FAULHABER

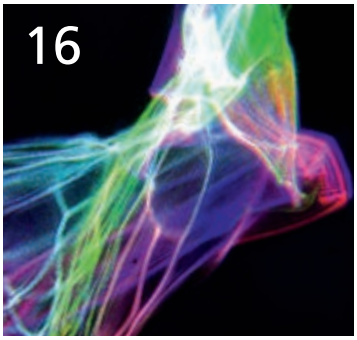
motion

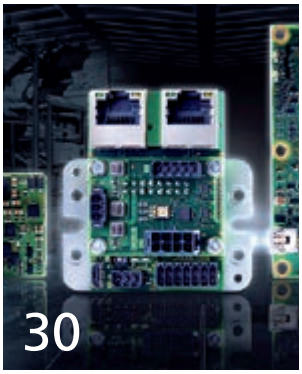
01.2023

THE MAGAZINE WITH DRIVE

A game changer in logistics

CONTENT





Dear readers,

For a year now, I have been leading this company together with the new management. This period has been shaped by geopolitical and macroeconomic crises, which the FAULHABER family has overcome with team spirit and solidarity. We are not the only ones to have noticed the growing competition for scarce resources, such as semiconductors – companies in all industries worldwide are affected. In the introductory interview, I answer interesting questions on this topic – in particular, how our drive systems integrate electronic features to help push forward automation in many markets, thereby increasing efficiency and competitiveness.
One example that is probably relevant to all companies is the topic of logistics/intralogistics. This area offers huge automation potential, with key work steps already being taken over by intelligent logistics robots, such as automatic storage and retrieval machines and driverless transport systems. Read the in-depth article to find out the crucial factors and how FAULHABER can contribute.

In the associated interview, Chief Developer Markus Fenn from EduArt Robotik GmbH provides insight into the innovative concept of "EduArt," their training platform for the development and operation of autonomous mobile robots.
The topic of increasing productivity, even with small batches, is examined in the article on the TKX-series changer from the specialists at IPR. This changer carries out the tool change on production robots fully automatically, even while production is ongoing.

The issue takes a sporty turn with the article on the miniature camera from LMP Lux Media Plan. The small camera goes unnoticed and captures some great footage for sports fans. Large, emotive images are also provided by the profile on LaserAnimation Sollinger. The Berlin-based company enhances big events worldwide with their breath-taking laser light installations. As you will see, the central theme of this issue of motion is automation, so we simply had to round it off with a report on our new motion controllers.

Happy reading!

Regards

Karl Faulhaber
Managing Director

Issue 01.2023

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INTERVIEW SERIES

Passion in motion – What drives us

#02

Karl Faulhaber
MANAGING DIRECTOR

Integration of electronic functions in drive systems: Benefits and dependencies

For the past year, Karl Faulhaber has been responsible for successfully leading the drive technology company founded by his grandfather into the future. In this interview, he talks about how he evaluates global supply chains with his team in the FAULHABER Group and where he sees growth markets.

What is your overall assessment thus far at the helm of the newly formed FAULHABER management?

The first year under the new management was characterized by an exacerbated situation due to various macroeconomic and geopolitical crises. Our success and growth despite of these crises are due to the team spirit and team work of all FAULHABER employees.

From a global perspective, what are the lessons and consequences?

We are working on our suppliers being positioned more broadly regionally and at the same time we want to localize the supply chains in important geopolitical regions. Moreover, the current situation also affects the cooperation with our international customers. They require more regional support and expertise. On the one hand, the global cooperation entails higher expectations of transparency on behalf of the suppliers, and, on the other hand, confidentiality when it comes to handling customer data and intellectual property.

Semiconductor prices have fallen continuously in recent years. Did this result in any benefits for the company?

As a company that is driven by technology and innovation, we have primarily benefited from miniaturization and the expanded functionality of electronics over the years, and less from falling prices. We have consistently expanded our product range, and we consider the integration of electronic functions and components in our products and system solutions a key advantage for our customers. This strategy entails a higher risk of dependency on these components.

What are your expectations concerning the future supply of semiconductors?

The main challenge we've had last year was the procurement of electronic components. Much like our customers and suppliers, we are also hoping that this situation will improve in 2023. But thus far, we have not seen any obvious signs of fundamental improvement.

What is more important in the future: Deliverability at all costs or cost optimization?

We are always working on improving deliverability and our cost structures. Under normal circumstances, you can't say that any given factor is more important than the other, but due to the extreme volatility in the semiconductor market and high inflation in some aspects, we've had to use different evaluation criteria in the short term. In the interest of deliverability, we've had to absorb significant cost increases in some aspects.

How does FAULHABER ensure deliverability in times of crisis?

In order to still be able to deliver in these times of crisis, we first had to establish a way of communicating even more closely with our customers and suppliers. We have to understand what their priorities and possibilities are before we can establish our solution approaches accordingly.

We have to pro-actively address the problem cases and solve them with flexible and adaptable methods, depending on the situation.

In the simplest but very expensive case, this can mean higher material costs and inventory buildup, but it may also mean that we need to quickly develop an alternative technical solution together with our customers. In these types of situations, it's people finding a solution, not the ERP system.

What are the strongest growth sectors today?

Medical technology and diagnostics as well as robotics and automation technology are currently our strongest growth markets. Our products and system solutions are perfectly suited to these areas of application.

What makes the market for medical technology unique?

In medical technology and diagnostics, we aim to be able to offer our innovative customers drive platforms with an extended range of functions and high power density. At the same time, simpler and cost-optimized solutions also allow us to offer state-of-the-art medical and diagnostic equipment to a broader segment of our society.

And what can customers expect in the field of automation?

In the automation market, we are concerned with supporting our customers with regard to the development of the processes and materials of the future and thus also with ensuring the efficiency, accuracy, productivity, and effectiveness of the next generations of machines.

Can you explain that to us with a specific example?

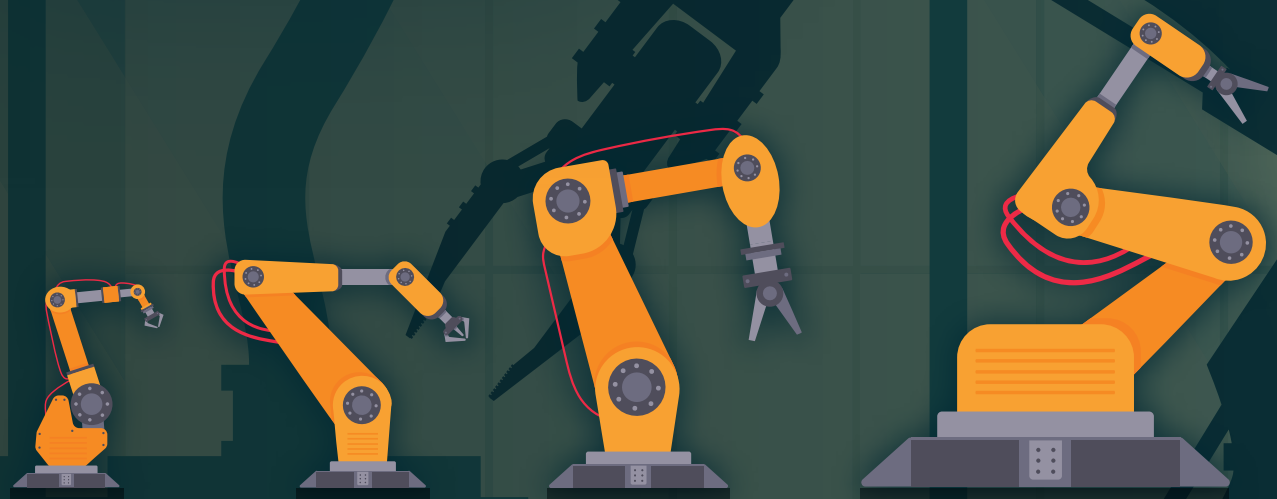
The examples are as varied as they are exciting. Our solutions are used in agricultural robots and for precision farming. Precision farming is about reducing or completely preventing the environmental impact of pesticides and fertilizers by dosing with more accuracy. This is achieved through the use of robots, which destroy the weeds with laser beams. Improving the land use and yield in the form of vertical or urban farming also plays a role here. Our light and compact drives and system solutions can be optimally used in these applications.

We provide further support for a more efficient and environmentally friendly use of space and energy with our solutions for intralogistics and warehouse logistics robots. We offer optimal drive platforms for very compact, efficient, and reliable robots that are able to sort and distribute goods quickly, even in increasingly tight spaces. A perhaps more accessible example is our solutions for storage systems in pharmacies, where robots controlled by the pharmacist quickly retrieve the desired medication from a very compact and anti-theft storage system at the push of a button.

Inspection and service robots are extremely important for sustainable cities in the future. The infrastructure should become more efficient and reliable. Our solutions enable our customers to build even smaller, more efficient, and more powerful robots that take care of the constant monitoring and maintenance of the infrastructure in cities that is often inaccessible to humans.

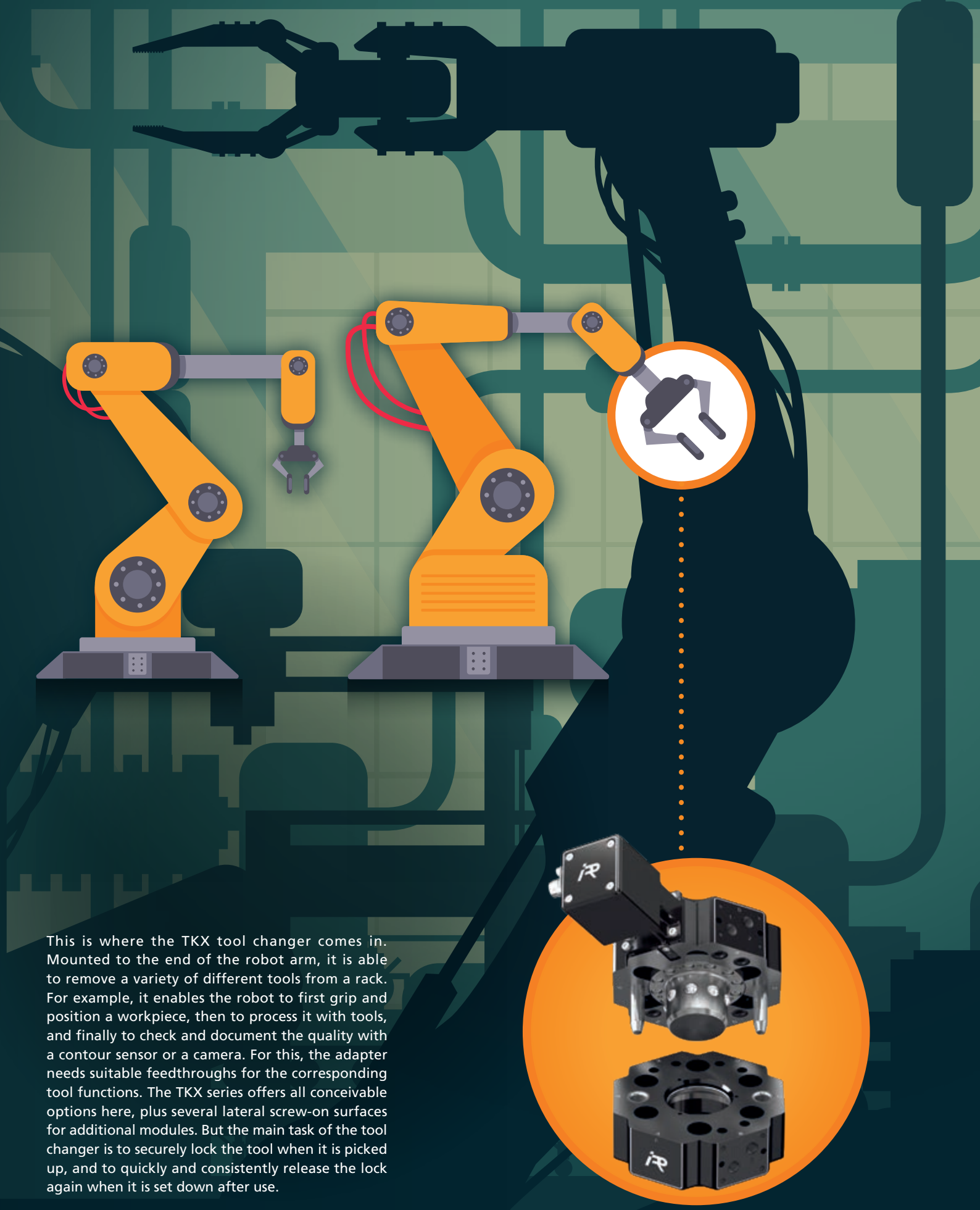
www.faulhaber.com/en/motion/

Evolution in robotics
Those who adapt the fastest win.

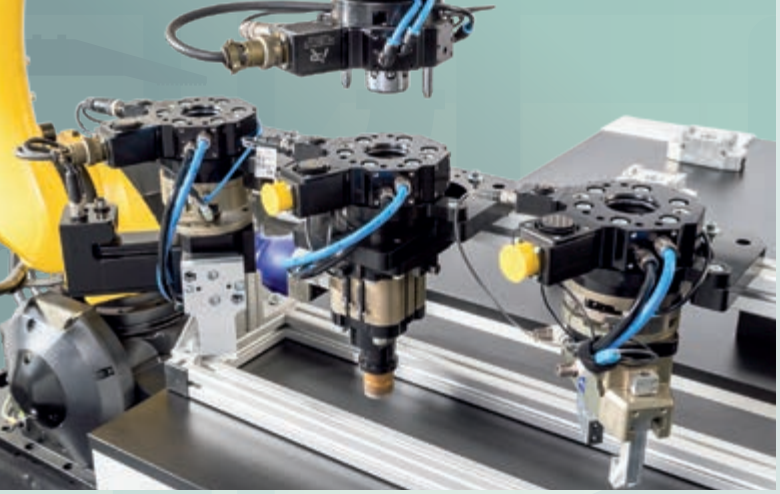


In industry and logistics, robots generally handle monotonous tasks that they can repeat almost endlessly with steady precision. A new type of tool changer now turns the specialist for large series into a flexible all-rounder, with which even small series and individual pieces can be produced economically. The innovative TKX changer series from the IPR specialists features a motor from FAULHABER in the electric drive of the automatic changer.

The range of tasks that is being carried out by robots has become limitless. It includes gripping, holding as well as manipulations such as clamping and screwing through to foaming and welding. And when it comes to standardized mass production, specialized robots can be used, which perform the same tasks day and night. But many processes require flexibility, such as when it comes to batch size 1. This is also important to save on investment costs. The greater the range of tasks that a robot can carry out, the better.



This is where the TKX tool changer comes in. Mounted to the end of the robot arm, it is able to remove a variety of different tools from a rack. For example, it enables the robot to first grip and position a workpiece, then to process it with tools, and finally to check and document the quality with a contour sensor or a camera. For this, the adapter needs suitable feedthroughs for the corresponding tool functions. The TKX series offers all conceivable options here, plus several lateral screw-on surfaces for additional modules. But the main task of the tool changer is to securely lock the tool when it is picked up, and to quickly and consistently release the lock again when it is set down after use.



TKT: Same tool side can be used for every drive variant.

TKP (pneumatic): Proven functional principle

Pneumatic or electric?

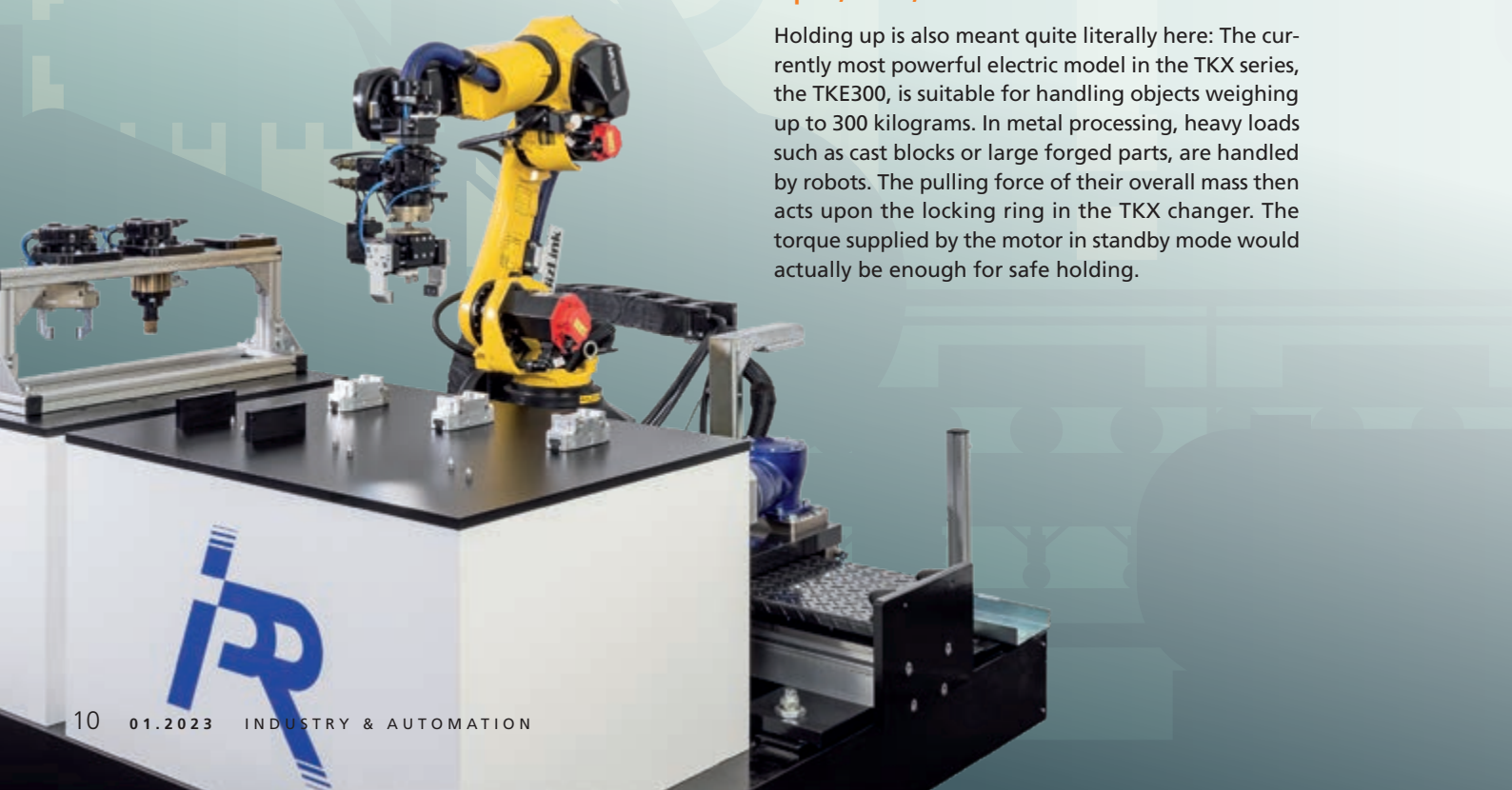
Traditionally, many industrial applications use pneumatic power transmission for this process. Compressed air technology has proven itself over decades, and it is well suited not least for handling very heavy objects. But a pneumatic system requires compressors, lines, and its own controller with numerous mechanical components – a considerable investment in new systems. In industries with increased demands on cleanliness and hygiene, such as microelectronics or food, pneumatics are out of the question in many places because of the unavoidable emission of compressed air. And pneumatics are an absolute no-go in clean rooms.

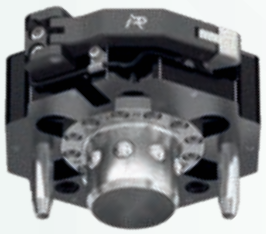
IPR – Intelligent Peripherals for Robots in Eppingen has seen a significant trend towards the use of electric drives instead of pneumatic ones: "In addition to the hygienic safety, electric motors are much more flexible in use. Unlike compressed air connections, power sockets are available almost anywhere. In newly built industrial plants, pneumatic systems are generally no longer installed. For cobots and smaller robots as well as for decentralized locations, the electric version is almost always the better solution."

The fact that the electric drive is a real alternative to pneumatics today also has something to do with motor technology, explains Roman Batz, development engineer at IPR: "Great strides have been made in recent years. For our applications, we basically need a lot of power with very small dimensions. FAULHABER offers motors that can easily hold their own compared to pneumatic drives."

Open, close, hold

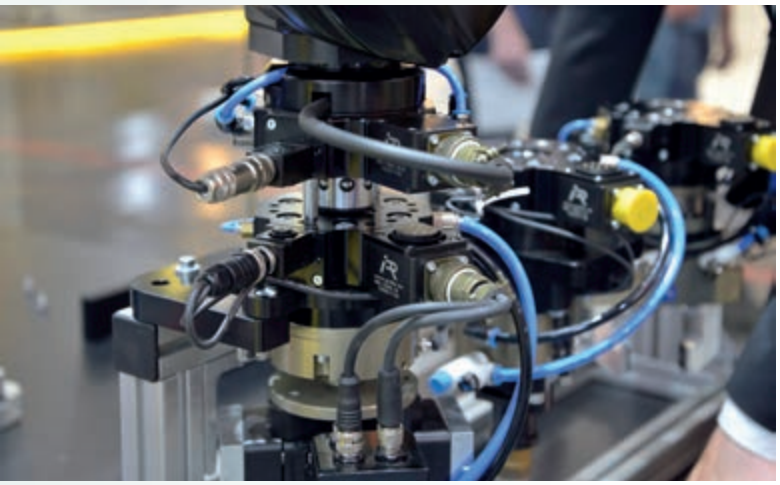
Holding up is also meant quite literally here: The currently most powerful electric model in the TKX series, the TKE300, is suitable for handling objects weighing up to 300 kilograms. In metal processing, heavy loads such as cast blocks or large forged parts, are handled by robots. The pulling force of their overall mass then acts upon the locking ring in the TKX changer. The torque supplied by the motor in standby mode would actually be enough for safe holding.





TKM (manual):
Change with ease and in seconds

TKE (electric):
Change with 24 V

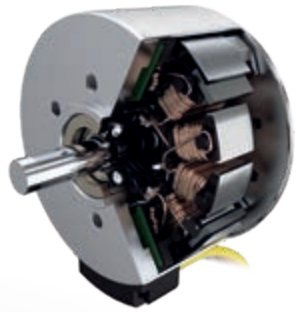


But to ensure particularly reliable fixation, IPR also installed self-retaining kinematics, which were developed in-house. A brushless motor from the FAULHABER BXT product family provides the driving force for opening, closing, and holding. With its external rotor technology, it achieves a ratio of torque to weight and volume that is unrivalled on the market. This power density is one of the prerequisites for the unique selling point of the new product family from IPR, which Roman Batz describes as follows: "The TKX series are the first tool changers on the market that are available on the same platform with both pneumatic and electric drives – we also have a manual version in the product range. This means that the entire range of accessories can be used with all drive types without retooling. And switching to electric operation is also quite easy. This opens up new possibilities for robotic automation."

Reliable and easy to combine

The TKE changers will be available in seven sizes for handling workpieces from 3 to 300 kilograms. The electric variant of the product family thus covers a wide range of applications, from lightweight robots to stationary applications. The dimensions of the BXT motors used are adapted to the application. "The range of sizes and the large selection of suitable gears for the optimum reduction in each case was an important criterion for us," explains Roman Batz. "Robots should be able to achieve seven-digit cycle numbers without maintenance. So only a brushless motor with the highest possible processing quality can be used. It should be easy to control and manage without additional control – the integrated speed controller takes care of that. Last but not least, the components have to be able to withstand temperatures of up to +80°C."

IPR procures all micromotors from FAULHABER. "We started working together many years ago, long before my time," says the development engineer. In addition to the unique quality of the products, other aspects play an important role for him: "It starts with the very simple design of motor-gear combinations on the FAULHABER website. It takes just a few clicks to get a comprehensive overview. The technical details are very well documented, and when it comes to precisely calculating the finer points – efficiency, power consumption, temperature development over time, etc. – I always get the support I need."



FAULHABER BXT
BRUSHLESS FLAT MOTORS

www.faulhaber.com/en/motion/
www.iprworldwide.com

Small

cameras for big emotions

Fans want to get as close as possible and the media must deliver: a subtle twitch at the corner of the trainer's mouth, contentious fraction-of-an-inch decisions or once-in-a-lifetime events. In the competition to deliver the most spectacular images, cameras are ahead of the field, right in the midst of the action but without being a nuisance – like the miniature devices from LMP Lux Media Plan. Drive units from FAULHABER are used to adjust the shutter and focus.

Down 39 kilometers

On October 14, 2012, Austrian extreme athlete Felix Baumgartner jumped out of a capsule that had previously travelled to an altitude of almost 39 kilometers by means of a helium balloon. In a free-fall from the stratosphere back to Earth, he reached a speed of 1357.6 km/hour and was the first human being to break the sound barrier without the use of an aircraft. He opened his parachute 1585 meters above ground and landed safe and intact.

TV stations around the world televised the preparations and the jump. The broadcaster of the main sponsor reported on the event live over more than 10 hours.

Nine cameras delivered spectacular images – five inside the capsule, two showed the exterior of the capsule, and two more were attached to the performer's body. The shutters and sharpness of the cameras were adjusted from the ground via remote control.

"The biggest challenge for the devices was heat," explains Friedel Lux, pointing out an unexpected obstacle, considering the freezing temperatures in the stratosphere. "The unfiltered sun radiation heated the housing enormously. And at that altitude there is no air to carry away the increasing heat. So the cameras had to withstand quite a lot."

Industrial camera on ski jump tower

Originally, the founder and technical director of LMP developed it for "regular" professional sports. With his unique equipment designs for recording and image transmission, he had previously made a name for himself as a service provider for TV productions. In 2002 for the Olympic Winter Games, he received an inquiry from an Italian TV station on whether it would be possible to mount an HDTV camera at the starting position of the ski jumpers at the top of the ski jump tower. "The space is very tight there, and the recorder wasn't to get in way, of course," he recounts. "So we took a still rarely used camcorder and dismantled everything that wasn't critical to video recording."

The tiny device that remained enabled the TV station to literally look over the jumpers' shoulders. It didn't take long for other types of sports to discover the appeal of up-close footage. In 2004, LMP in co-operation with TV-Skyline for the first time mounted a camera on the net strut of a soccer goal, which showed every movement of the goalkeeper from behind and at the same showed a view of the entire game situation from his perspective. The device could only protrude 3 cm into the area of the net.

The second generation was released in 2008: was completely further developed in-house under the commercial name "Cerberus" and it is still used today. You can find it in handball goals as well as on crossbars for pole vaulting and many other places where fans want a close-up view. The camera head of the Cerberus is no bigger than three regular-size matchboxes stacked on top of each other.

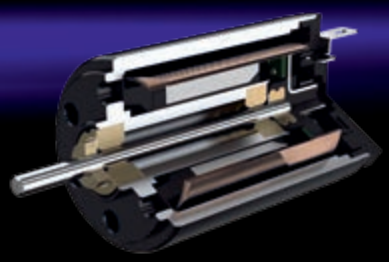
Hellishly efficient drive for Cerberus

An even smaller version was developed for installation into the pole of a corner flag on the soccer pitch. It is currently being used in two top games of every match day in the Bundesliga. The cameras mounted on mobile cranes, which are part of everyday life in team sports in the top leagues, are also from LMP in many cases. "In this case, it's more about the weight than the size," explains Friedel Lux. "The lighter the camera, the faster and more precisely the crane can perform the desired movements."

The drive unit mounted on the camera plays a decisive role in the function of the Cerberus. It performs the mechanical work of adjusting the shutter and focus via a gear train. To do this, LMP uses DC-motors from the 0816 … S series and 08/1 gears with a diameter of eight millimeters from FAULHABER. The diameter of the corner flag camera is slightly larger, but the motors are shorter.

"For these types of applications, we need as much torque as possible with the smallest possible mass and volume," the camera specialist points out. "The gearhead is almost more important. It has to withstand a lot and must be very robust. At the same time, it must ensure that the drive unit functions very precisely. Our top priority is that there are no sudden movements and everything works very smoothly, no fluttering, snagging, or start-up delays. Only then can you actually see whether the goalie is tense and by how many hair's breadths the high jumper cleared the bar."

But the drive units from LMP are not only used for sporting events. Lens controls for aerospace applications, from Space-X to Boeing and Airbus, are also part of the program. Precision and robustness are also of utmost priority here.



FAULHABER SR
DC-MICROMOTORS

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www.luxmediaplan.de/cameras/

How to get the right colors with laser light

Today, every large event includes a spectacular laser show. The magically glowing light patterns are the result of a huge amount of high tech and know-how. In the case of the most sophisticated installations, both are often provided by the company LaserAnimation Sollinger from Berlin. The drives used in the laser projectors to align the laser beams and generate the light effects come from FAULHABER.

Photos and videos can give only a vague idea of the actual effect that the laser projections have on site during a performance. One example is the "Global Rainbow" by the artist Yvette Mattern: seven brightly colored very powerful laser beams shine towards the sky from Berlin's Ernst-Reuter-Platz in the direction of the Victory Column and change the vibe of an entire city center. Or 'Another Moon' by the artist duo Kimchi and Chips, where a second moon appears in the sky over the Zeche Zollverein in Essen. Or the fast-paced show at the closing ceremony of the Winter Olympics in Pyeongchang... these are just a handful of many examples.

Light pen with a diameter of four millimeters

The often surprising and sometimes breathtaking light effects are based on the unique qualities of the laser beam. In terms of intensity, beam focus, and range, it outperforms light beams from other artificial sources many times over.

On the other hand, the laser is subject to optical and technical limitations, as sales manager Richard Schäfer explains: "The beam is usually very small. With our devices, its diameter is usually around 4.0 millimeters. So only a small dot appears on a projection surface."

In order create a pattern – such as a logo, lettering, or cartoon-like moving images – laser projection relies on the inertia of the human eye. To be precise, it is the image processing in the brain, which also creates a continuous progression in a film made up of 24 individual frames per second. If the laser beam moves fast enough, the person "sees" the projected animation instead of a point of light darting around. To achieve this, the beam in the projector is deflected by means of two mirrors – one each for the x and y axes. Its movement is induced electro-magnetically and reaches a very high speed.

Fig.: Installation Lumia Narrow

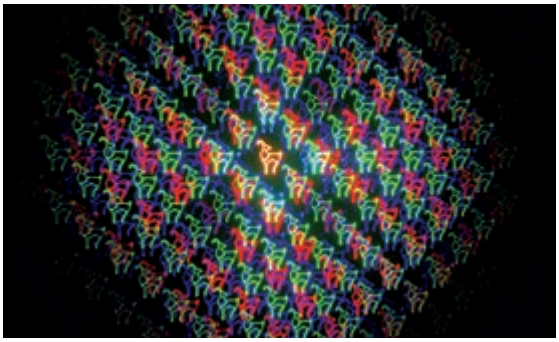
"A deviation of one hundredth of a degree results in an offset of 1.7 centimeters per one hundred meters ..."

Another limitation is the color. The color of a laser depends on the laser-active material in which the beam is generated. In the case of laser projection, it is the semiconductor, since diode lasers or Coherent OPSL sources are used here. But laser diodes can only produce a few basic colors, mainly red, green, and blue. The high-end devices from LaserAnimation Sollinger also have Coherent OPSL sources for yellow, orange, and cyan. To produce a white beam, beams of multiple colors must be "collinearly superimposed." The same is the case for other colors: in order to create the different tones of the entire palette, the intensity of the individual rays is modulated.

Not even a hundredth of a degree of deviation is allowed

The trick is to superimpose the different laser sources, each with different wavelengths, as collinearly as possible. The more precisely this is carried out, the sharper and more precise the final beam will appear to the human eye. This is where special optical filters, so-called "dichroic filters," are used, which deflect certain wavelengths while other wavelengths (colors) beam through the glass filtrate. This is how different laser beams can be "superimposed" to form a single beam. So what looks like a "white" ray to the human eye is ultimately the combination of red, green, and blue sources.

But that only works if the beams stay together very precisely and, above all, for a long time and at a great distance, because laser installations often have to be visible from hundreds of meters or even several kilometers away. The dichroic filters have to be adjusted with the appropriate precision, as Richard Schäfer explains: "A deviation of one hundredth of a degree results in an offset of 1.7 centimeters per one hundred meters. This means that the individual colors are no longer on top of each other and can be distinguished by the human eye – the color mixing effect is lost."



Graphic motifs created using a grating effect

Now, it's not unheard of that a device from Laser-Animation Sollinger leaves the premises in Berlin to be set up a day later, for example, for a laser show on the Burj Khalifa in Dubai. After minus twenty degrees on the cargo flight, the housing heats up to sixty degrees or more in the desert sun. Despite high-quality materials and sophisticated fastening technology, a certain level of distortion in the optics is inevitable. This means that the position of the dichroic filters may need to be slightly readjusted. This is the reason why the dichroic mirror holders are equipped with a drive: brushless DC-motors from FAULHABER with integrated gears are used for software-controlled fine adjustment to at least a thousandth of a degree.

Optical gratings for breathtaking effects

Another motor is used for protection. To prevent the intense laser light from penetrating the human eye in an uncontrolled manner, the projectors are equipped with a two-stage switch-off mechanism. In addition to an electronic protective circuit, there is also a mechanical shutter for emergencies. Its flap is held open during regular operation by a motorized rotary magnet. In the event of a fault, the safety circuit stops the motor and allows the flap to fall into the beam exit.

Other drives from FAULHABER are used in the grating module. Diffraction grating is an optical element that uses the deflection of light rays when passing through very narrow gaps. In addition to beams and graphics, a laser projector can also generate a variety of patterns and effects, such as a kind of artificial polar light or the wafting, abstract forms of Robert Henke's "Destructive Observation Field": A light object that changes continuously and looks like a mix between cosmic fog and biological cell structure, reflecting the micro- and macrocosm, as it were. The effects can not only be produced on a projection wall, but also freely suspended in space.

The wheels in the grating module are positioned by stepper motors to select a specific grating for the projection. The circular gratings themselves are set in motion by brushless DC-motors, which in turn creates its own optical effect that can range from wild fidgeting to meditatively slow changes in the image at a snail's pace.

Highest demands on drives

"For these types of effects, we often use several projectors," explains Richard Schäfer. "They can only unfold their effect if the gratings move completely synchronously, at the highest and lowest speed as well as in start/stop operation with constant changes of direction." The projectors and the grating modules are full of technology, which means that the installation space is extremely tight. Only very small motors can be accommodated here.

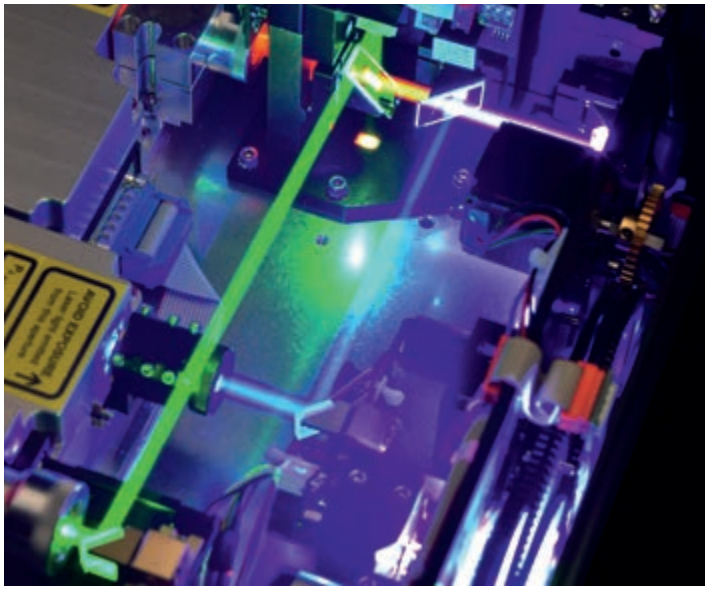


Fig.: Beam path

Maximum precision and repeatability are additional minimum requirements. The integrated backlash-free gears play an important role here. When asked about the beginning of the collaboration with FAULHABER, Richard Schäfer replies that it must have been before his time. Looking for the very first order, he finds the year 2003. This means that FAULHABER motors have stood the test of time for this demanding application over the course of twenty years: "We build top of the line devices for laser projections. To do this, we need drives that are on the same level."

FAULHABER B-MICRO
BRUSHLESS DC-MOTORS

www.faulhaber.com/en/motion/
https://laseranimation.com/projekte/

A game changer in logistics

Faster, more efficient, more sustainable – due to global competition in industry combined with booming online trade, transport structures in intralogistics are facing new challenges.
The industries' answer: Automation. From storage to shipping, key work steps are being taken over by intelligent logistics robots, such as automatic storage and retrieval machines and driverless transport systems.
To work efficiently and reliably around the clock, these robots need flexible and particularly compact drive solutions.

The demands that modern intralogistics place on the used drives are high: In many instances, they must be capable of releasing tremendous forces under extremely confined conditions, also work reliably in continuous or stop-and-go operation, and oftentimes they must also perform highly precise positioning tasks. The speed also plays an important role, after all, many thousand orders need to be processed every day in large warehouses.

Drive systems from FAULHABER have often demonstrated their performance here during sorting and transporting as well as with storage and retrieval. Thanks to their modular design, the motors can be combined with a variety of high-resolution encoders for precise positioning tasks and with high-performance gearheads for high torque requirements. There are also compact motion controllers that can either be integrated in the drives or arranged externally.

Powerful handling with finesse

Autonomously driving and self-contained logistics robots are a critical component of "Intralogistics 4.0". They are used both for storage as well as removal and dispatch preparation. They optimize material flow, relieve employees and replace, e.g., conventional lift trucks or pallet trucks. Autonomous picking robots that allow individual objects to be precisely accessed are one example. A typical picking robot comprises a lifting column and gripper. As a drive unit, it contains, e.g., BX4 series brushless DC-servomotors with integrated motion controller and planetary gearhead. When used in the gripper, this combination ensures precise positioning during storage or retrieval – all during continuous operation with constant load changes.

Yet the complete drive unit weighs only about 300 grams. This means that no counterweight is required even when the gripper is fully extended. With a diameter of only 32 mm and a length of 85.4 mm, the brushless DC-servomotors are also very compact. This makes it possible to design the gripper very flat, allowing it to also pick up packages that are stored just above ground. Expensive storage areas

can thus be optimally used. Thanks to the brushless commutation system, the motors are long-lasting and reliable. They deliver high torques and, with the balanced rotor, are very quiet running. With the integrated current control, the torque demands are limited and the drive is reliably protected against overload.

Storage and retrieval is performed by a vacuum gripper arm driven by FAULHABER motors.

Compact drives for rapid start/stop operation

Graphite-commutated DC-micromotors of the CXR series combined with matched gearheads have also proven themselves in handling tasks. Their commutation system is very robust and is especially well suited for dynamic, high-performance applications with fast start/stop operation as is required in many handling systems as well as with automatic sorting, e.g., in cases where switches are used to change routes on transport paths.

An AGV in use as a shuttle robot

Thanks to their linear characteristics, the DC-motors are also easy to control. Combined with high-resolution encoders, this makes them ideal for precise positioning tasks. High-quality neodymium magnets and the proven FAULHABER winding ensure a high power density in a compact design. They can thereby be installed directly in the handling elements. In spite of their small size, they can lift considerable weights there.

Flexible through production

Automated guided vehicles (AGV) are the means of choice when it comes to ensuring flexible transport in production processes. Among the most important requirements for the used drives with in-house material transport systems are availability, speed, flexibility and – often – low space requirements. The current consumption also plays a role in ensuring that the battery of the vehicles is as long lasting as possible. For example, brushless DC-servomotors of the BP4 series are suitable to drive the wheels, whereby the motor power can be transferred to the wheels via planetary gearheads and drive belts. The motors operate with high efficiency: their innovative winding technology allows for a high copper content and keeps losses to a minimum thanks to high winding symmetry.

Encoders of the IE3-1024 series are built right onto the servomotors for precise position detection. These magnetic incremental encoders, which are available with different resolutions, feature an indexing channel for referencing a revolution of the drive shaft as well as a standardized, electronic encoder interface. The resolution, direction of rotation, index width, and index position can be flexibly adapted to the application. A motion controller controls the servomotors. Such drive systems are also used for mobile robot platforms, which move about completely autonomously in industrial halls without a preinstalled guidance system. Above all, their high power density is particularly evident in the wheel modules.

FAULHABER CXR
DC-MICROMOTORS

FAULHABER BX4
BRUSHLESS DC-SERVOMOTORS

FAULHABER BXT
BRUSHLESS FLAT MOTORS

A lot of power in a very small space

If there is limited installation space for wheel drives in the axial direction, the high-torque flat motors of the BXT series are often an option. Thanks to innovative winding technology and an optimized design, the motors are just 14, 16 and 21 mm in length but deliver torques up to 134 mNm, within a diameter of 22, 32 and 42 mm respectively. For precise speed control or in the case of high requirements on positioning accuracy, diameter-compliant magnetic encoders or speed controllers are now fully integrated into the housed motor variants, whereby the drive is increased by just 6.2 mm. Speed control is performed by the digital Hall sensors integrated in the motors. Thus, a wide speed range from 200 rpm to 10,000 min^{-1} is available. The compact drive combination is ideal for space-critical applications and simplifies installation and commissioning. The matching metal planetary gearheads of the GPT series too are characterized by a short design, high torque and extremely fine graduations of the numerous reduction ratios.

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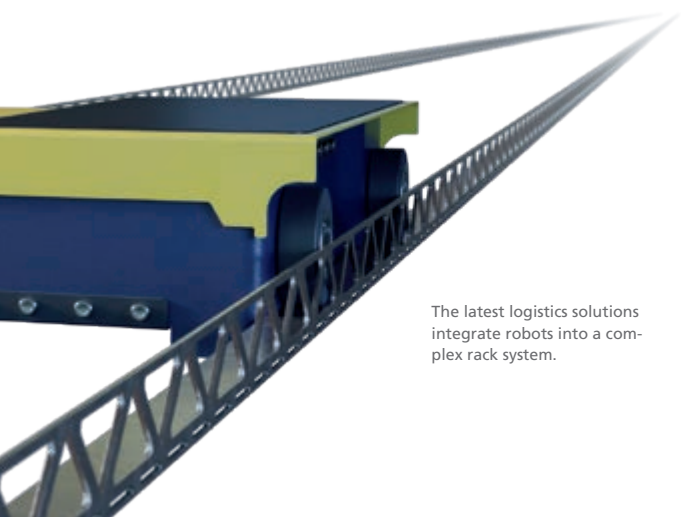
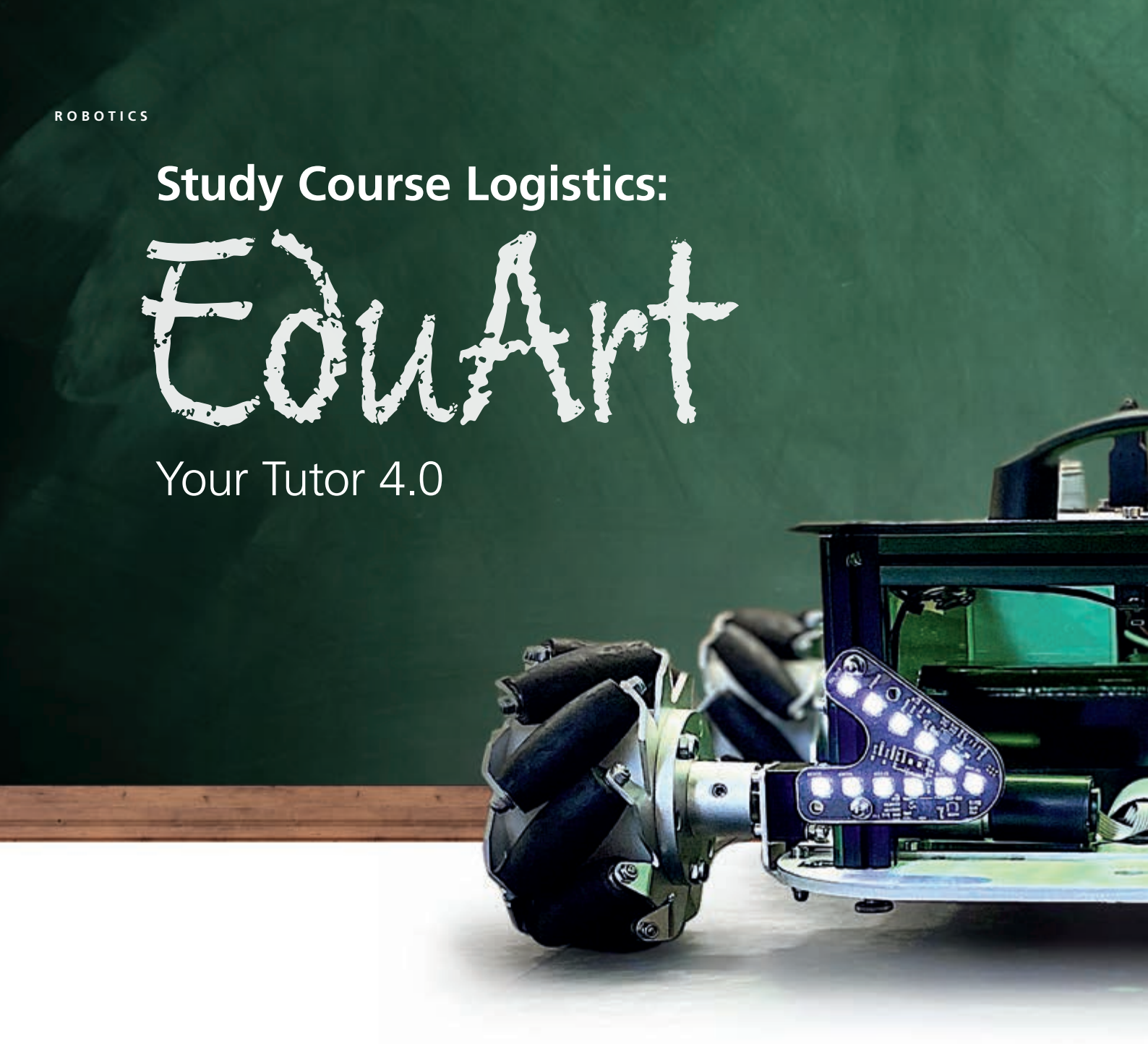


The latest logistics solutions integrate robots into a complex rack system.

Study Course Logistics: EduArt

Your Tutor 4.0



How did your robot platform come about?

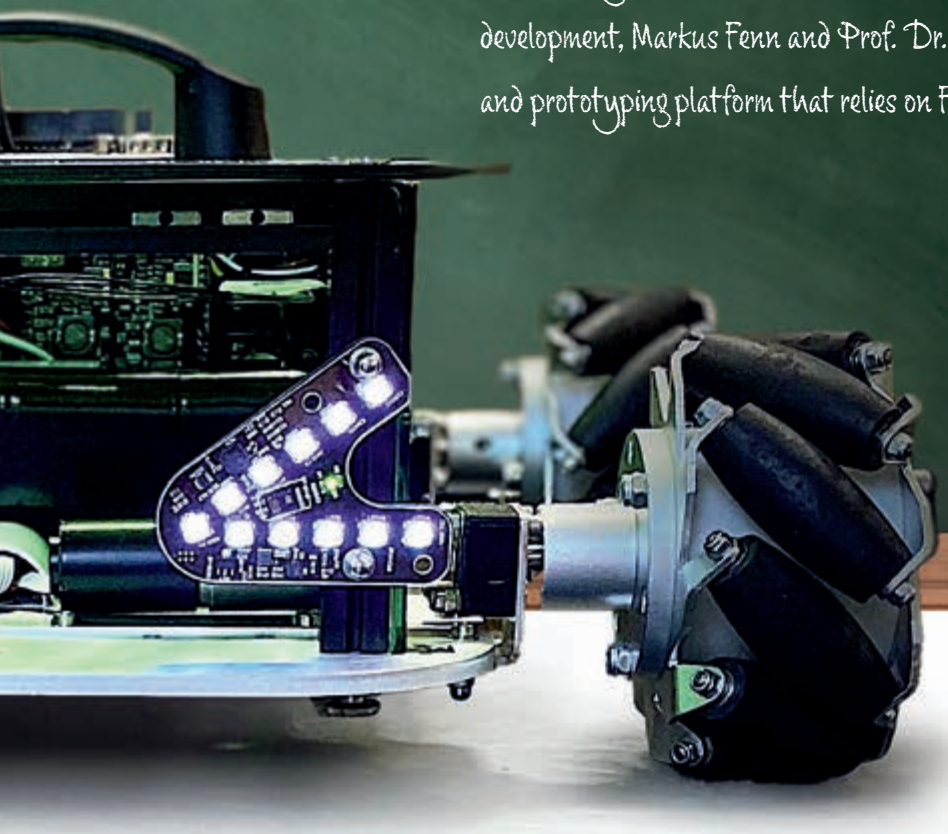
It started as a result of an inquiry from a company to Prof. Stefan May. The company needed a platform to educate and train their employees on mobile robotics. Subsequently, we developed "EduArt" together. In addition to the robot platform, EduArt Robotik GmbH provides a range of teaching and service offerings for testing and optimization.

What makes your robot platform unique?

The robot is about 40 x 40 x 15 cm in size and weighs almost 8 kg. The platform offers simple rubber tires as well as mecanum wheels. These allow the robot to turn on the spot, drive sideways or diagonally. This enables exact positioning and navigation in very tight spaces. The rubber tires are mainly used for testing in outdoor areas or in rescue robotics, but only in pretend scenarios. The use of high-quality FAULHABER motors is ideal for both applications.

Furthermore, the platform has open interfaces, an integrated sensor concept with integrated distance and inertial measuring devices, and an integrated battery management system (BMS). This basic equipment can be expanded at the customer's request, either by us or the customer himself. This allows the customer to, e.g., select the gear ratio of the drive, whether 72:1 or 89:1, depending on the speed or torque required. This enables the customer to cost-efficiently test his

Industry 4.0 and Intralogistics 4.0 are changing the production environment long term. The need for autonomous guided vehicles (AGVs) and autonomous mobile robots (AMRs) as well as the requirements on them are becoming more and more complex. In order to enable the industry to keep up with the latest trends by means of quick and cost-efficient development, Markus Fenn and Prof. Dr. Stefan May have developed "EduArt," a learning and prototyping platform that relies on FAULHABER motors for drives.



new concepts. But we are also helping with the implementation of application solutions.

How relevant is the use of EduArt in the industry?

AGV and AMR are becoming more and more important for automation, but unfortunately companies are largely uninformed. The robot platform, for example, makes it possible to quickly and easily test a new sensor system. And because the platform can virtually be expanded as needed, it can bring the relevant knowledge into production.

The trends for AGVs and AMRs are towards more autonomy. They are becoming a production component and work with production modules instead of conveyor belts. So AGVs and AMRs work together out of necessity. Are they able to understand each other?

AGVs and AMRs have the VDA5050 standard interface and can thus also communicate with the control center. Customers can easily test new software using a platform like EduArt, and the results can be transferred 1:1 to large AGVs and AMRs. Applications can thus be evaluated without much simulation, because the software essentially remains the same, whether with EduArt or with a large system. A digital twin helps with the planning and expansion, this is available with the platform on request.

EduArt's drive systems also have to meet the future requirements of AGV and AMR concepts. Which drive systems do you use for the platform and why?

For our training and PoC platform we are using DC-micromotors with precious metal commutation from FAULHABER. They are capable of generating high torques despite their small size and are particularly power efficient. They are also easy to control and are suitable for high-precision control loops.

For larger platforms, we use large DC-motors from the same manufacturer to enable a quick proof of concept, e.g., easy controllability with own electronics. Where necessary and depending on the application, we have replaced these with BLDC motors, because they are maintenance-free and durable.

For a long time, production has been characterized by decreasing lot sizes and a greater number of variants. What effects does this have on logistics and on the functionality of AGVs and AMRs?

In this context robots are needed for smaller loads, i.e., smaller robots with smaller but more powerful drives, like the high-quality drives from FAULHABER. These autonomous industrial trucks have fewer electronics and smaller batteries, which means lower weight and decreased energy consumption. If the loads get higher again at any time, it is easy to scale up and work as a unit, as the robots are able to work together collision-free thanks to high-precision drives.

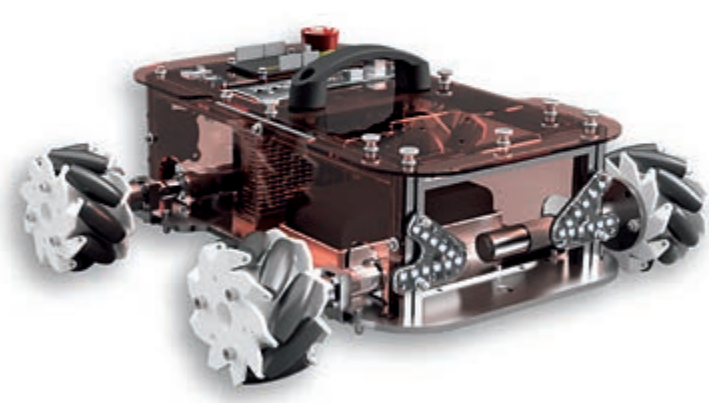
More functionality requires more complexity in AGVs and AMRs: What is feasible and what makes sense in this regard?

When it comes to AGVs and AMRs, only the software is complex. What is important is the planning, so that AGVs can work together seamlessly. To ensure that it not only recognizes pallets, but also sees whether these are full or empty or perhaps tilted, the AGV must be as intelligent as possible. This is where AI (Artificial Intelligence) comes into play. The complexity will increase due to the use of AI. Our small robot is suitable for testing this efficiently.

Another trend is towards larger automated fleets. For that you need fleet management.

For this the robots have to interact with each other, "think" themselves, exchange information via standard interfaces and, if necessary, cooperate. Whether these are small or large AGVs/AMRs only has a small impact on the software. Short of a few different lines in the program, they are essentially the same. The software only needs little information about the AMR. It only has to calculate where the robot is located on the hall plan. The navigation, which is one of the few components that knows the dimensions of the robot, then searches for the appropriate path. But testing remains an important factor, because mobile robotics is still in its infancy and has few standards.

In order to reach the required speed, the motor controller calculates the number of wheel revolutions required. Adjusting this requires three lines in the program code or a configuration file. FAULHABER supplies motors with high-precision gearheads and encoders for precise positioning for this, which together provide optimum performance and safety.



Intralogistics 4.0/Industry 4.0 require networked AGVs and AMRs: Does the networking take place via the cloud or is it better via the edge? And what about security and protection from hackers?

Depending on the manufacturer, the systems can be made "unhackable" to a certain extent by separating the hardware from the Internet. Robots have safety scanners with distance sensors so they don't hit the wall. This means that even if hacked, no dangerous movements can be triggered on the robot. And the process data is as secure in the network as the company network itself.

One of the goals of the Industry 4.0 are self-organizing, heterogeneous, multimodal systems. These require the exchange of data between AGVs and AMRs, and AI also requires data. What are the requirements for FAULHABER components, as they also have to collect and forward data?

This takes place via 5G or via the company's internal WLAN. The systems do not need the data in real time because the data from the planning phase is already available. For example, the routes and speeds are available in the system in the route planning and do not change continuously. If the robot moves from one point to the next, a sign of life every few seconds is all it takes. This means less data traffic and the networks are not overloaded. The available data are compiled and evaluated on the AMR. Encoders record what is happening and ensure safe control with the controllers.

How safe are AGVs and AMRs?

Very safe. If one of four motors fails, the motor controller recognizes it and stops the drive. If a person enters the driving area, this is recognized by the laser scanner and the system brakes. These two safety levels are sufficient.

Where is research still needed for the development of future AGVs and AMRs, and how does that impact the requirements on your test platform? At the same time, the demands on drives are also increasing. What about the drive of the future?

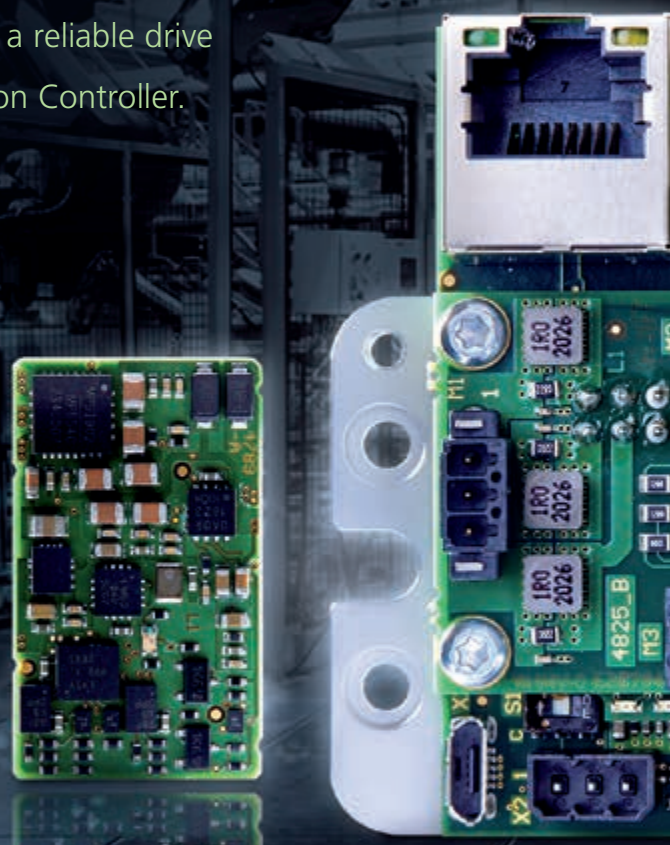
Robots still have to be better networked with each other. For example, if four small robots instead of one large robot are working on a transport task together, you need small motors that work very precisely. Otherwise, the robot swarm will stumble or lose its synchronization. In order to improve reliability, encoders must be absolutely immune to interference so that the robot is not influenced by external interferences. For this reason, FAULHABER sometimes uses two encoders on each motor.
When you combine the different motor variants from FAULHABER with gearheads, encoders, controllers etc., you theoretically get 25 million combinations. A considerable percentage of which has already be realized by FAULHABER. This enables every company to find the optimal drives for current and future uses.

FAULHABER SR
DC-MICROMOTORS

www.faulhaber.com/en/motion/
www.eduart-robotik.com

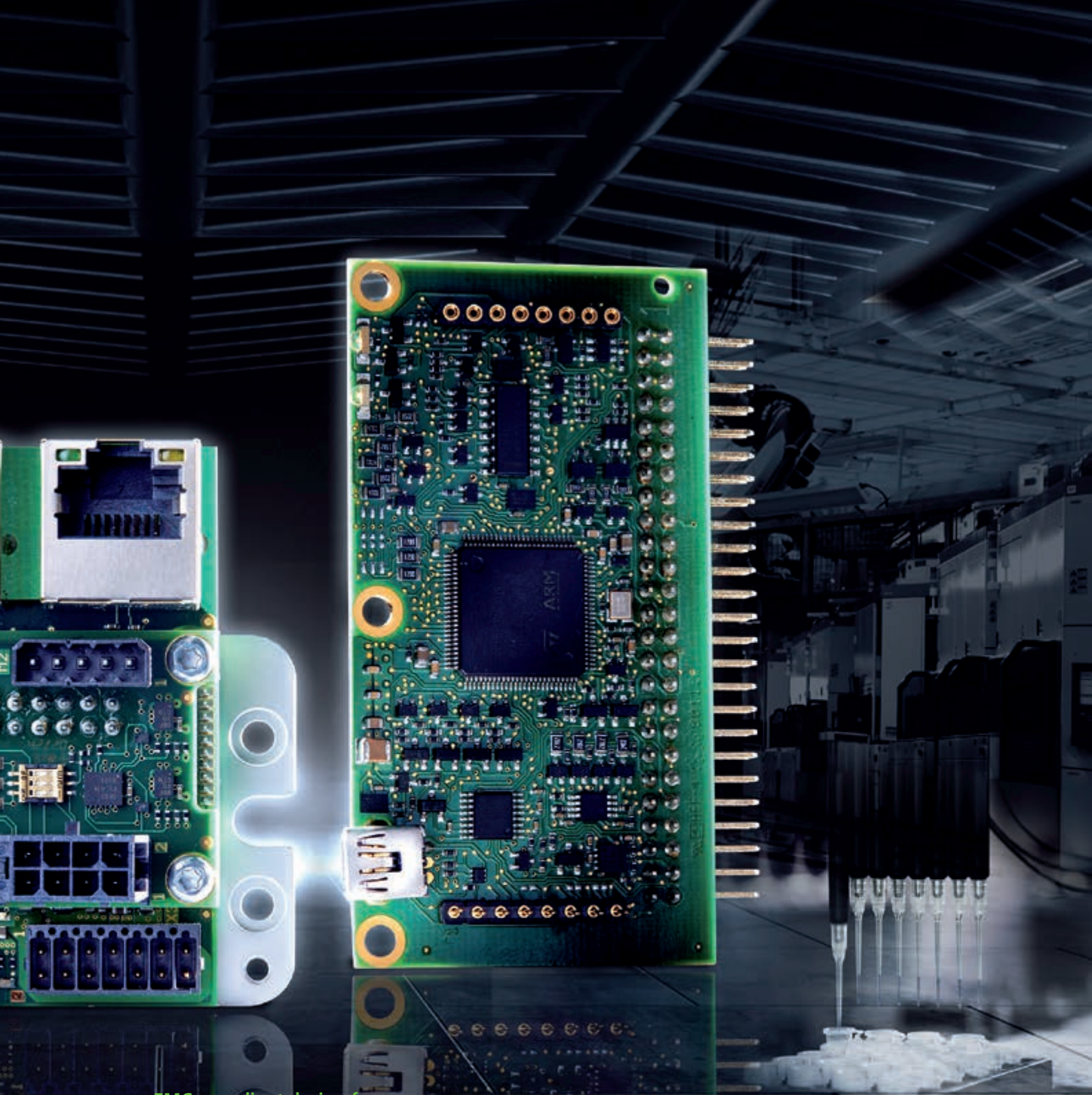
Extend your range of movement

Miniature motors and micromotors only become a reliable drive system when combined with the matching Motion Controller.



They are then able to perform tasks such as precise positioning and speed control. To make developers' work easier, and to benefit as many applications as possible, Motion Controllers should generally require minimal installation space and be available in optimized variants – as is the case with the Motion Controllers from FAULHABER. The existing Motion Controllers, which are designed in different power classes with or without housing for a wide variety of applications, are now joined by a new addition without housing: The MC 3603, which, owing to its compact size, is ideal for integration in equipment manufacturing and medical technology applications.

With 36 V and 3 A (peak current 9 A), the new Motion Controller covers the medium power range up to approx. 100 W. It is suitable for "normal" DC-motors with encoder, brushless drives and linear motors. The I/O options and encoder interfaces are the same as the rest of the product family. USB, RS232, CANopen and EtherCAT are available for communication. The Motion Controller already contains the new firmware version "M". To ensure quick and easy system setup, it should be used in combination with the latest FAULHABER Motion Manager update (version 6.9).



EMC-compliant design for all Motion Controllers

With the introduction of the new MC 3603, the Motion Controllers now cover the entire application range typical for miniature motors and micromotors, starting with the postage stamp sized MC 3001 with 30 W and 1 A (peak current 2 A) through to the MC 5010, the largest member of the family with 10 A (peak current 30 A), which is designed for installation in switching cabinets and has been tried and tested primarily in the industrial sector. All motion controllers comply with current EMC regulations. Not only has the hardware been appropriately optimized, but the documentation has also been redesigned to provide users with the best possible support during the certification of their own devices.

www.faulhaber.com/en/motion/

VICTORY IS IN THE AIR

Champagne shower or pit stop blues? For drivers, three factors are decisive for the speed of their race cars: engine, tires and aerodynamics. In the wind tunnel, teams test models of their bolides to find the perfect balance between minimum air resistance and optimum contact pressure. The Swiss motorsport experts from Sauber use FAULHABER motors to move the adjustable components in the test chamber.