

# DRIVEN

by  
maxon

10  
YEARS  
OF  
DRIVEN

## Helping hands

Humans and machines on a mountain  
rescue mission p.10

Freeride through the maxon  
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## Legal & contact information

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# The heroes of this issue



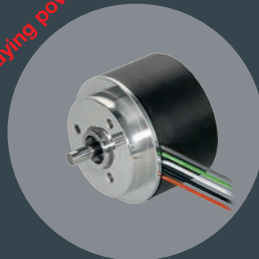
Powerful and silent



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**Roger Villiger,**

Head of Business Unit  
Aerospace at maxon  
and passionate  
mountain biker

## Seeing red

Recently while on my way to a meeting, I was stopped abruptly in my tracks as a red flash zoomed past me. It was none other than mountain bike world champion Alessandra Keller, who was riding a bike through the offices of the Aerospace department here in Sachseln. She disappeared around the corner. More and more heads looked up. "There, I see her. Wow!" said my colleague. The mountain biking fan community is clearly bigger than I thought. I had to act quickly, so I grabbed my bicycle helmet and got her to autograph it. So cool, I love it! For our BIKEDRIVE AIR campaign, she filmed a crazy tour of our campus on the world's lightest e-bike, which is generating a lot of excitement and has our drive on board. She circled desks, hopped over computer cables, and navigated stairs effortlessly. We simply had to have this bike here. To test it extensively, of course, because as someone who works in aerospace, testing is everything.

I've rarely felt so tired, but never prouder than I am of this great maxon product. It combines all of the talent that maxon has to offer. Alessandra and the Thömus maxon Swiss Mountain Bike Racing Team are

introducing our brand to huge numbers of people at race-tracks all over the world. This edition of *driven* gives you a look inside this and much more.





Moment



**COMPACT**  
**MiniMACS6-AMP4**  
**multi-axis**  
**controller**  
More on pages 22-25.





# I am E-TERRY!

I am an autonomous agricultural robot and I want to revolutionize organic farming. How will I do it? With my clever carrier system that adapts its height and track width to suit different growth stages and crops. Look left, look right. I can integrate devices and sensors for the variety of processes that need to be carried out in the field. Thanks to comprehensive software, I take care of weeding automatically and keep a close eye on every single plant in the field. I am powered by several maxon products: the IDX compact drive, the wheel drive system, and the MiniMACS6-AMP4 zub controller. My prototype was developed by the employees of the company from which I get my name: E-TERRY. Founded in 2022, the startup has already grown into a fully-fledged enterprise. We've got big plans for the future.



## **E-TERRY** at work

The autonomous,  
highly flexible  
robot in the  
field.







**“Our order books have never been this full.”**

Karl-Walter Braun,  
majority shareholder and chairman of the board of directors of the maxon Group



Keynote 2022

## Drive technology that impresses

What matters to us at maxon? Constantly improving our products, systems, and services. Our primary objective is to align them with the market requirements of industry – today and in the future. We are driven by the desire to find the perfect result for every market need, no matter how complicated it may seem. Our customers and sales engineers all over the world work closely together to make this happen. In this year’s Keynote we present impressive examples of maxon drive technology for industrial applications such as Scara robots, drones, or our app that gets the best out of the BIKEDRIVE AIR.



[keynote.maxongroup.com](https://keynote.maxongroup.com)

Financials

## Record sales at maxon despite the coronavirus

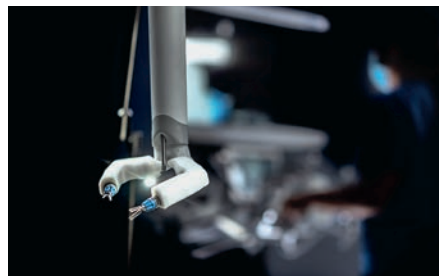
The maxon Group further increased its revenue in 2021. Revenue grew by 13.2 percent to a new record level of CHF 626.5 million (from CHF 553.5 million in the previous year). The increase in revenue results from the strong growth in the industrial automation and mobility solutions markets, as well as from the high demand for medical technology in the fight against the coronavirus pandemic. maxon invested around CHF 45.9 million to expand its capacities. With CHF 77.4 million, cash flow also reached an all-time high. Demand in Europe and Asia rose sharply, while the US and Swiss markets had comparatively moderate development. The maxon Group created new jobs in its anniversary year: The number of employees grew by 4.8 percent, from 3,059 to 3,206 globally.

Aerospace

## Surgery in space

In the future, surgeons will be able to perform operations in space from Earth thanks to MIRA. The world’s first miniaturized in vivo robotic assistant weighs just under a kilogram. In 2024, a mission is scheduled to be launched into space with MIRA on board and deployed on the International Space Station (ISS), where the robot will simulate activities performed in surgery. US firm Virtual Incision developed the device

and is testing it in a national clinical study under an IDE (Investigational Device Exemption). The company is delivering MIRA as part of a grant awarded to the University of Nebraska-Lincoln. maxon products are used for the rotation and exact positioning of the surgical device. These products have been specially tested for missions in space.



Photos: iStock/ntmw



New products

## New from Parvalux

British company Parvalux, a manufacturer of high-performance motors and gearheads, has been part of the maxon family since 2018.

Parvalux has developed a new line of brushed motors named BRx.

The new BRx90 motor is an improved version of the previous 90 mm DC motor. Customers from mobility, intralogistics, and industrial automation will benefit from higher torques thanks to new magnets and new lamination. Also new is the GB65 two-stage, compact gearhead. Its design means that it can be combined with a number of Parvalux and maxon motors by means of a coupling.



**“The gearhead was developed to meet the new EN81-40 stair lift standards, for which the safety factors and weight have increased. With its hollow shaft and the symmetrical assembly arrangement, it is suitable for uses in other sectors because it achieves higher torques than before.”**

Paul Bascombe,  
Head of Business Unit Intralogistics,  
Parvalux

Buzzword: Digital Playbook

## Inspired by sport: the journey to become digital leader in drive technology

A Digital Playbook is a bit like the tactics that a sports team outlines on a board before a game in order to win. maxon has developed a playbook with which the company intends to become the digital leader in drive technology for its customers. Like many other industrial companies, maxon is digitizing more and more of its activities. Plans are taking a big step forward this year, with revenue increasingly being generated through new online services. First, online sales and marketing activities will be increased, and through the continued expansion of our e-commerce and CtO (Configure to Order) platform, sales and customers will be able to influence product development at a very early stage. In the future, maxon will offer its customers a new, digital platform, on which employees can make even complicated ideas for new drives a reality. Training, consultation, and technical services will play an increasingly important role going forward.





# 200,000 km

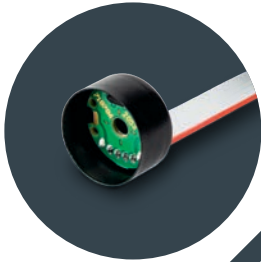
The Solar Butterfly has embarked on a four-year journey across six continents and 90 countries. With the solar-powered mobile home in the shape of a giant butterfly, environmental activist Louis Palmer aims to bring public attention to over 1,000 climate projects. Larso (from so-lar = lar-so) will cover a total of 200,000 kilometers. The tour will end on December 12, 2025 in Paris, just in time for the tenth anniversary of the climate agreement. maxon has provided support for the solar mobile's design and construction. Built by Swiss universities and engineers, Larso's wings are solar panels that provide energy to power the mobile home and charge the electric car that tows it. When unfolded, they have a wingspan of 14 meters and cover an area of 80 square meters. They can collect enough energy to drive up to 300 kilometers a day. Anyone can apply to be a crew member for one of the stages of the tour. To watch the Larso TV interview with maxon Group CEO Eugen Elmiger and for more information, visit:

[solarbutterfly.org/journey](https://solarbutterfly.org/journey)





# New products



**ENX GAMA**  
resistant to  
ionizing radiation

ENX 10/13 GAMA

## The magnetic 2-channel encoder

The ENX GAMA is a magnetic 2-channel encoder and is available in 10mm and 13mm sizes. It replaces the existing MEnc encoders and has been developed for radiation-affected environments. It is resistant to ionizing radiation and can withstand a dosage of up to 500krad (SiO<sub>2</sub>). This property means that the GAMA encoders can be used, in radiotherapy devices (such as multileaf collimators, MLC). The axially arranged connecting cable is designed as a single-cable system and simultaneously integrates the motor cables of the installed DC motor. This single-cable solution permits compact and space-saving installation.



**IDX**  
with compact  
design

IDX70

## The compact powerhouse

Our experience with the IDX 56 has shown that there is strong market demand for even more powerful drives and motors – in particular in intralogistics and industrial applications. The new IDX 70 meets these needs while having a compact size. With a nominal torque of up to 3.75Nm and nominal power of 954 W, it sets new benchmarks at maxon and beyond – the compact size of this drive is unique on the market. The IDX70 is available in two different basic configurations, with and without integrated positioning controller.



The maxon online shop has more than 6,000 products, selection aids, combination tools, and comprehensive product information:

[shop.maxongroup.com](http://shop.maxongroup.com)



An aerial photograph showing a rescue operation in a mountainous region. A rope line is stretched across a rocky, vegetated slope. Several people are visible at the top of the slope, and one person is positioned near the bottom of the rope line. A river flows through the bottom of the frame, surrounded by dense green forest.

# Helping hands

Text: Michael Thiem



It's important to have people who are there to help others in an emergency, but state-of-the-art technology can play a vital role too. For success in rescue operations, humans and machines must form a powerful duo. We join a search for missing persons with the Swiss Alpine Rescue team from the Engelberg rescue station.

**H**elmets, carabiners, headlamps, and carefully rolled-up climbing ropes are stored on the wooden shelves. Two-way radios are plugged into their chargers. In summer, the avalanche airbags are tucked away in the corner of the almost 40 square meter equipment room of the Swiss Alpine Rescue (ARS). However, once the first snow appears, the probes, shovels, flags, and blankets are brought back into service. Here, in the basement of the community center, the Engelberg section of the Swiss Alpine Club stores its equipment. Dino Ineichen is holding the most important tool of all in his hand: his smartphone. It emits a shrill beep. The 27-year-old looks at the Alpine Rescue Mission Control app and reacts immediately to the alarm. He confirms the operation and assumes the role of team leader. He can immediately see the available support team members, who have been informed automatically. Ineichen quickly knows who will soon be arriving for the operation. "In the past, countless phone calls were necessary, but now everything is very quickly and perfectly organized," he says. The app gives everyone the information they need about the upcoming operation: 27 years old, female, brown hair, dressed in black. A woman is missing, her last WhatsApp status update was at the Alpenrösli mountain restaurant. Is it a routine case? "There's no such thing as routine. The uncertainty factor is always there," says Ineichen, as he gets the coordinated high-tech operation underway.



We're with the mountain rescue team in Engelberg, Switzerland. It's getting pretty cramped in the equipment room now. Ten women and men jostle in front of a large topographical map. The Engelberg section covers a large area.

Ineichen marks the primary search area with a red marker. Local knowledge and experience are important when deciding on a strategy. It quickly becomes clear that search dogs and aerial support from a drone should help. The two dog handlers Michael Stutz and René Geisser divide up the areas to the left and right of the hiking trail into the valley. Rolf Gisler prepares for drone deployment. In addition to their love of nature and the mountains, they are united by their attitude toward their



**The Engelberg rescue team in action**

See the drone recordings here:  
[hvr.ch/reportage.html](http://hvr.ch/reportage.html)







1

**1** The Engelberg section covers a large area. Dino Ineichen marks the search area.

**2** All buckled up: The rescue team members rappel around 100 meters with the rescue stretcher.

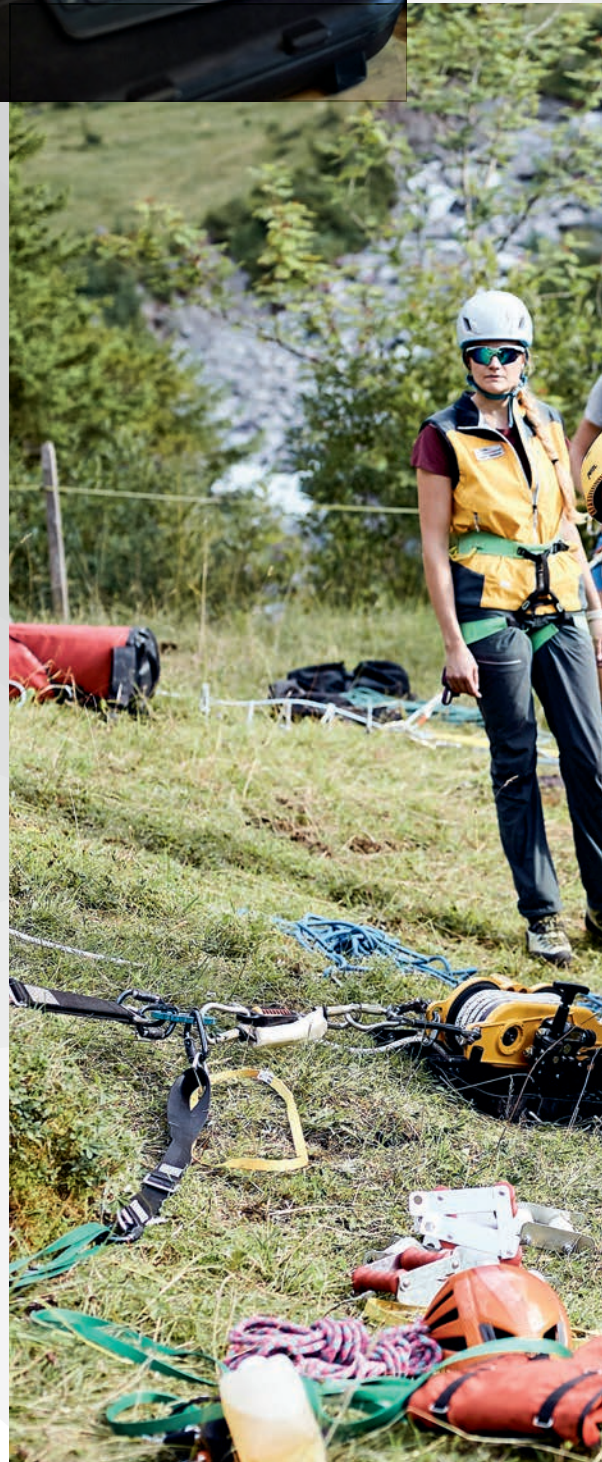
**3** The drone expert uses various maps on the tablet to check the conditions, where ropes are tensioned, and where there are no-fly zones.

**4** The strategy is clear: Search dogs and aerial support from a drone. The search areas of the hiking trail into the valley are split up.



3

Photos: Herbert Zimmermann



2





4



▶ volunteer work. “We like to help people. Even if every operation doesn’t end well,” says Ineichen, and everyone agrees with him. “I always wondered who rescues people who have had an accident from the mountains when the weather is bad,” recalls Thomas Hurschler. The trained carpenter has been one of these volunteer helpers for the past 13 years.

#### The drone geek

The operation is going according to plan. Rolf Gisler is driving along Wasserfallstrasse toward Niedersurenen in his red minivan. He aims for the highest point, parks his vehicle, and unpacks a flat-screen TV and several suitcases. Every move has been carefully orchestrated. The expert in charge of drones at Swiss Alpine Rescue has his own multimedia services company. He describes himself as a technology and drone geek. A look in his suitcase confirms this description. Inside there are three DJI Enterprise Series drones, professional equipment of different generations, each weighing around one kilogram and adaptable to all requirements. He has a 4K camera with 30x zoom, along with various apertures and filters to increase the contrast depending on the brightness. He also has a rechargeable battery with integrated heating, which is important for use at low temperatures, and a thermal imaging camera that helps when rescuing fawns. In 2022, drones helped save more than 3,000 fawns from accidental death by heavy-duty mowers. “I decide what I need for the operation,” says Gisler. Today, he doesn’t need the crash dummy for contact with rock faces in narrow gorges or in trees, nor does he need attachments for lights, speakers, or flashing lights.

Meanwhile, Hans von Rotz joins the team. The 61-year-old has been head of the Engelberg section since 2010 – following in his father’s footsteps. Helping others is in his DNA. He heads a team of 37 men and women, who are called out between 10 and 20 times a year. Around two-thirds of all emergency calls concern missing persons. In the majority of cases, every second counts. “We mostly use technical aids – from helicopters to cell phone locators to drones or avalanche beacons,” says von Rotz, adding: “We still need our eyes and ears.” The increase in the number of operations in recent years is mainly due to changes in recreational habits since the beginning of the coronavirus pandemic. More and more people are being drawn to the mountains. However, many do not have the required physical fitness, equipment, and mountain experience to match their chosen routes. It is not without reason that the Alpine Rescue team exceeded the thousand mark for the first time last year with 1,071 operations. “People watch a YouTube video and then jump headlong into the freeride paradise on Mount Titlis,” explains Rotz, “but we’re not here to judge, we’re here to rescue.”







➤ The rescue chief looks over Gisler's shoulder. Before he starts the drone, he stops to think. "I look at various maps on the tablet to see what I need to watch out for, where ropes are tensioned, where there are no-fly zones," he says. Dino Ineichen reports over the radio: "The dogs are on the way." Gisler presses the push-to-talk button and gives the green light: "I'm ready too." He places the drone on a box and starts the propellers using the remote control he's wearing around his neck. In seconds the whirring aircraft is in the air. He follows the images on the large screen with great concentration.

With him is Marco Sicher from the Business Unit Aerospace at maxon. He oversees development projects together with customers and is fascinated by these practical insights. "Being able to see a real-life application up close shows the untapped potential that lies in the commercial use of drones," says Sicher. Ineichen suddenly announces

over the radio: "We've found her! It was the dogs."

Gisler steers the drone in the direction of the Aa Gorge, descending a bit deeper as it heads toward the mountain stream, and is successful. "OK, I see her too," says Gisler, pointing to the monitor and focusing the camera on the site beneath the rock.



Marco Sicher is fascinated: The maxon specialist for aerospace customer projects accompanies the rescue operation.

## Welcome to Drone Valley

Switzerland is the world's leading location for the development of key technologies and commercial applications for drones. The Swiss Federal Institutes of Technology in Lausanne (EPFL) and Zurich (ETH Zurich) and the University of Zurich are among the best technological universities in the world and are leaders in flying robotics and unmanned systems. This has led to the area between the two universities being nicknamed "Drone Valley". In recent years, more than 80 startups have been established here, creating 2,500 jobs.



“She’s waving, she seems to be fine. But it looks like she’s injured her leg.” The dogs were faster, but while they’re already eating a piece of Cervelat (Switzerland’s national sausage) as a reward, Gisler’s work with the drone continues. With visual support from the air, he can give the rescue team important tips for the impending winch rescue from a depth of around 100 meters and identify obstacles and problem areas. “I see things that nobody else can see right now,” he says.

### Technology performance is crucial

Humans and machines complement each other perfectly. Digitalization is progressing at breakneck speed. In rescue operations, autonomous robots for particularly dangerous situations (see info box, p. 17) as well as sensors, satellites, mobile communication systems, and digital networking have become indispensable. “Quality and precision make the difference,” says Marco Sicher. “The earlier we sit down with potential customers during development, the more expertise we can bring to the table. It’s becoming increasingly important that in such a complex system the components can communicate with each other and provide feedback to the operator.”

“What happens when it rains?” asks Sicher. “We had a situation where water got into the electronics. The drone fell to the ground like a stone from the sky. You need a specially designed drone for use in the rain,” explains Gisler. Sicher nods. From his work at maxon, he understands the importance of extensive testing of protection against water, the ingress of solid particles, and other environmental influences to ensure safety. Battery performance can also save lives in an emergency. Gisler’s drone can remain in the air for half an hour. Longer would be even better. Lighter too.

Meanwhile, the rescue team is ready for the final step. The winch is prepared for the recovery operation with a secure three-point anchor in the rock. Peter Zumbühl grabs the first-aid backpack. The ventilator, oxygen, defibrillator, and other supplies required for emergency medical care weigh 15 kilograms. Zumbühl and Adi Bauer abseil around 100 meters with the rescue stretcher. At the scene of the accident, Zumbühl splints the injured woman’s right leg before she is safely lifted into the stretcher and strapped in. Supported by manual effort on the pulley block, the rescue is successfully completed in just under 30 minutes. It’s easy to see how much a light, powerful electric motor could have helped as a winch drive. “You took your time today,” jokes Daniela Abächerli. She then gets up and high-fives her rescuers. Everyone laughs. Today’s rescue is actually just an exercise. Abächerli enjoyed playing the part of the missing woman. Now she can go home. As can the mountain rescue team – at least until the next smartphone alert from Alpine Rescue Mission Control.

### Q&A

## Ready, set, search!



**One of the most important mountain rescue workers is of the four-legged variety. Despite all the sophisticated technical support available in the search and location of missing persons, almost no operation takes place without a dog handler. Michael Stutz has worked with the team at the SAC Engelberg rescue station as a dog specialist for several years. With him, of course, is his five-year-old Labrador, Fox.**

**Michael, at what point do you know whether a dog is suitable for this type of work?**

Labradors are very friendly. They love people. This becomes apparent during the first six months of training, when you’ll see that the dog is interested in the work and finds it fun.

**How does the dog actually search for someone?**

Unlike police dogs, our search dogs don’t need a trail. Fox just needs the human scent (skin particles) of the missing person. He can therefore search a large area in a short time.

**How does Fox indicate that he’s found someone?**

Fox wears a small piece of rope on his collar, known as a bringsel. As soon as I say the word “Search!” he darts away, sometimes up to 500 meters. When he comes back with the bringsel in his mouth, I know he’s found something. He then leads me to the location. We don’t need it in winter if there’s an avalanche, because he’ll paw at the snow instead.



# The flying Swiss Army knife

Innovative aircraft from Swiss startup Dufour Aerospace with electric drives combines the best of both worlds. The cross between drone and helicopter could mean significantly faster and more efficient air emergency operations.

**A**t 4,634 meters, Dufourspitze is the highest mountain peak in Switzerland. It is named after engineer, topographer, and army officer Guillaume Henri Dufour, who in 1864 chaired the first Geneva Convention, which led to the establishment of the International Red Cross. Two good reasons why the name is a perfect fit for Dufour Aerospace. The startup founded in 2017 has high-flying ambitions, and develops and builds innovative aircrafts in pursuit of its goal. “We want to bring together the worlds of drones and manned aviation,” says Jasmine Kent, co-founder and CTO of Dufour Aerospace, which is headquartered in Valais. In addition to opening up new possibilities for logistics, the company also aims to revolutionize emergency operations.

Anyone who looks at the Aero2 inevitably tilts their head to the side and frowns. This is then followed by deep contemplation. The combination shown in the photo has never been seen before. It's like a picture puzzle featuring a mash-up of a helicopter and an airplane. The Aero2 is a multi-purpose aircraft with hybrid propulsion module that, thanks to tilting wings, can take off and land vertically without a runway like a helicopter, but flies like an airplane in the air at speeds of up to 170 km/h. The small



Jasmine Kent, co-founder and CTO of Dufour Aerospace, with the Aero2.

unmanned multi-purpose aircraft is robust and has a payload of up to 40 kilograms, a maximum take-off weight of 150 kilograms, and a maximum flight time of three hours. VTOL aircraft (Vertical Take-Off and Landing) are extremely maneuverable and offer significantly lower operating costs than a commercial helicopter. Electric drives offer energy efficiency of 90 percent compared to 40 percent for combustion engines. Electric motors have fewer parts and need little maintenance. Nevertheless, they offer a high level of reliability and safety. Electric drive trains open up new possibilities for developers of aircrafts. Due to their smaller size, electric motors can be positioned directly where propulsion is needed without having to install complicated power transmission. The heavy and maintenance-prone hydraulics in the secondary systems are also

completely eliminated. “The potential of electric drives in aviation is enormous,” says Kent. Co-founder and CEO Thomas Pfammatier underscores this: “Aero2 is as versatile as a Swiss Army knife. This innovative small unmanned aircraft will greatly support our customers in their activities.” The Aero2 should be ready for the market and for mass production within the next two years. However, there are still some development details to be ironed out.

Photo: Jan Bolomey



### Every gram counts

In the case of electric motors in particular, “finding the best parts, in other words the most powerful components, is a constant challenge,” says Kent. “We count every kilogram, even every gram. Every increase in performance helps us and is very welcome.” The certification process for the Aero2 is currently underway. That’s the main focus, according to Kent. Compared to the Aero3, which is intended to transport up to eight people and larger payloads, the road to series production for the unmanned aerial vehicle is somewhat easier. On the one hand, the development costs are lower and, on the other, there are far fewer regulatory and bureaucratic hurdles to overcome. The makers are in no doubt as to the Aero2’s enormous potential. “It is the perfect tool for applications in logistics, topographical surveying, mappings, measurements, and public safety,” says CEO Thomas Pfammatter. The company’s first customers feel the same way. Under a partnership agreement, Dufour has already sold 100 Aero2 and 100 Aero3 aircrafts to Blueberry Aviation. The global commercial aircraft and helicopter specialist will provide marketing advisory services to Dufour Aerospace. “We’re extremely proud of this partnership,” Kent emphasizes.

There’s another reason to prioritize unmanned aerial vehicles. With the unmanned Aero2, the development of flight control systems is becoming faster and less expensive. With these successes, the startup can continue to attract equity capital for the Aero3 and bring in investors from all over the world. “Because the US venture capital market in the field of aerospace technologies is already somewhat saturated, these investors are also increasingly looking at startups in Europe,” says the expert for onboard digital control systems, software, and automation. The American was a software developer at Google for many years before founding Dufour in 2017 together with Swiss colleagues Thomas Pfammatter and Dominique Steffen.

Both innovative aircrafts could revolutionize future rescue operations and open up a host of new possibilities. The major advantage that the Aero2 has compared to drones is that the operator doesn’t have to first travel to the site with the device and equipment. The Aero2 can be equipped with everything necessary and controlled from a central location. Medical devices or blood supplies can get to where they are urgently needed in record time. Emergency doctors can use the Aero3 instead of traveling by road in an ambulance. Apart from avoiding possible traffic jams, this would also save time, money, and, most importantly of all, save lives. ■

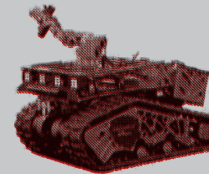
**More information:** [dufour.aero](http://dufour.aero)

# Robots to the rescue



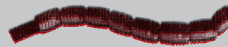
### PACKBOT 2011

After the reactor disaster in Fukushima, robots were deployed at the scene of the accident. PackBots were the first to enter the reactor building, equipped with cameras, Geiger counters, and other radiation measuring devices.



### FIREFIGHTING ROBOT 2019

When the fire in the Notre Dame Cathedral in Paris threatened to collapse the nave of the church, the fire brigade sent the Colossus robot into the burning interior.



### SNAKE ROBOT 2012

Students at ETH Zurich developed a multi-segment robot with maxon components that moves like a snake. It can be used to locate people buried by an earthquake.



### DRONES 2021/22

In Austria, tests for delivering blood supplies by rescue drone were successful. According to the Red Cross, the aim is to use rescue drones to provide fully automated, targeted deliveries in the future. Swiss Air-Rescue (Rega) uses an unmanned, automatically flying drone to search for missing, injured, or ill persons.



### SWIMMING ROBOT 2017

Six years after the nuclear accident in Fukushima, a swimming robot explored the areas that had been flooded. No bigger than a loaf of bread, the device was equipped with lights for its tough mission, maneuvered with tail propellers, and was able to collect data with two cameras and a dosimeter to measure radiation and help with repairs.



Text: Marie Veronesi

# A big step forward



More information:  
[revivalbionics.fr](http://revivalbionics.fr)

To fully compensate for physical disability: This is the mission of French startup Revival Bionics, which is developing cutting-edge technology to help people walk properly again. For its first product, a foot prosthesis with a drive, the company used the EC 60 flat brushless motor from maxon.



Guillaume Baniel, who has been passionate about technology since he was a child, has big plans. In addition to the many professional projects that are close to his heart, the entrepreneur is currently learning to play the piano.

**D**espite modern technology, a person with an amputated or paralyzed lower limb still cannot regain 100% of their abilities. The CEO of Revival Bionics knows this fact only too well. To compensate for the paralysis of his left leg, Guillaume Baniel used his experience as an engineer to develop a powered orthosis. “In rehabilitation I met many young people who face the prospect of spending their whole life wearing prostheses that don’t fully compensate for their disability. Imagine nearsighted people having to wear glasses that don’t correct their vision properly,” explains the 32-year-old. “It became clear to me that there was a lack of satisfactory products.”

The only bionic prostheses available on the market were developed by Hugh Herr, a famous double amputee rock climber who now heads the Biomechanics team at the MIT Media Lab. Although very advanced, they have their limits. With every step they make a high-pitched noise, and they are also rather rigid, which is a source of discomfort. Guillaume Baniel set out to design a comfortable, low-noise, powered foot prosthesis for people with below-knee amputations that is compact and offers greater autonomy. After an initial development phase, the Frenchman founded Revival Bionics in 2021. Nathan Girard, who is passionate about robotics, joined the startup as CTO soon afterward.

## The key role of the motor

Unlike passive prostheses made from simple carbon springs, the prostheses from Revival Bionics has a drive consisting of a motor and an artificial Achilles tendon. The

motor provides propulsion to the walker, making walking easier and relieving strain on the other leg. There is more comfort over the whole of the step and the occurrence of osteoarthritis is reduced. “We offer a foot that patients put on through a socket and that walks correctly without you having to influence it. You can simply roll your foot through the step,” explains Baniel. Reproducing walking fluidly was challenging. On the one hand, the mechanical structure had to be compact and silent. On the other, algorithms were needed to simulate walking and control the mechanism. Because the prostheses are subjected to a great deal of stress, high-performance materials such as titanium, aluminum, and carbon fiber were required. In addition, the size of the battery had to remain manageable because voltage levels like those found in exoskeletons could not be used.

Performance, autonomy, compactness, torque, noise – the choice of motor was crucial. This is where maxon came in. “The quality of the products, their rapid availability in the online shop and the expertise, especially in the early phase, were crucial,” emphasizes the engineer, adding: “The high torque of the EC 60 flat delivers a real benefit for patients. The motor is also much quieter. We found a standard model with which we could quickly build a first usable product.”

### Powerful yet affordable?

Now it's a matter of raising funds to further develop the product and get the CE mark. Then comes the next challenge: the market launch. “Pricing is complex. It must ensure the profitability of the company and at the same time allow broad marketing,” explains the CEO of Revival Bionics. “That's why our prosthesis will initially be available to patients whose insurance will cover the costs. After



### POWERFUL AND SILENT EC 60 flat motor

Performance, autonomy, compactness, torque, and noise: The choice of motor for the prosthesis was crucial. The EC 60 flat has a high torque and is silent – ensuring natural walking.



that, the product will be included in clinical trials and become more affordable.” This is particularly important for diabetics, who represent around 60 percent of amputees. Women, who usually have smaller feet, should also benefit more from the new bionic prostheses in the future, since products from current manufacturers only start at EU shoe size 40. Revival Bionics also wants to develop special prostheses for children who were born without limbs or where cancer has led to an amputation. In this case, the prosthesis and software must be adapted to the growth of the young patient – one of the next stages in the biomechanics revolution. ■

## Supporting innovative ideas

Revival Bionics won the Banque Publique d'Investissement (BPI) i-Lab Grand Prix for its invention. The competition is organized by the Ministry of Higher Education, Research, and Innovation and honors the ten best startups in innovative technologies every year. In Cybathlon, various teams from all over the world compete against each other using state-of-the-art technical assistance systems. maxon is supporting the third event as a Gold Partner.

**More information: [cybathlon.ethz.ch](http://cybathlon.ethz.ch)**



# Beyond time

Taiwanese artist Chen Hsiangfu has created a poetic interpretation of the relativity of time.

Her work “Beyond Time” is on display in the Starlux Airlines flagship store in Taipei, framed by an extraterrestrial atmosphere. maxon motors have helped set this work of art in motion.



## STAYING POWER EC 32 flat motor

Eight hours a day, five days a week: The three low-noise EC 32 flat motors used in the installation deliver low speed and torque to provide a perfect turning mechanism.

**Text:** Flora Lin

**T**hree balls on round discs rotate noiselessly around an axis. It's no coincidence that the work "Beyond Time" by Taiwanese artist Chen Hsiangfu reminds you of the orbits of celestial bodies. The flagship store of Taiwanese airline Starlux Airlines in the capital Taipei, for which the artist created the kinetic installation, exudes an extraterrestrial atmosphere throughout its design. Space, time, and technology are important themes for Chen Hsiangfu. "Beyond Time" presents time as a cognitive order that gives people orientation in the face of the inexplicability of their existence. At the same time, the balls rotating at different speeds symbolize the individual perception of time, which sometimes seems to move faster, sometimes slower. Since the artwork was designed for the interior of a commercial premises, it had to meet strict requirements. The motors for the turning mechanism must run at a low speed (2 revolutions per minute), with low torque (2 Nm), and as quietly as possible (below 25 decibels). They need to do this over a long period – eight hours a day, five days a week. They should also require very little maintenance.

#### maxon sets art in motion

The maxon online shop had the solution. The three turntables were each equipped with three brushless EC32 flat motors. "Everything went perfectly," explains Chen Hsiangfu. "The small motors were the right size and were in stock. That's the only reason why we were able to keep to the tight schedule." The artist's team was particularly impressed by the user-friendly search function in the maxon online shop. It gives customers quick and easy access to all necessary product information. However, it's even easier to contact the local experts directly. "maxon was extremely helpful and assisted us in finding the required products at short notice," emphasizes Chen Hsiangfu.

Finally, all the parts were assembled, the motors were activated, and everyone involved in the project waited with baited breath ... it worked! All of the calculations and the selected components had been correct. It was an emotional moment. ■



The safety requirements for the work were strict. Above all, the installed motors had to run as quietly as possible.

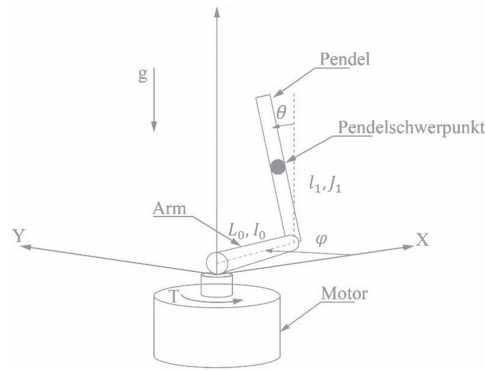


You can admire  
Chen Hsiangfu's  
works of art on:  
[instagram.com/  
chenhsiangfu](https://www.instagram.com/chenhsiangfu)



**Chen Hsiangfu** (33) born in Taipei, Taiwan, deals with the themes of space, technology, and societal issues in her works. Transforming our daily life experiences into kinetic installations, she captures the primitive emotions of human nature.





# MiniMACS6 stabilizes the Furuta pendulum

A classic problem in engineering is the rotational inverted pendulum. It is used to demonstrate and examine movement patterns and control algorithms in control and electrical engineering as well as in mechanical engineering. These help to control robots and other machines.



**Beda Föhn**  
Application Engineer  
Motion Control &  
Robotics maxon | zub

The pendulum, named after its Japanese inventor Katsuhisa Furuta, has a simple structure. A driven arm rotates in the horizontal plane and a pendulum attached to that arm rotates in the vertical plane. Theoretical modeling and the need to stabilize these movements are issues that have long racked the brains of engineers. With the Furuta pendulum, there are two variables: the direction of the rotational joint and that of the pendulum, which can be controlled. The pendulum is controlled in the vertical, unstable position, while the arm assumes any position.

Since it is a nonlinear, unstable system, it is suitable for conducting experiments, for testing existing control algorithms, and for developing new calculation methods. It frequently combines approaches from research areas such as robotics, control theory, and computerized control.

### Finding the right controller

A suitable controller can be developed using different design strategies. Suitable controller structures for an inverted pendulum ➤

continued on page 25



# Together as one

As maxon | zub celebrates its fifth anniversary, the two development departments have combined their expertise for the first time. The result?

The MicroMACS6 controller. The compact master controller is an essential component for system solutions, as Fabian Vogel, Managing Director of maxon | zub, explains.

**Interview:** Annalisa Isler

They complement each other perfectly: maxon's acquisition of zub, which had been put up for sale, in 2017, delivered advantages for the customers of both companies. They benefit from complete solutions, expertise, and a worldwide sales network, along with an extended product range. maxon synchronizes the development of all-inclusive motion control solutions with the specialists at zub. One of the first products of this collaboration is the jointly developed MicroMACS6. maxon can now offer its customers one-stop system solutions, which means fewer interfaces, consolidated expertise, and efficient development times.

**Fabian Vogel,**  
Managing Director  
of maxon | zub



**Fabian Vogel, what strengths have been combined?**

zub has been developing programmable master controllers for many years. We wanted to create a product that would be a good fit for our system developer strategy. We therefore focused on the strengths and expertise of the respective departments. maxon has many years of experience in the development of motors, electronics, and hardware, while zub specializes in the development of motion controllers with power stages, software programming, and application development.



### Why is the maxon Group developing programmable master controllers?

maxon has been developing and producing drive components and mechatronic systems for decades. However, the system business is becoming increasingly important and more complex. Programmable MACS controllers are thus an essential component for these system solutions. The master controller (MACS) can be used in a variety of ways. Practical examples include autonomous repetitive processing of travel profiles, as well as complex synchronized multi-axis movements and complete kinematics modules for Scara or Delta robotics applications.

### What are the key features of the MicroMACS6?

The programmable motion controller without power stages autonomously controls between one and six axes and can be combined with EPOS4 positioning controllers and ESCON servo controllers. Its compact size and attractive price/performance ratio make it an excellent choice for equipment engineering. In contrast to the MicroMACS6, the MiniMACS6-AMP4 has four integrated power stages.

### Who can program the MicroMACS6?

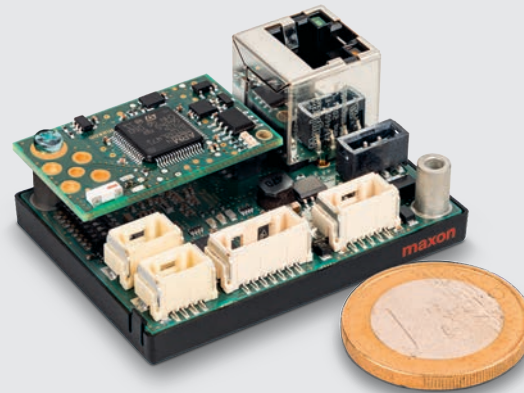
Everyone who has programming experience in C. For a quick and easy start, we offer a software development kit free of charge. This development kit provides useful functions and some programming examples.

### Where does maxon draw the line when it comes to being perceived as a system provider?

In application development, questions that concern the entire architecture inevitably occur. Is there a higher-level controller? If yes, which one and which interfaces are used for communication? What real-time capabilities are required? How many axes have to work together and in what way? What are the dynamic range requirements? What level of precision is required? And just like that, we are already taking a systems approach. It is important to maintain a clear identity: maxon is a systems expert for drives.

### How does maxon provide support?

For questions about drive technology, the maxon service portfolio can be accessed at any time. Experienced system architects and application developers advise or develop customer-specific solutions on request. ■



Small, smaller, MicroMACS6: shown here with a 1-euro coin for comparison purposes.

## zub – a name steeped in history

Founded in Berlin in 1986, the company originally bore the names of its founders – Zurmühlen & Bieler GbR. The company was later renamed Z&B (zub), which is still its name today. Owners Eberhard Zurmühlen and Dieter Bieler developed electronic phototypesetting systems. When Zurmühlen took a job at one of the first robot companies, the two stayed in touch. They often spoke about how difficult it was to control drives. Thirty-six years ago, users looking for a drive positioning solution had a choice between a cost-intensive CNC solution or hardware-based programming of motion control chips. There was no happy medium. Zurmühlen and Bieler came up with the idea of developing a modular multi-axis controller with a programming environment. This led to the creation of the Mocon – the first 1 to 9 axis controller with the APOSS programming language. At the beginning of the 1990s, it was expanded to include the CAN interface and used in theaters from St. Petersburg to Copenhagen to control stage platforms. This is where the paths of zub and maxon crossed. The controller was well received by maxon and the Mocon was added to the range under the name PCU2000.



➤ include PID, LQR, fuzzy, or self-learning neural controllers. The physical system with multiple degrees of freedom can be modeled mathematically. For the swing-up of the pendulum from the rest position (zero position), nonlinear approaches such as energy approaches are required. A suitable controller is then designed with the help of the mathematical description. This controller can be approximated or discretized for real-time-capable systems and transferred to a controller such as the MiniMACS6-AMP4.

**The compact controller**

The maxon MiniMACS6-AMP4 is a programmable master controller with integrated power stages. It is the stabilizing controller for the rotational inverted pendulum. This allows complex movement patterns to be executed with simple commands, for example for jerk-free synchronization with a rotating master axis.

Benefits of the MiniMACS6-AMP4 multi-axis controller:

- Assumes the master function; no higher-level controller required
- License-free motion control functionality included
- Compact drive solution with integrated power stages

The license-free automation software ApossIDE (Integrated Development Environment) can be used to set up positioning and synchronization tasks with simple commands or you can run your own control algorithms using C (ApossC). ■



**COMPACT  
MiniMACS6-AMP4  
multi-axis controller**

The programmable multi-axis controller with integrated power stages is the stabilizing controller for the rotational inverted pendulum and ensures jerk-free synchronization with the rotating axis.



**In action**  
The MiniMACS6-AMP4 stabilizes the rotational inverted pendulum.



**maxon and colleges**

maxon promotes collaboration with universities and colleges. The exchanges with students and research departments are enriching for both sides. The HSLU (Lucerne University of Applied Sciences and Arts, Department of Technology & Architecture) and the maxon Lab have been developing and researching mechatronic systems for many years. The Furuta pendulum was developed as part of a bachelor thesis.

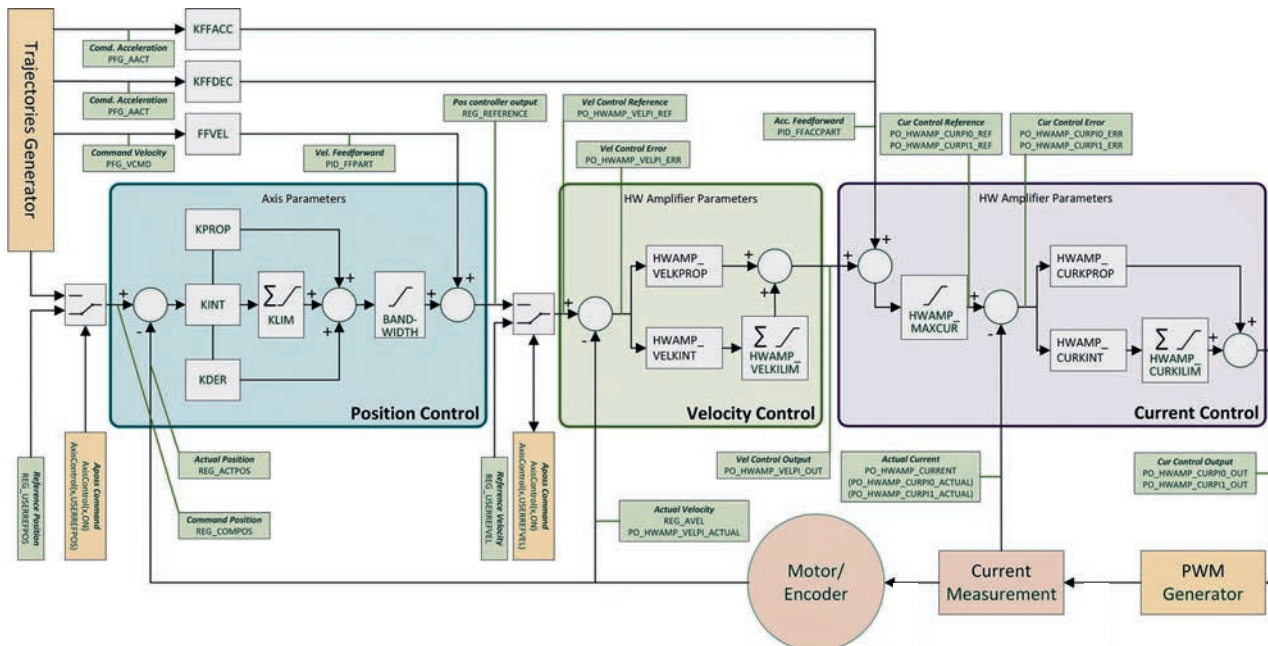
With its Young Engineers Program (YEP), maxon also supports innovative projects with discounted products and technical advice.



Apply now:  
[www.drive.tech](http://www.drive.tech)

**Cascade control**

Example of cascade control with a maxon motion controller such as the MiniMACS6-AMP4. The programmability and integrated path planning mean that a higher-level controller is not strictly required.









# “In Mexico, relationships are the driving force”

Maintaining customer proximity, strengthening our global presence, and expanding our sales network are three reasons why maxon opened a sales company in Mexico in March 2022. In our interview, site manager Marcial Gähwiler reveals how important personal business relationships are in Mexico and which culinary highlights he can no longer live without.

## Why did maxon choose Mexico as a location in Latin America?

Mexico is Latin America's second largest national economy and has long been a global player. maxon's new sales company is located in Monterrey, the capital of the Mexican federal state of Nuevo León. The region, where numerous international and national companies have their headquarters, has one of the strongest economies among industrial areas in Mexico and is home to a sizable manufacturing sector.

## Which maxon products have great potential here?

Our DCX motors are very popular because of the flexibility to adapt them online to fit requirements. In Mexico, industries such as automotive, aerospace,

and medical technology have a strong presence and the trend is to develop more products locally. In recent years, large international companies have heavily invested and have opened R&D centers or are about to do it. This is where I see potential, and with our local presence, we are close to the customers. Our Parvalux products are robust and also suitable for many applications in Mexican industries at a competitive price.

## What's important when doing business in Latin America?

In Latin America, especially in Mexico, relationships take center stage and are a major driving force. Business contacts usually form via already existing networks. It is important to establish trust as well as a relationship. Here, getting to know the potential business partner personally is essential and often join each other for dinner.

## What brought you to Mexico?

In 2006, after my vocational training, I traveled through Mexico and Guatemala. I liked Mexico very much: the country, the food – the open-mindedness, and in particular the warmheartedness of the people. During my studies, when I had to choose a destination for a semester abroad, I quickly knew: I want >

**Marcial Gähwiler** (37) completed his vocational training as an electronics technician at Siemens. After studying industrial engineering with a focus on electrical engineering, he worked for various companies, most recently as site manager in Mexico. He lives in Monterrey with his Mexican wife.





**Top** Marcial Gähwiler visits the customer RELANT in Guadalajara. Together they check the choice of drive system and correct function of the prototype.

**Bottom** Lunch with company owners and married couple Trinidad Villaseñor and Francisco Ibañez. Cultivating relationships is hugely important in Mexico.

to learn Spanish, and I want to do it in Mexico. So I decided to go to a university in Mexico.

**Mexico is known for its food. Is there a culinary highlight you cannot live without any more, and which food from your home country are you missing?**

Chilaquiles Verdes for breakfast. These are soft corn tortilla chips, mixed with green salsa, and with a fried egg on top, garnished with onions, coriander, cream, and cheese. It is frequently served with beans and avocado. From Switzerland, I miss homemade capuns (spätzle dough and meat wrapped in a chard leaf) with tomato sauce and rösti (fried grated potatoes) topped with cheese.

**Going to another country for a vacation is one thing – living and working there is something else. Is there anything that you first needed to get accustomed to?**

Yes, there are many differences between Mexico and Europe that I had to get used to. For example, hot food – even for breakfast [he laughs]. In the beginning, I could not eat anything spicy so early in the morning. Now I love it and I need it to wake up. ■■■

**Interview:** Felicia Gähwiler



## EC motor for dosing systems

Mexican couple Trinidad Villaseñor and Francisco Ibañez specialize in the precise dosing of fats, pastes, oils, lubricants, and other substances with their company RELANT. The system is used in the automotive, aerospace, and mining industries, among others. Because these substances are often very expensive, precise and loss-free dosing is crucial. Applications are often safety-related, with the highest quality requirements coming into play and documentation and rigorous traceability being of the utmost importance. The high-precision, volumetric dosing systems from RELANT work with the compact drive system from maxon: a brushless EC motor in combination with high-performance control electronics.





**10 YEARS OF DRIVEN**

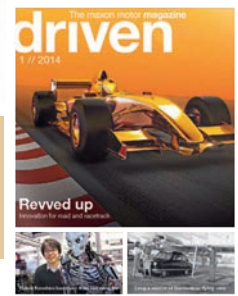
**The big review**

maxon inside \_\_10 years of driven

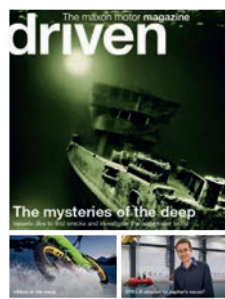
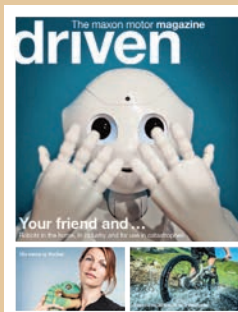
For ten years, *driven* has given center stage to our drive heroes and their deeds in medicine, aerospace, mobility, and industrial automation. 17 issues packed with expertise, background knowledge, and insights into the world of maxon.



**2012**  
Tablet magazine with an annual best-of print edition



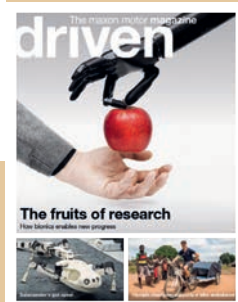
**2014**  
Switch to print only



**2015**  
First Chinese edition



**Chinese**  
In addition to German and English, a Chinese edition of our magazine has been available since 2015.



**16 international awards**  
Over the past decade *driven* has received many international awards for its concept, design, and content.



### Social media and blog

After the print edition has been published, our stories are posted on social media and our drive.tech blog, which was launched 2016. The story "DC motors as generators" is our most-read blog post with 42,785 clicks – and proves that people actually view our online content.

### The best feedback from the past ten years

**"I always take the magazine home with me, and my wife and kids read it too. It has something for everyone: in-depth technical information, as well as surprising stories from the world of drive technology."**

Ulrich Dersch, former CC Head at Lucerne University of Applied Sciences and current Director of plc-tec



**2019  
New design**



**2020  
New agency**



**2022  
New editorial team**



**2018  
Redesign**



### Mars always a hot topic

The Red Planet has featured regularly in *driven*, with around 25 articles in total.



### Helping hands

Without the maxon team, the protagonists from the stories, the authors, the photographers, and everyone involved in design, proofreading, translation, layout, and printing, there would be no *driven*. Around 90 people and 12 helping paws have helped get the current edition off the ground.

### Jury statement on the BCM Gold 2021 Award for the "Smart Farming" edition

**"The idea of making 'hidden products' visible through their end products is impressive. Super cover, a visually appealing and easily accessible portrayal of a complex topic."**





# “We share our stories to drive inspiration”

The launch ten years ago was completely digital. Since then, the original tablet magazine has become a print publication. Today, *driven* uses multiple channels to tell stories about maxon products. Michel Riedmann, who joined maxon in 2006 and is now Head of Brand and Digital Marketing, has been involved since the very first edition. He talks about the story behind the magazine and plans for the future.

**Interview:** Zoe Arnold

## ▼ What was maxon’s vision when creating *driven* magazine ten years ago?

Behind every maxon drive system there are people and companies with ideas, as well as challenges and breakthroughs in development. We wanted to share these stories to provide customers, young engineers, and technicians with inspiration for their projects. Our plan was to interact more frequently with our target groups and create an exciting reading experience in the process – in a way that sets a standard in our industry and underlines maxon’s innovative strength.

## ▼ Were you successful?

Our tablet magazine offered state-of-the-art interaction options and surprising features at an early stage. Reader engagement was also very high. However, we fell short of our expectations in terms of reach, as installing the app was ultimately too big a hurdle for many users. At the same time, many customers and business partners wanted to see more print editions, not just the annual print best-of with the year’s top stories – which basically spoke to the quality of the content.

▼ **How did maxon reconcile these different needs?**  
First, we discontinued the tablet version and are still publishing two print editions a year. Secondly, we simplified access to our digital content by launching the corporate blog *drive.tech*. This proved to be a good solution, and we’re very satisfied with the visitor numbers.

## ▼ The needs of readers will obviously change over the course of a decade. How has this affected *driven*?

Surveys and analyses indicate that technical reports and white papers are particularly popular with our readers. In other words, content that sheds light on technical details and concepts. We’ve expanded this over the years. At the same time, it’s becoming increasingly important to react quickly to searches, queries, and comments – on our own channels and in search engines. In this respect, we’re constantly developing our content so that it ranks well and can be found quickly.

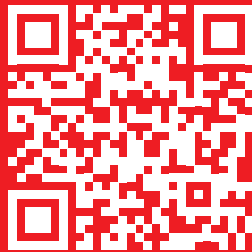
## ▼ What do you look at first in *driven*?

The “Heroes of this issue” in the table of contents. I’m always amazed at the places where our drives and systems are used. I see great potential in our online shop here. By expanding the product information to include context-related content, we can inspire even more customers with our exciting background stories and articles from *driven*. ■

# Let us know what you think!

We want to continue to offer a magazine with drive and depth in the future – up-to-date, relevant, and tailored to your interests. That's why we want to hear from you. What do you like about *driven*, what's missing, what would you like to see more of? Was there any content that you found particularly irrelevant or anything very memorable?

Your honest feedback will bring you one step closer to the magazine you've always wanted. Above all, you'll help us make *driven* even better. As a thank-you to everyone who participates we're giving away ten Fujifilm instant cameras – one for every year of *driven*. Good luck!



To participate, scan the QR code or visit:  
[surveydriven.maxongroup.com](https://surveydriven.maxongroup.com)

The deadline for entries is January 31, 2023

Winners will be notified by email. maxon employees are not eligible to participate. All decisions are final.



Instax Mini 40 instant camera  
with extra pack of 10 film sheets



# Our passion



There are many people behind the development of the innovative BIKEDRIVE AIR drive for e-bikes at maxon. Professional mountain biker Alessandra Keller got to meet some of them and hear their stories on a special freeride through the Sachseln campus.





**Text:** Michael Thiem

**A**lessandra Keller loves a challenge. The professional mountain biker, who rides for the Thömus maxon team, has no idea what's in store for her today. It's a demanding route with plenty of obstacles, a course full of pitfalls. A trail with varying levels of difficulty, undulations, small jumps as well as balance and trial elements. It will require every ounce of her skill. She'll also be challenged by big height differences, narrow office corridors, and people on the route. But Keller won't have to worry about any of these things, because this unique ride around the maxon campus in Sachseln is a victory lap rather than a competition. It's an opportunity to engage with like-minded individuals. maxon has been supporting the Swiss professional cycling team since 2021, and most of its employees are on the same wavelength as Keller. "They're all cyclists!" the 26-year-old remarks in amazement, adding: "It's really cool to see that the people here also share my passion for cycling. When you realize that an entire company is behind the project, it gives you an enormous boost." And what a boost it is. Keller is riding a very special e-bike. The Lightrider E Ultimate is the world's first full-suspension cross-country electric mountain bike weighing less than 15 kilograms, made possible thanks to the innovative maxon BIKEDRIVE AIR drive.



So, what lies behind it? Alessandra is eager to find out. After inspecting the route, she nods her head: "Perfect!" The superwoman from Central Switzerland puts on her gloves and helmet, clicks her shoes into the pedals, and off she goes. After a few meters, she turns right off Brünigstrasse, going cross-country past the maxon company sign and over the first grassy hill onto the campus. She immediately picks up speed. A short wave at reception, a rapid descent, then across the courtyard and a small bridge into the elevator of Technology Center V. Her destination: the fourth floor. In the hallway she signs a bicycle helmet for Roger Villiger, Head of Business Unit Aerospace (p. 3), who is himself a passionate cyclist. The next section is narrow and winding. It would be safe to say that this is probably the first time anyone has ever been here on a mountain bike. Keller makes her way through the open-plan office...



Severin Portmann, Technical Buyer



## Stop 1 – The Facilitator

Keller arrives at the desk of Severin Portmann. The 37-year-old is a technical buyer for all parts of the e-bike drive. He knows all about bikes. Every year, he covers around 8,000 kilometers and 100,000 meters of altitude in his free time on his mountain bike or racing bike. The two hit it off immediately. Portmann is an important facilitator at the interface between development and production. Given the current delivery and logistics bottlenecks, having the right components in the right quality and quantity at the right place is a puzzle with many unknown parts. "At the end of the day, it's down to us if development takes longer," says Portmann. More than 100 parts are required for the BIKEDRIVE AIR drive, around twice as many as for most other projects. On top of that there's the procurement of batteries. "We're learning so much," says Portmann. In his job he needs a good instinct when it comes to finding the right supplier along with his own expertise. Only those who understand the developers' specifications can speak to potential partners on an equal footing. The diversity in development at maxon and his training as a polymechanic help him, as do his many years of experience in operational purchasing and material planning. "You should know how a gearhead works if you're looking for suppliers for the required parts," explains the keen cyclist.







**Cross maxon**

Check out the video of Alessandra Keller's e-bike tour of the maxon campus here: [maxonbikedrive.com](http://maxonbikedrive.com)



➤ She nods. She knows from experience that it's the little things that make the difference when it comes to success. One such factor in her sport is the weight of the bike. The mountain bike she uses in competitions weighs 11.5 kilograms. At 14.9 kilograms, the e-bike she uses to go full tilt through the factory is slightly heavier. "Weight isn't a big factor in this case. The e-bike has the same tires and the same frame construction. Maneuvers with an e-bike are often much less agile. But that's not the case here," says Keller. It's more important to her that the bike has a lowerable seat post, as this makes it easier to overcome technical obstacles. "I can get into it easier and am ultimately faster," she explains. Even today, seated in a low position, she takes the last turn in the production area with a lot of momentum and only brakes when she reaches the workbench.

Gjillijmsere "Cele" Abdula, Special Production employee



## Stop 2 – The Specialist

Waiting for her in production is Gjillijmsere Abdula. The Special Production employee is one of the few people at maxon who doesn't ride a bike in her free time. Gjillijmsere Abdula is known to everyone as "Cele". She is the expert when it comes to the special challenges in production. She assembles the BIKEDRIVE AIR motor by hand. It takes a good hour to produce one drive. She has carefully lined up the individual components for Keller to see. There are many small steps that have to be carried out with great precision. The expert is particularly good at this, not least because she is constantly learning new work techniques and standards. First, she puts the drive shaft on the stator plate and glues it. Next come the magnets for the rotor, followed by the ball bearing, which is pressed onto the shaft. After casting the stator, she inserts the rotor into the stator. Then she solders the motor's PCB and assembles the gearhead. "We get this without lubrication. After I've pressed it onto the ball bearing, I apply five grams of lubricant," explains Abdula. The gearhead is then connected to the motor. Done. Keller holds the drive component in her hand, clearly amazed: "Wow!" Abdula adds: "The most difficult part is the casting of the stator and the gluing process. But it's working great." The result is impressive. Keller smiles, points to her e-bike drive, and gives a thumbs-up: "Absolutely!"





**INVISIBLE**

**E-bike drive unit**

The centerpiece: A brushless DC motor and a low-noise planetary gearhead supply a torque of 40Nm. Equipped with a 250Wh battery and an optional Range Extender with an additional 250Wh capacity, technically challenging trails can be tackled with ease.

After just a few meters, Keller is convinced: “This e-bike is great to ride. I used it in training. It’s perfect for fun bike tours to improve basic fitness.” Of course, Keller can’t use technical assistance in training and competitions, but she appreciates the chance to ride the innovative e-bike whenever she can. On trail sections where even she would have to dismount, the maximum support and torque of up to 40 newton-meters mean that she can easily climb further up. She turns into the test laboratory and stops at the development department.



## Stop 3 – The Creator

Erich Lerch also played a large part in BIKEDRIVE AIR. The development project manager has been with maxon for six and a half years, but has around 40 years of experience and boundless enthusiasm for all things electric. It’s not for nothing that he experiments with high voltage in his free time and likes to conduct electrostatic experiments using a Wimshurst generator. Anyone who can handle up to 500,000 volts will know exactly how to get the most out of a battery capacity of 250 watt-hours for the e-bike drive. Lerch and his team had to overcome many obstacles on the journey to develop a new motor and gearhead. “We were able to draw on our expertise, but we also found ourselves in uncharted territory. We had to develop and fine-tune a sensor system that absorbs the pedal force and precisely controls the motor. It needed to deliver just enough power so that riders would perceive it as natural support,” says Lerch. A kind of harmonious tailwind at the push of a button. Keller is able to reassure him. “When the support kicks in, you react very sensitively as a rider. But with this drive it feels perfect,” she says. Erich Lerch smiles. A lot of time was spent working on this sensation with the software developers. The well-measured support when pressure is applied to the pedal – a little less at the dead center of the pedaling movement and a little more on the other pedal – means that the lightest e-mountain bike is also exceptionally clever. The motor is undergoing endurance testing in the background. “The toughest test of all, however, is real operation,” says the 63-year-old. Behind the scenes there was another challenge to overcome. Rules and regulations made it necessary for maxon to guarantee the functional safety of the entire drive system. This involved a lot of laws, standards, and certificates. “We must above all document that the e-bike motor is safe,” emphasizes Lerch. “That’s an awful lot of documentation and evidence that needs to be prepared in parallel with the actual development work.”

Erich Lerch, Development Project Manager







## The Champ

Alessandra Keller has been unstoppable this year. The 26-year-old mountain biker made her international breakthrough and secured a double overall World Cup victory, with a win in the cross-country category in Snowshoe, USA, despite a fall, and a short track win in Vallnord, Andorra. Shortly thereafter she topped the overall rankings in Val di Sole, Italy, again in cross-country and short track. At the World Championships, the professional cyclist from the Swiss Thömus maxon Swiss Mountain Bike Racing Team won silver in the short track category. A knee injury had thrown her off course two years earlier, causing her to miss out on her big goal of competing in the Olympics in Tokyo in 2021. Keller, whose first successes were the Junior World Championship title in 2013 and the U23 World title in 2018, studied pharmacy and lives in the canton of Nidwalden. [alessandrakeller.ch](http://alessandrakeller.ch)

➤ When it comes to safety, the drive must not suddenly start and push the bike forward while the cyclist is waiting at a red traffic light, for example. There are no red lights to stop Keller's progress – either on the mountain bike trails she rides or on her route through the factory. As soon as the elevator door opens, she pedals hard. The tour is over. Keller is quickly out of sight, but she leaves behind her passion for the sport of mountain biking. For the maxon employees who were delighted to welcome this special guest, one thing is certain: Alessandra Keller is one of us. ■

BIKEDRIVE

# AIR

SECURE IN THE SADDLE

Perfectly tuned motor:  
At 3.5 kilograms, the maxon drive is one of the lightest and most compact e-bike systems.

**TORQUE**  
40 Nm

**MAXIMUM SUPPORT**  
25 km/h

**SYSTEM WEIGHT**  
3.5 kg

**BATTERY**  
250 Wh

**RANGE EXTENDER BATTERY**  
250 Wh

**VOLTAGE**  
36 V

**CHARGING TIME**  
3.5 hours (full charge)

**APPLICATIONS**  
Mountain bikes, racing bikes, gravel bikes, urban bikes, and kids' bikes

**SPECIAL FEATURES**  
The maxon BIKEDRIVE AIR e-bike system is mounted out of sight inside the frame. Control using the maxon Connect app

**CUSTOMERS**  
Cipollini, Dirtlab, IQ-Labs, Thömus, Transalpes

60 YEARS OF EXCELLENCE



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# Microscopic precision

Is this the surface of an alien planet? No. It's the nickel coating on a neodymium magnet. Images from a scanning electron microscope allow maxon to understand and optimize drive components down to the last detail and to guarantee perfect quality in every application.