" in relation to one another. The hexapod is distinguished by a number of features that make it ideal for the task at hand, as SYMETRIE managing director Olivier Lapierre explains: "It performs - under the most limited tolerances - the minimum movements required with exact precision, yet is also extremely rigid and can thus accurately maintain the specified position." A further strength of the product is its sophisticated software that ensures smooth component interaction and allows, for example, any virtual centre of rotation to be specified for the platform, and particularly gentle sequences of movement to be achieved.

These features of the SYMETRIE precision hexapods are also in use in other space programmes such as the James Webb Space Telescope, which is set to replace the famous Hubble telescope in 2018, as well as in the GAIA project aimed at mapping the Milky Way. In each of these projects, hexapods are being used to mount optical units. Mr. Lapierre describes a typical task as follows: "The hexapod helps to adjust a mirror in the specified position with submicrometer precision." As is the case with StarTiger, an almost incredible degree of accuracy is required: the Webb telescope should theoretically be able to detect a single candle on one of the moons of Jupiter.

The most powerful X-ray beam

However, the BORA hexapod used for the GAIA project was not originally developed for astronomy, but for the observation of extremely small objects. It originated as part of a collaboration with the European Synchrotron Radiation Facility (ESRF) in Grenoble, France. The synchrotron in the French Alps accelerates electrons almost up to the speed of light, causes them to collide, and generates the world's most powerful X-ray beam. It is around ten thousand times more powerful than the output of a medical X-ray device, yet as fine as a human hair. This beam is used to analyse a whole range of samples and materials, from semi-conductor crystal structures through to molecular movements in living cells. "Our hexapods are used at the ESRF to move calibration mirrors and samples into specific positions and to accurately maintain those positions thanks to their excellent stability", explains Olivier Lapierre.

Regardless of whether we are looking into the infinity of space or at detailed structures at molecular level, the essential requirements that a posi-

European Synchrotron Radiation Facility (ESRF)

tioning hexapod must meet remain the same: maximum manoeuvrability and precision together with absolute stability. Additional specifications may be added, depending on the application. Both for ESA and at the ESRF, a considerable amount of work is performed in a vacuum or cleanroom environment where the equipment must obviously also meet corresponding requirements. Space is also often at a premium, with the result that mini-hexapods are required.

The ideal solution for positioning in the smallest of spaces is the BREVA model's little brother, BORA. With a footprint diameter of 212 millimetres, it is also just 145 millimetres tall. Despite these almost minuscule dimensions, it can move a load of up to 10 kilogrammes at a resolution of 0.1 micrometres on its directional axes and of 2 microrads on the rotational axes. "The FAULHABER motors play an essential role in our hexapods", explains Olivier Lapierre. "They offer the best combination of compact sizing and product quality on the market."

Standard BORA

FURTHER INFORMATION

SYMETRIE, Nîmes, France
www.symetrie.fr

FAULHABER France
www.faulhaber-france.fr

Bionic MODELS conquer the 3rd DIMENSION

Microdrives spur on bionics. Analysing the principles of nature for technical purposes and putting them to practical use is one of the aims of bionics. However, these principles can also be used to gather attention at trade shows, on television or in presentations. Today, modern, very compact microdrives open a degree of freedom of movement which comes impressively close to that of nature, thus enabling a multitude of models.

Filigree construction - the BionicOpter only weighs 175 g with a span of 63 cm.

The dream of flying has fascinated many people since time immemorial. Whether floating almost weightlessly in the air or in the water, the three-dimensional movements still fascinate people, even today. Airstage, an offshoot of Effekt-Technik GmbH, uses this attraction in order to enthral people with hovering models. Each object is different and demands different drive concepts. What they all have in common: the drive must be very compact and be able to transform the battery power into motion with high efficiency. Consequently, the model specialists work with motors and gearheads of the microdrive expert FAULHABER. The distinctive aspects of the flying objects and the drive technology ideally complement each other in this area.

The flying robotic dragonfly, just like the original, has mastered the act of hovering.

Model engineering and bionics

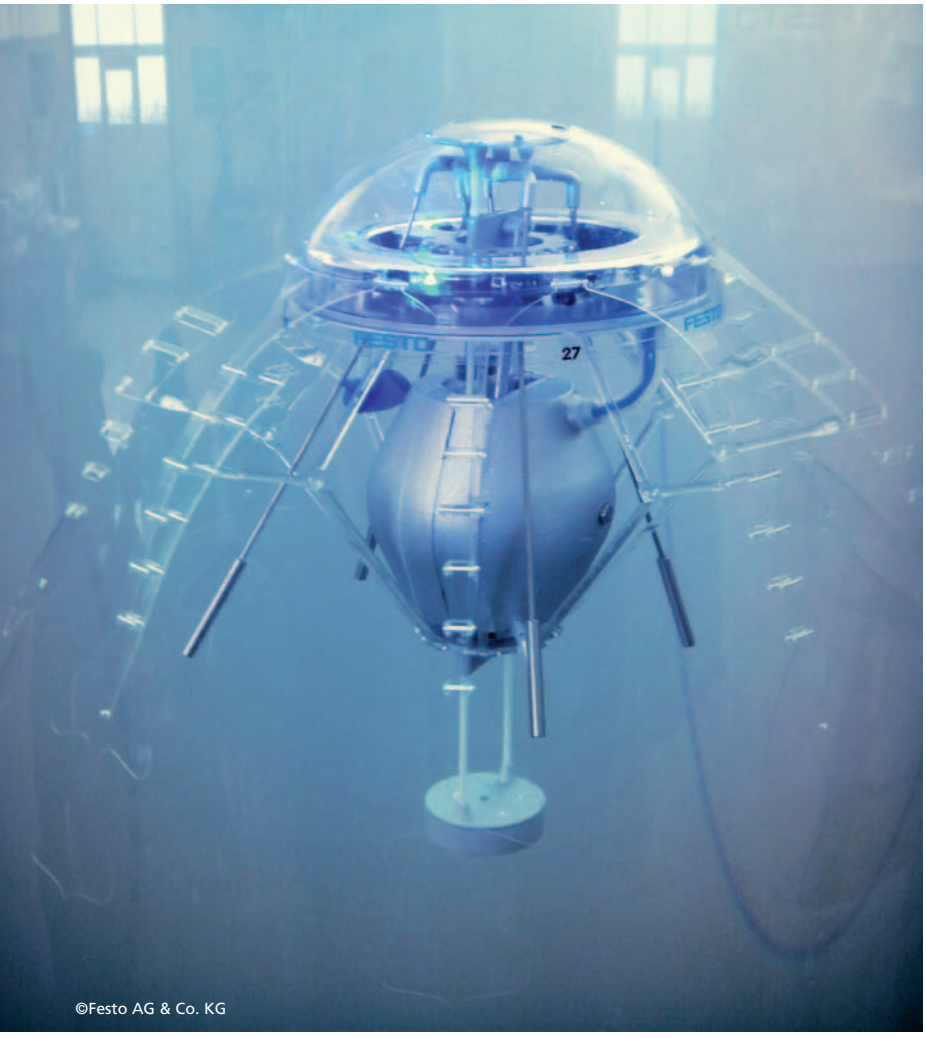
The experts have a wealth of experience in designing a wide variety of drive concepts. It all started with Rainer Mugrauer, who in the 1990s was a pioneer in "slow flyer" development. Already back then, the determinant factors for effective flight operations were the same as today: the greatest possible performance with the lowest consumption of the scarce battery capacity and the quickest reaction to control commands. Bell-type armature motors with brushes are particularly well-suited for this purpose. With the compact drives it was possible to propel both the earlier slow fliers as well as the current, distinctly more sophisticated, bionic and show models.

While objects such as the flying 7 Series BMW are purely for show purposes, the bionically driven models also support the training of students and engineers. Airstage is a partner of the Bionic Learning Network. Festo AG & Co. KG established this research association – consisting of renowned universities, institutes and developmental companies – in 2006. In interdisciplinary core teams, test objects are originated which combine the new ideas, solutions and technologies. This is intended to provide prospective engineers with an opportunity to 'think outside the box'. By the same measure, natural principles and propulsion concepts are put into effect in technical applications and in industrial practice. One of these future concepts are the AquaJellies: artificial jellyfish that float in water with air-filled, pressurised vessels and that propel themselves with their tentacles just like real jellyfish. An internal logic unit monitors the battery status and autonomously leads the jellyfish back to dock on the charging station. Its counterpart is the "flying" jellyfish, which works with a helium-filled balloon as its lifting body. The "drive ballast", which is kept as light as possible, consists of two lithium polymer batteries and the central drive unit for the tentacles. A pinion gear, connected with eight spur gears, sets the tentacles in undulatory motion by means of cranks. The control is handled by two servomotors that shift the internal centre of gravity.

Even more exquisitely constructed is the flying dragonfly – the BionicOpter. With a total flying weight of just 175 g and an impressive wingspan of 63 cm, it can be steered through 13 degrees of freedom and has even mastered hovering flight – just like the original. Flying dolphins for a show production underscore that not only efficiency and performance matter. Silently cruising through the sea of air is what is sought. More importantly, because the models hover over the heads of the spectators, the utmost in reliability and rapid response to control commands

INSPIRED BY NATURE

The flap of the SmartBird's wings is similar to that of the herring gull.

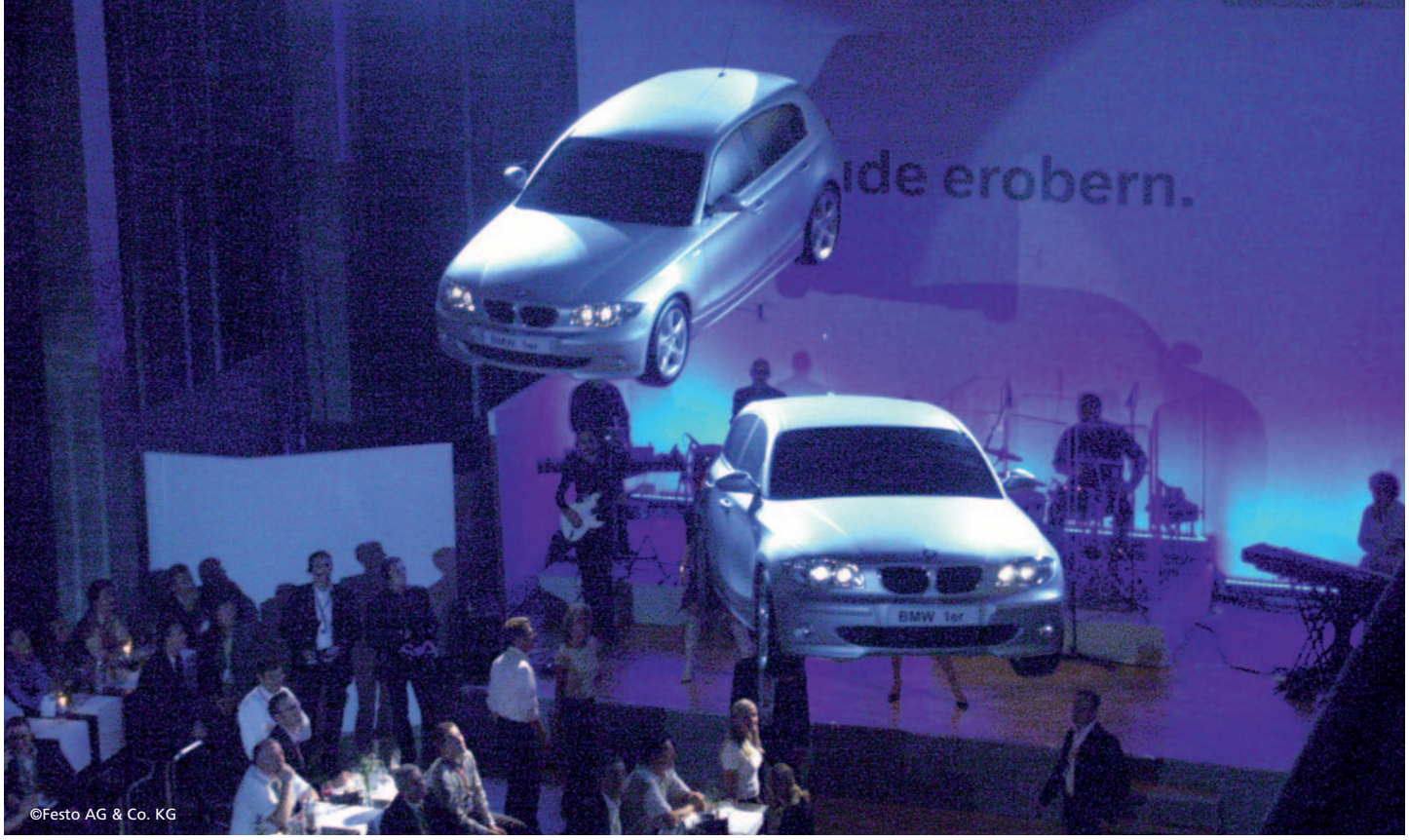


Majestic hovering motion over water or in the air.

are required. Here, the compact microdrives are in their element.

Small bell-type armature motors come out big

As aircraft that are lighter than air behave sluggishly similar to ships in water, the pilot's commands must be executed with no loss of time. Intermittent overloading of the drives allows precise, high thrust impulses, while avoiding the excess weight of larger motors that would negatively impact the model aircraft the entire time. "Essentially, for us the advantages of the DC-Micromotors from FAULHABER lie in their high efficiency and excellent intermittent overloading capacity, combined with very smooth-running operation, the uncomplicated actuation and easy interference elimination", explains Rainer Mugrauer. Bell-type armature motors have no cogging whatsoever; the precious-metal commutation guarantees a gentle start-up already at the lowest voltages. As a result, most models can be operated at a weight-savings with only a 3.6 V lithium battery. With diameters of 13 to 17 mm and 12 to 27 g of mass, a power output of approx. 1 to 3 Watt is attained. Planetary gearheads appropriate to the diameters increase the torque as needed and reduce the speed, e.g. for operating the jellyfish tentacles.



Sophisticated concepts can even make cars fly.

If especially compact drives are needed, flat micromotors with integrated spur gearheads are well suited. With an overall length of just 19 mm – including the gearhead, and a diameter of 26 mm, they stake out a unique position in the microdrives market. What all of the drives have in common is the ease of speed control by simply varying the input voltage. Thus, application-specific, ultra-light electronics control the motors of the model aircraft. As the precious-metal commutated motors generally have only a very low level of EMC emissions, and furthermore provide for simple interference suppression, these motors can also score points with their wireless compatibility. Any potential brush wear is negligible for the models. Most of the model aircraft are only in operation for a relatively short time; even with the AquaJellies, which swim around in basins for hours at trade shows, in practice the brush wear is insignificant.

Despite the trend to electronically commutated drives, microdrives with brushes are still convincing with their specific advantages. The cogging-free, silent-running bell-type armature motors, with the lowest operating voltages, are not only indispensable for model aircraft. In research, and in measurement equipment for medical technology too, or even in outer space, these drives are outstandingly suitable for implementing an idea in practical mechanical workings. A broad multitude of models, with corresponding off-the-shelf accessories, supports the developer in achieving this. Whether down-to-earth technology, bionic concepts or even more fantastic ideas, microdrives provide for the necessary movement in all areas.

5 servomotors make for autonomous movement in a defined space

FURTHER INFORMATION

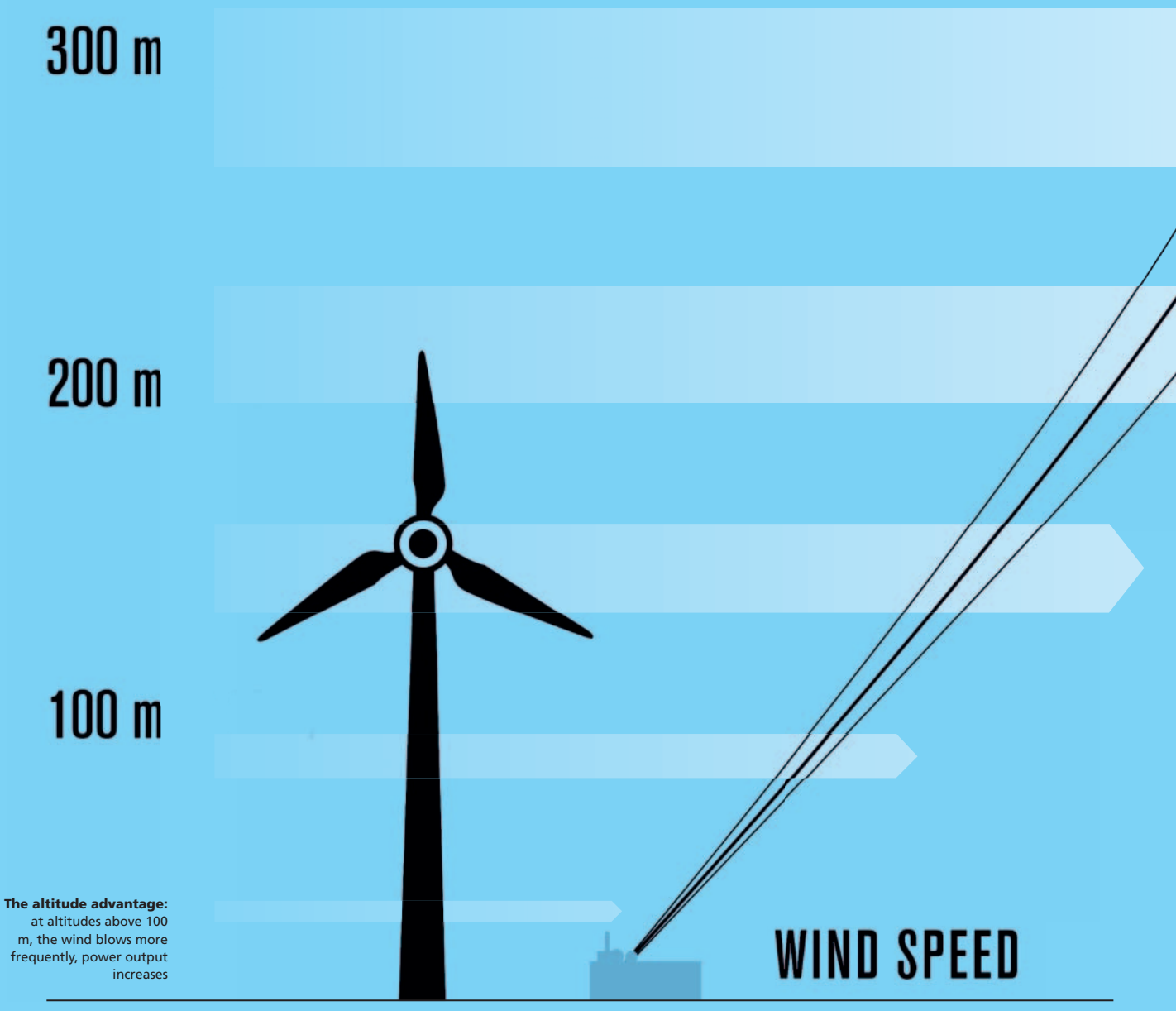
Airstage by Effekt-Technik GmbH, Schlaitdorf, Germany
www.airstage.de

Festo, Germany
www.festo.com/bionics

FAULHABER Germany
www.faulhaber.com

Using WIND ENERGY EFFICIENTLY

Microdrives aid in the control of "energy kites". An innovative approach, which harvests wind power through the use of comparatively small turbines by means of steerable kites, is setting new standards. Microdrives support the fully automatic control of the kite.

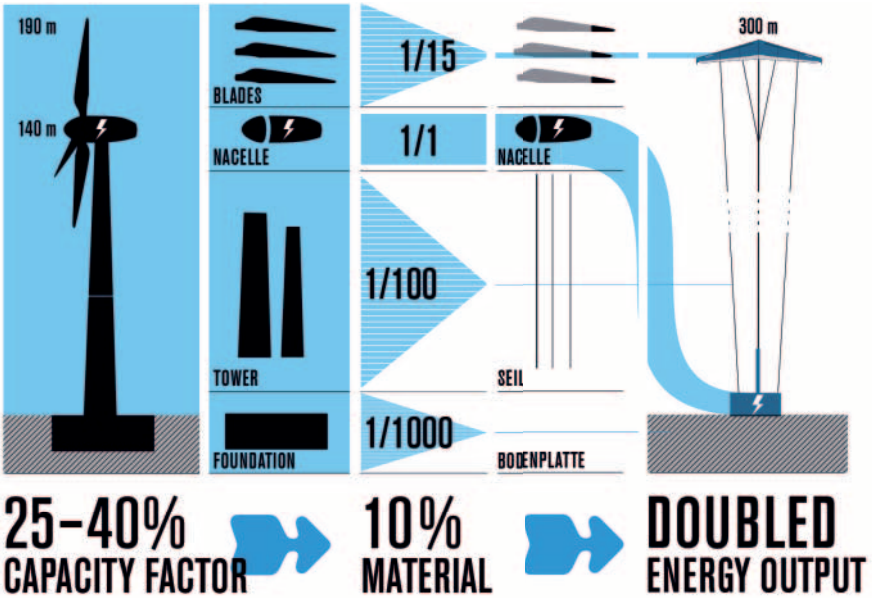


The altitude advantage: at altitudes above 100 m, the wind blows more frequently, power output increases

Today, ecologically generated power is a sought-after source of energy. How is "ecological" defined? Does it refer only to the generation of power, or does the manufacture of the turbine flow into the calculation? Cement and steel plants are front and foremost when it comes to industrial energy consumption. Large foundations and giant steel towers have an ecological cost even before the first kWh flows. The EnerKite company is therefore taking a new approach: instead of the dinosaurs of wind technology, it is using slim solutions that concentrate on the key components needed to utilise wind power. A steerable kite transfers the energy of the wind to a generator via a rope. A fully automatic control holds the functional component, i.e, the kite, at high altitude in the best wind window. This ensures high efficiency. To be able to respond quickly to wind gusts, drives from FAULHABER aid in controlling the kite.

New philosophy for new technology

To achieve change in energy policy, innovative technology for power generation is needed. Unfortunately, many alternative concepts are based on inventions that are more reminiscent of the steam engine era than of modern solutions. Without a doubt, this technology also works. However, like the steam locomotive, which is much more resource intensive than modern three-phase locomotives with respect to construction and operation, it rather contradicts an ecological approach. A great amount of material is needed to construct windmills, since the rotor and the heavy generator act on the tower with bending moments and with enormous static loads. Overload events complicate the dilemma: a tower cannot be simply retracted in the event of a hurricane. To safely dissipate the forces, massive concrete or pile foundations, which are a major cost factor and require a large amount of energy, are therefore needed. With respect to their size and expense, the subterranean structures look more like the 2 m thick steel domes of nuclear reactors than ecological structures. Off the coast, the manufacture of the foundations is particularly complex and expensive, and dismantling after use is rather doubtful.



The kite generator operates with a 50% smaller CO_2 footprint and twice the energy output of 140 m windmills

While the kites likewise operate according to an ancient principle for utilizing the wind, the method is refined through the use of modern material and control technology. In order to produce power, a generator is needed in which a magnetic field rotates in a coil. Conventionally, the rotational movement is transferred via heavy, rigid rods and shafts. The devel-

opers from Berlin instead use lightweight, high-performance ropes made of heavy-duty fibres for power transmission. Peter Kövesdi, design engineer and specialist for wind systems at EnerKite, offers a visual comparison: "Just like you can use thin spokes placed under tension to make a wheel that uses much less material than one which is solid, ropes can be used to transfer large forces with very little material."

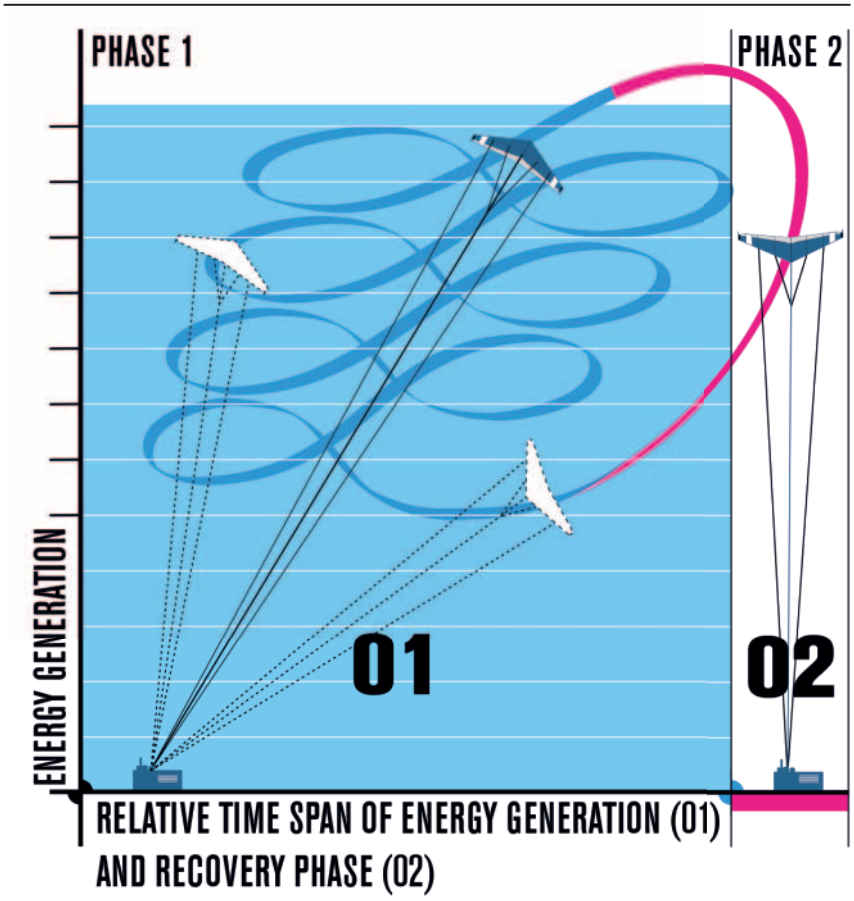


Diagram of the flight concept: flying in a figure 8 pattern, the kite rises and produces power, then quickly descends before rising again

Focus on efficiency

With the EnerKite, a flexible kite – a so-called parafoil – is brought to a height of approximately 150 m. There, unlike on the ground, the wind blows constantly, largely free of turbulence and at higher speed. One load rope and two control ropes transfer the pulling force of the kite to three generator drums. The kite is then "pulled" by the wind automatically from 100 m to 300 m, thereby generating the effective power. Once it has reached the maximum altitude, the kite is controlled in such a way so as to turn it out of the wind and the ropes are quickly drawn in. Very little energy is necessary for this purpose. Afterwards, the kite begins to climb, thereby generating power again.

Peter Kövesdi compares the good aerodynamic properties of the kite to the "down-to-earth" solutions as follows: "The advantage of the kite over windmills is the better utilization of the wind, as there is no turbulence caused by upwind rotor blades or by the tower. The kite is also always at an altitude in excess of 100 m and not, like the rotors, intermittently closer to the ground and intermittently higher than the tower. Thus, the technology can be designed for more uniform loading; in the event of a storm, the kite can be drawn in. This, too, reduces construction costs. The slow movement of the rope while the kite is close to the ground prevents collisions with birds, and the soft parafoil eliminates the risk of falling ice, as ice accumulations quickly flake off."

At sea, simple anchor buoys suffice for securing the generator pontoon; on land the turbine can be both stationary as well as mobile. Large access aisles for giant rotor blades and tower elements are not necessary. A kite can simply be rolled up like a tent; the same applies for the ropes.

Exact control in the wind

In addition to the towing rope, two so-called steering ropes are attached to the kite. In the lingo of kite experts, the EnerKite is a three-liner. The fully automatic control was one of the main problems in making the new technology suitable for practical use. The experts now have a handle on the programming. The best control is only as good as the executing actuator permits. Here, the microdrives from the town of Schönaich come into play. Ropes can only be precisely wound on rope drums while under tension. The wind is a very "dynamic system" with short-term fluctuations. So-called negative gusts can allow the control rope to sag at short notice. This is not a problem for the flight characteristics, but a "no go" for the rope drums. The developers therefore placed a rope tensioner in front of the winding drum that always ensures a defined rope tension at the drum. At winding speeds of 20 to 30 m/s and a pressure roll with diameter of approx. 30 mm, the rope tension motor needs to operate at high speeds that can exceed 10,000 rpm and must be able to very dynamically respond to demands for changes in speed. Here, an electronically commutated standard motor with an output power of approximately 200 W was able to deliver the required performance. The motor is connected to a 32 mm diameter, very robust Planetary Gearhead with all-metal construction. The high required torque for the pressure is thereby ensured. A Motion Controller optimally matched to the motors relieves the EnerKite control of motor management and allows the dynamics of the microdrives to be used optimally.

With this application, the motto is "small but efficient", as the microdrives perform a substantial part of the work in controlling the new wind power gen-

The test turbine with 30 kW and 15 m² kite demonstrates the suitability of the concept for practical use

erator. They ensure that the kite can quickly respond to changes in the wind and that the new material-saving system safely functions in practical operation. In this case as well, drives right off of the shelf could be used to reliably implement the developers' specifications. In difficult situations, simple, small changes to components often facilitate optimum operation. The use of microdrives is limited more by imagination than by technology. The application described here illustrates that even unusual ideas can be practically implemented.

FURTHER INFORMATION

EnerKite GmbH, Kleinmachnow, Germany
www.enerkite.com

FAULHABER Germany
www.faulhaber.com

ENERGY KITE CONCEPTS ON THE TEST BENCH

DIPL.-ING. JOACHIM MONTNACHER

Fraunhofer Institute for Manufacturing Engineering and Automation IPA

Mr. Montnacher, you are an engineering graduate at the Fraunhofer Institute for Manufacturing Engineering and Automation IPA in Stuttgart, Germany. What exactly are your duties at the IPA?

The Fraunhofer IPA is a manufacturing technology institute, with 14 departments and a broad range of competence areas. As the Power Industry business unit director at the Fraunhofer IPA, it is my duty to coordinate and focus these diverse competence areas in a customer-specific manner pertaining to energy sector issues and to serve as the principal contact person for all related matters.

Within the scope of a research project, in the field of high-altitude wind utilisation you have concerned yourself with energy conversion by way of kites. How did this idea come up at all? And, what are the distinctive technological aspects?

The idea originated with the managing director of NTS, who had already requested technological support from Fraunhofer IPA many years ago. The concept of that time was continuously developed and then implemented in the form of a prototype. A distinctive technological aspect is the combination of the specially-developed cable winch system and the measurement system which enables continuous control of the kite while in flight.

Government policy has, with regard to the development of renewable energy sources, set very ambitious goals. What realistic potential do you see in the concept of the high-altitude wind energy generation, also in comparison with other approaches such as biological fuel cells, for instance?

The concept of high-altitude wind energy generation makes possible an extremely efficient utilisation of our "renewable energy sources". In contrast to many other potential energy sources, wind is available practically without limits and free of charge. In addition, the NTS principle is also suitable for establishing systems of the magnitude of a power plant.

Which critical aspects must be taken into account with respect to the practical feasibility of the concept?

To be practically utilised, many specific problems must first be resolved, starting with the durable strength of the materials employed and further to legal approval issues.

For your concept studies, a kite wingspan with a surface area of 15 m² was constructed. How large must such a kite actually be in order to generate the energy of a conventional wind turbine?

There have been practical trials with kites with a surface area of several 100 m². But it's not necessarily a question of how large an individual kite should be. Based on the NTS principle, multiple kites could – and should – constitute a system. According to current plans, a system consisting of 24 units is being examined.

By reason of that, can all parameters simply be scaled up 1:1?

Technical upscaling is certainly possible, if not exactly 1:1 and undoubtedly not without intensive development work. Up to which magnitude this is possible is currently unknown; this is due to no restrictive criterion having yet been reached.

A particular developmental challenge was posed by the fully automatic control of the kites, which was resolved by means of drive systems from FAULHABER. How will the demands on these technical components change once the kite has been scaled?

An upscaling of the kite surface would, in addition to the requirements that would arise directly due to the greater forces, certainly also have conceptual consequences. Thus, I am convinced that one result will be a clear-cut separation of the control and winch systems. This would then have significant effects on the control concept and also on the control components.

In case of innovative power generation on the one hand, on the other hand a correspondingly efficient usage of energy should also not be neglected, of course. With regard to automated industrial applications, what significance do state-of-the art microdrives, such as those from FAULHABER, have already today – and in view of future development?

Today, efficient energy utilisation is largely ignored in detail. There, the potential – especially in production processes – lies in a multitude of small optimisations which, when added up, amount to a worthwhile amount. Here it is imaginable that microdrives will take over many tasks in the energy-optimised process control in the future.

POWER and PRECISION. For CHALLENGING APPLICATIONS.

The new 3890...CR series expands the power spectrum of the DC-Micromotors from FAULHABER in an impressive way. And what's more: with a rated torque of up to a full 224 mNm with an extremely flat n-M characteristic curve, the power pack demonstrates in every application where it comes from and what it was developed for.

MARKUS KRUMBEIN

Dipl.-Ing. (FH)
Platform Construction Development

3890...CR

17/1

DC-Micromotors series 3890...CR

The development of the new 3890…CR series is based on the successful motor concept of the CR DC-Micromotors series with Graphite Commutation from FAULHABER. A very powerful neodymium magnet and particularly high copper content in the winding of its FAULHABER rotor provide the compact drive with an enormous amount of power.

For drives in autonomous robot systems, electro-mechanical orthoses and exoskeletons or power tools like the electric loppers, high dynamics and torque in the smallest possible space are central requirements. In addition to the one-of-a-kind power density (rated torque per volume), the high efficiency of the 3890…CR series is also a decisive factor. Thanks to the further development of the commutation system, the motor also achieves high service life values even with extremely heavy loads. The coreless rotor also ensures cogging-free, precise synchronisation with very low energy consumption. In short: the 3890…CR series offers everything required for use in challenging power applications.

The new 3890…CR DC-Motors series is available as standard with four nominal voltages: 18 V, 24 V, 36 V and 48 V. A continuous torque of up to 224 mNm is thereby achieved as well. The short-term torque, required for many applications, is much higher. With no-load speeds of just over 5,000 rpm, the motors are optimally tailored to combination with FAULHABER Precision Gearheads. The standard drive can be combined with an IE3-1024 (L) three-channel encoder or optionally with optical encoders from the HEDx series for applications with precise speed controllers or positioning tasks.

Planetary Gearheads series 17/1

Thanks to the sturdy construction, FAULHABER metal Planetary Gearheads are ideal for applications which demand the highest torque. The new 17/1 Precision Gearheads are an addition to the FAULHABER gearhead product line in the 16 to 20 mm diameter range and are available with up to five gear speeds with standard reductions of 3.33 : 1 to 1,367 : 1.

The 17/1 series, with a diameter of 17 mm, stainless steel housing as well as steel and hard metal Planetary Gearheads and pins, is designed for continuous torque of 550 mNm and short-term loads of up to 800 mNm. Sintered bearings ensure axial shaft clearances under 0.1 mm. With the version with pre-loaded ball bearing, this can be reduced completed to 0 mm if necessary. The operating temperature range is between +100 and –30 °C by default. The gearhead is also available as a low-temperature model for down to –40 °C.

High copper content in the FAULHABER winding.

PREVIEW

EVOLUTION humanoid ROBOTICS

Robots explore other planets, produce car parts and vacuum dust and are today almost omnipresent. They do not, however, usually look like the science fiction fan might imagine: they move around as a flat trolley on wheels or are permanently installed as bulky machines in industrial halls. The development of human-like robots, however, is still in its early stages. The human locomotion machine poses huge challenges for the developers of this kind of humanoid robots. Walking on two feet in particular is infinitely more complex than precisely-controlled driving on wheels and demands a huge amount of power.
In the next edition of FAULHABER Motion, you can learn how powerful microdrives from FAULHABER set the "human machines" from Korean company Dongbu Robot in motion.

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