#04

TOMORROW NOW

04.2023

EDAG

FOREWORD

Dear Reader,

In view of today's enormous ecological and social challenges, the product automobile is facing a paradigm shift. The current transformation in mobility is as great and as comprehensive as everything that happened in the last 100 years combined. Questions as complex as these call for complex answers - answers which possibly do not yet even exist and need to be found.

For this very reason, we bundled a variety of key competencies some time ago, to create a separate Innovations division. For us, innovations arise mainly from practical experience for practical application. Company-wide, we work in cooperation with our customers and partners from science and industry - because, especially in times when digital transformation is affecting all areas of our lives, the only way to create innovations is by working together in our strong partner network.

In our fourth issue of "Tomorrow Now", you can find out which innovative projects we are currently working on in close cooperation with our customers and partners. Starting with a hydrogen combustion engine for a 12-tonne truck, through to our modular and reusable vehicle platform KOSEL which, in combination with our zone-based EE architecture ZOBAS, received the Sustainability Award in Automotive 2023.

I hope you will enjoy reading the fourth edition of "Tomorrow Now", and look forward to introducing some of the technical staff behind our lighthouse innovation projects.

Cosimo De Carlo CEO of the EDAG Group

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SHORT NEWS

THE VR PAINT SHOP "RELOADED"

With the VR-Paintshop tool developed by Feynsinn, manual painters can train and experience manual paint application in a virtual paint booth. Since no real paints or workpieces are used, costs are reduced and at the same time resources & the environment are protected. So it's a clean affair, and the VR Paintshop's independence in terms of time and location means that paint shops remain flexible in their use: the Paintshop can be used at any time and in any place.

PLAYFUL TRAINING
The VR Paintshop was developed on the basis of the Unity game engine and transports real painting into the digital world. The integrated, virtual feedback system provides feedback on all relevant parameters such as paint thickness, spraying speed, spraying angle or distance between paint gun and workpiece. The user can choose from various training methods to continuously improve his own performance. Additional gaming elements such as "high scores" and "challenges" keep the motivation high and challenge the user again and again.

BUT WHAT'S NEW NOW?!
We have further developed and expanded the system. The user now has new functions at his disposal to make his training even more efficient:

- Support for additional painting processes (HVLP, Airless, Airmix).
- More choice of virtual environments (construction site, workshop, etc.)
- More than 25 different components for the painting process from the automotive, metal construction and general industry sectors
- Up to 6 different paint layers can be painted per component
- Extended user management for workshops, participants and their administration

CONSTRUCTION WORK ON NEW EMV CENTER

A new competence center for electromagnetic compatibility covering a total area of 2500 m^2 is to be constructed in Fulda. There are plans for three different types of absorber halls (a large vehicle hall, a medium-sized vehicle hall, and three component halls) and a shielded chamber with cutting edge technologies and a roller test bench. The entire laboratory complex has been defined in line with state-of-the-art technology for maximum flexibility and to meet a wide range of requirements.

Before we can begin construction of this new EMC center, however, the old apartment building that is currently still standing on the site must first be demolished. We are glad that the building work is to begin, and will provide further information to keep you posted!

LOCATION OPENING LINDAU

The opening ceremony for the new office in Lindau took place on 30.09.2022. Around 25 employees came to celebrate the inauguration together. At the beginning of the celebration, after welcoming the guests, the first thing was a guided tour through the new office space. After a short speech by Cosimo De Carlo and Jochen Hagel, the symbolic red ribbon was cut for the inauguration.

The buffet was then opened, for which each employee brought a delicious home-cooked dish from a country of their choice with which they have a personal connection. A colorful mix of different specialties from countries such as India, Denmark and Italy came together. Afterwards, the employees sat together in a relaxed atmosphere, where there was also a lively exchange between colleagues.

E-CHARGING COLUMNS IN OPERATION

In recent weeks, our pilot project EDAG charging columns has started in Fulda and we are pleased to announce that this has now been successfully completed.

Our total of 11 charging columns with 22 charging points in Fulda are now in operation and ready for use by all plug-in hybrid or electric company vehicles.

We are very pleased to be able to take a further step towards reducing CO2 emissions, as these charging points are of course powered by 100% green electricity.

HACKATHON 2022

80 participants demonstrated their skills at the HACKATHON Fulda 2022. It was already the fourth edition of the competition. The Slackoverflow team was able to convince the expert jury with its technical fitness solution this year. The eight-man team went home on Sunday with a prize money of 2000 euros. The event is characterised by a strong network of regional companies, institutions and public partners. Since the first edition of the Ideas Competition we have been represented as organizer and sponsor.

Under the motto "hacks 'n health", smart solutions were sought for the growing market of health and fitness services. Heiko Herchet, co-organizer, reports on the HACKATHON FULDA weekend: "Congratulations on Slackoverflow. Their solution SportSwipe not only describes a platform for sports offers, but also actively motivates users to participate. This convinced the expert jury. The decisive factor for the decision was the most coherent overall concept in all categories: team website, product pitch and code quality – the team performed an extraordinary performance."

Team "Team 1" took second place, Team "MetaPumking" took third place. Team "DT Health" was able to win the audience prize. "Once again this year, many young talents have travelled to Fulda to look for innovative solutions for our digital, networked lives," says Heiko Herchet. "Especially in the area of digital health, there is great potential for IT solutions. All nine participating teams have demonstrated this impressively. We congratulate you on your performance. We are proud to be able to accompany the format as co-organizer and sponsor since the year of its foundation in 2019."

Next year, the Fulda Hackathon will once again be an integral part of the calendar of events of the Region Fulda GmbH. "The anticipation of the next 25-hour hackathon is great," says Christian Vey, Managing Director Region Fulda GmbH. "This year we have already set a new record with more than 80 registrations. We look forward to seeing how many young talents we can inspire to take part in the Hackathon Fulda in 2023. "

EDAG INTEGRATES INNOVATIVE HYDROGEN ENGINE AND FUELING SYSTEM FOR CUMMINS' IAA PROJECT

Developing competitive, sustainable mobility for the transport, heavy-duty and work machinery sectors is one of the major challenges in the energy transition. With this in mind, Cummins presented a 12-tonne truck, the Mercedes-Benz Atego, powered by a Cummins B6.7H hydrogen combustion engine (H2-ICE) at the IAA Transportation from September 20 to 25. Cummins accomplished the powertrain and fueling system integration for this vehicle in cooperation with EDAG's truck, complete vehicle and hydrogen experts. As a proof of concept, the exhibit on show demonstrates an exciting development in zero carbon internal combustion engine technology.

"Hydrogen engines can make a significant contribution to achieving the zero carbon target, especially where commercial vehicles and mobile machinery are concerned," explains Jim Nebergall, General Manager – Hydrogen Engines at Cummins. "As the industry is looking for ways to reduce its environmental impact, the engines are interesting not only because of the lower cost of conversion compared to other zero carbon options, but also because they build on technologies already familiar to vehicle manufacturers, fleet managers and drivers. In addition, conventional powertrains can be used without impacting payload or vehicle performance."

"In these transformative times, openness to technologies is essential if high-performance alternative drives are to be implemented in all fields of mobility. Especially where commercial vehicles with energy-intensive superstructures and mobile machinery are concerned, the hydrogen engine can be a simple, efficient and climate-friendly powertrain solution," states Cosimo De Carlo. "To this end, and in collaboration with partners from industry and research, we have brought about sustainable H2 solutions for the powertrain and safe tank systems for Cummins."

No radical changes need to be made to the vehicle and drive concept in order to convert a truck, a tractor, a construction or rail vehicle for a climate-friendly hydrogen combustion engine. "We work with an internal combustion engine that has been adapted accordingly. If hydrogen is being used as a fuel, the drivetrain simply needs to be adapted, not completely redesigned. The after-treatment system is smaller, which leaves room for hydrogen tanks, with the intervals between refueling depending on the number of tanks integrated. These are much easier to position than the heavy batteries used in BEV solutions. The conversion is primarily a matter of hydrogen-specific integration services and domino effects in the overall vehicle, with technological and geometric adjustments," explains Dr. Andreas Quanz, Key Account Manager, Commercial Vehicles at EDAG. "In particular, this benefits manufacturers who carry out tasks that are weight-sensitive and where hydraulics plays a critical role. For them, heavy batteries and not having access to a powerful charging infrastructure detract from the desired performance and cost-effectiveness," continues Andreas Quanz.

"Green hydrogen combined with internal combustion engine technology provides us with a vitally important means of accelerating decarbonization: A dynamically growing market for this practical solution," adds Jim Nebergall.

What is more, in order to share its experience and expertise in the emerging H2 market and harness these to increase the pace of innovation, the EDAG Group has joined the 'Allianz Wasserstoffmotor' [Hydrogen Engine Alliance]. This is a cross-sector technology initiative focusing on sustainable transformation. In this way, we acknowledge our commitment to the advancement of this technology, and provide another element in the mobility of the future.

ADVANCEMENT THROUGH INNOVATION

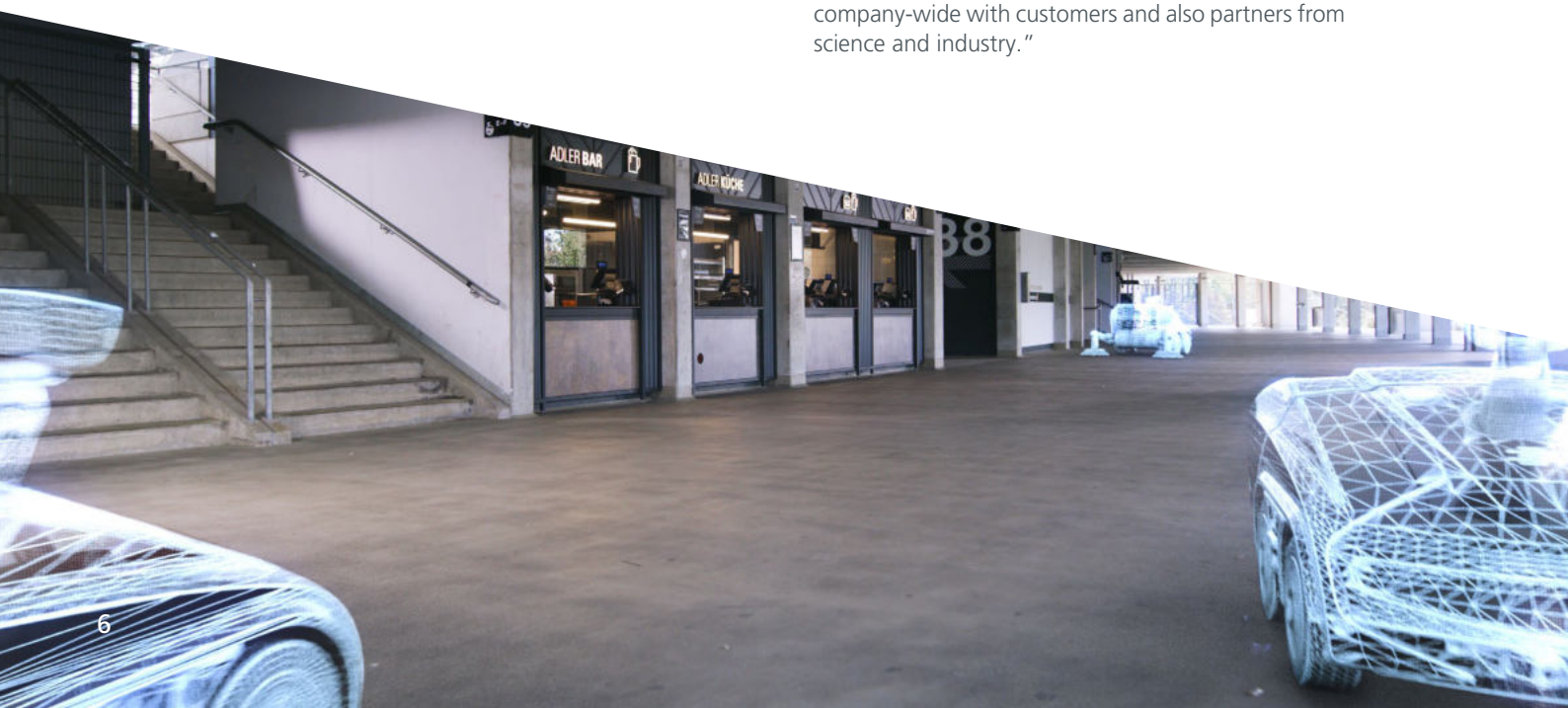
ALWAYS ONE STEP AHEAD

ADVANCE IS NOT A MATTER OF CHANCE. SO YEARS AGO, THE EDAG GROUP CREATED ITS OWN INNOVATIONS DIVISION. THIS IS WHERE THE COMPANY'S WIDE VARIETY OF COMPETENCIES ARE BUNDLED, AND TREND-SETTING FUNDING AND RESEARCH PROJECTS INITIATED. TO THIS END, THE EDAG GROUP FOCUSES ON A STRONG CULTURE OF CROSS-DIVISIONAL COOPERATION AND OPEN, CONSTRUCTIVE EXCHANGE.

Inventions that change the world can be so simple. Archimedes lowered himself into the bathtub one evening and saw the connection between density, volume and weight. Isaac Newton was sitting quietly under an apple tree when an apple fell on his head, revealing to him the law of gravity. And the Scottish bacteriologist Alexander Fleming, going into the laboratory after the summer holidays, found a Petri dish that had been forgotten and now contained a moldy culture, so discovering antibacterial penicillin.

So is a happy coincidence or a brilliant flash of inspiration all it takes to get something new and groundbreaking off the ground? In our complex, highly digitalized and interconnected world, in which hardware, software and the cloud are moving closer and closer together, hoping for this is not a viable option. Nowadays, innovation drivers are much more interested in the structured acquisition of know-how and skills, in a interdisciplinary exchange of information and continuous transfer of knowledge. "The only skill that will be important in the 21st century is the skill of learning new skills," is how US economist and management thinker Peter Drucker once described the situation.

This applied, and still does apply, to mobility in particular. Alternative drive systems, digitalization, autonomous driving, additive manufacturing, new materials - in view of the great ecological and sociopolitical challenges, the automotive product is on the brink of total reinvention. "The current transformation in mobility is as great and as comprehensive as everything that happened in the last 100 years combined. Complex questions call for correspondingly complex answers," states Cosimo De Carlo, CEO of the EDAG Group. "Therefore, as the world's largest independent engineering service provider to the global mobility industry, we bundled the various different competencies some time ago, and created a separate innovations division. Here, we work company-wide with customers and also partners from science and industry."



OWN SOLUTIONS FOR THE INDUSTRY'S FUTURE-ORIENTED SUBJECTS

Dr. Jan Leilich is the EDAG Group's Head of Innovations and head of the innovation field of digitalization. He and his employees focus primarily on funding and research projects: "In interdisciplinary teams with our colleagues from various departments, we develop solutions, concepts and strategies for the future-oriented subjects that will be relevant to the industry," explains Leilich. The four fields of innovation – digitalization, drive and storage technologies, sustainable vehicle development and safe mobility – are, as it were, "enablers", and we have made it our task to identify our customers' future needs as early as possible. The core team is based in Fulda, and from here, the relevant skills are networked in the global organization of the engineering service provider, the EDAG Group. "The intensive exchange of ideas and experience is the key to our success," states Leilich.

The framework for such research and development is set by the sometimes disruptive changes in the automotive market, which are being driven by the current megatrends of autonomous driving, eMobility, mobility services and connectivity. "Playing an active role in shaping this unprecedented change calls for agility, courage and creativity in particular, but also the ability to be constantly developing something new and bringing it to market," explains Leilich. This includes not only new business models and mobility services, but also innovative vehicle and system technologies for developing the vehicle of the future.

CREATING THE FUTURE IN THE REAL LAB

One example of this is the "Campus FreeCity" project. The EDAG Group, the digital subsidiary of Eintracht Frankfurt – EintrachtTech GmbH – and other partners are working together to research highly automated driving and the interaction of EDAG CityBots in dynamic urban and economic areas. The researchers in this living laboratory are looking not only at technical but also at human aspects. How does someone react when he is standing there with the robot vehicle in front of him, and it says "Please get in". How does this human-machine interface need to be designed to enable it to generate people's trust? In other words: Not only are groundbreaking technologies currently being tested in the "Campus FreeCity" project; many fundamental questions relating to networked mobility are also being clarified.

The EDAG Group's innovations are not, however, targeted solely at this kind of spectacular "big picture" of the future. On the contrary, they also include many details which are no less challenging. ZOBAS, for instance, a zone-based, service-oriented electrics/electronics architecture recently developed within the framework of a project funded by the Federal Ministry for Economic Affairs and Climate Action. Such an approach is essential in view of the ever-increasing flow of data and information in vehicles, which, according to Leilich are becoming more and more like "smartphones on wheels", and need to be designed for permanent communication – with both the occupants and its surroundings.

As more and more software is being introduced into vehicles, the importance of cybersecurity is also increasing. Although a constant online connection makes vehicles more and more comfortable and safer on the road, it does at the same time also make them vulnerable to criminal hackers and cyber attacks. Effective cybersecurity measures therefore need to be implemented to fully protect vehicle functions from external manipulation. Consequently, EDAG development teams are working on appropriate concepts to provide all-round protection for the vehicles, back-end systems and customer devices. In this respect, EDAG was last year one of the first companies in the automotive sector to be certified in accordance with the latest standard ISO / SAE 21434 Cybersecurity - Road Vehicles. To this end, a wide variety of damage scenarios relating to possible cyber attacks on vehicles and their digital security architecture were subjected to close scrutiny. The certification process evaluates all relevant measures, from the concept phase through development and production to maintenance and decommissioning.

INNOVATIONS FROM PRACTICAL EXPERIENCE FOR PRACTICAL APPLICATION

In the EDAG Group, thinking about innovations in these dimensions and then reliably implementing them follows a clear idea management roadmap. "For us, innovations arise mainly from practical experience for practical application," says Jan Leilich, describing the process. "In a structured process, we gather ideas from the circle of employees, look through and

substantiate them. We then use our expertise to check the suggestions to see whether they are feasible and of economic value to the company and then, where applicable, put them into practice as projects with their own budgets," says Jan Leilich, describing the procedure. In this way, some 40 relevant suggestions in the context of digitalization alone were received from employees in 2022. Some of the suggestions have already been successfully developed and are now being implemented.

The innovations team attaches special importance to research projects from the EU, the government, the federal states or foundations. "These often involve large-scale developments and out-of-the-box thinking, which further stimulates the investigative spirit of the employees," adds Leilich.

This applies all the more when the innovations envisaged will make a considerable contribution to greater sustainability. As is the case, for example, with the EU-wide DigiPrime project which kicked off in 2020, on which the EDAG Group and 35 partners from 11 EU countries are working on a new digital platform for the circular economy. In this context, the EDAG Group's project team is involved in various areas including the online acquisition and storage of hardware data, user history and the manufacturer's documentation for the batteries in electric cars. One idea behind this is, for example, to optimize the recycling and processing of recyclable materials used in the energy storage system in the future.

A hydrogen combustion engine for a 12-tonne truck which saw its world premiere at the IAA Transportation in Hannover last September is also aimed at the energy transition and sustainable "green" mobility. Developed by the EDAG Group and Cummins, a US manufacturer of diesel and gas engines, the exhibit is a milestone in zero carbon internal combustion engine technology. The integration of the powertrain and fueling system was accomplished with the EDAG Group's truck, complete vehicle and hydrogen expertise. "This hydrogen engine will make a relevant contribution to climate protection in heavy goods traffic," says Jan Leilich.

ALSO INNOVATIONS OUTSIDE OF OUR SECTOR

One of the conditions to enable the implementation of innovations is the use of artificial intelligence. As a key skill, this plays a decisive role, whatever the industry: which might be anything from autonomous driving to medical diagnostics. There is no limit to the possible applications; in the AI environment, the EDAG Group offers services in the fields of data engineering, architecture engineering, net engineering, consulting and the training of complex deep learning architectures. As part of a research project, EDAG Group experts developed a pipeline for the extraction of similar texts from a database. Using natural language processing (NLP) for the technical processing of natural language makes it possible to deal with the rapidly growing number of short texts.

"We want always to be one step ahead on transformative markets," says CEO Cosimo De Carlo. In the course of more than half a century of company history, we have repeatedly demonstrated that we can do this. As an independent engineering service provider, we are just as attractive to the classic OEMs as we are to new players, who come perhaps from Asia and are looking to enter the European markets. We are well positioned and ready to react to upcoming changes in the market with innovations in all relevant fields of technology – not by chance, but as a result of careful planning and focused skills."

OUTLOOK

UPCOMING EXHIBITIONS AND EVENTS

RETTMOBIL
FROM 10.05.2023

BATTERY SHOW + ELECTRIC UND HYBRID VEHICLE EXPO
FROM 23.05.2023

SAFETY WEEK
FROM 23.05.2023

AUTOMOTIVE TESTING EXPO
FROM 13.06.2023

PRAXISKONFERENZ FUSSGÄNGERSCHUTZ
FROM 13.06.2023

GREENTECH FESTIVAL
FROM 14.06.2023

EUROBIKE
FROM 21.06.2023

AUTOMOBIL-ELEKTRONIK KONGRESS
FROM 27.06.2023

AUTOMATED GUIDED VEHICLES ARE NO MIRACLE CURE - BUT THEY CAN WONDERFULLY REVOLUTIONIZE YOUR LOGISTICS

Automated guided vehicles (AGV) have become an integral part of our modern logistics. Making orders from high rack warehouses available in time for production? Keeping the logistics in hospitals up and running? Regardless of the industry – automated guided vehicles facilitate the material flow immensely.

In order to meet the constantly increasing demands of logistics, many companies would like to use automated guided vehicles in the future. Maybe you too? However this technology is neither a miracle cure nor easy to use. Careful planning is essential so that an automated material supply system can perhaps also revolutionize your intralogistics.

EARLY DETECTION OF DISSONANCES – EDAG PRODUCTION SOLUTIONS MAKES IT POSSIBLE

Let's take for example the modern production of an OEM that is converting its plant to the drive system of the future so that the latest e-mobiles can later roll off the assembly line. In order to cope with the increasing number of variants and the resulting growing complexity of logistics, logistics planners in body construction and assembly increasingly rely on automated guided vehicles (AGVs) to transport materials to the line.

If you want to conduct this orchestra of about 300 autonomous and manual vehicles, they must be precisely controlled and coordinated with each other. As with a real orchestra, each performance is precisely defined.

To plan this perfect interplay, the EDAG Production Solutions process simulation team accompanies these and other customers from a wide range of industries, all with very different requirements of the transport system.

We, the simulation experts at EDAG Production Solutions, are on safe ground when it comes to such topics. With the help of a dynamic simulation model we can answer these questions together with you and find the best solution for the use of an AGV.

Martin Peters
Team Leader Process Simulation
EDAG Production Solutions

SECURE THE PLANNING OF AUTOMATED GUIDED VEHICLE SYSTEM WITH A SIMULATION

All material flows and processes are displayed in a 2D or 3D model and can be extended at any time. Once the route network, stations, demand locations and the control system have found their way into the model, the planned supply concept can be systematically analysed.

The logistical processes are traced in detail and put through their paces. Open or unclarified processes can be temporarily abstracted and refined at a later date. Planning alternatives mature and find their way into the planned logistics concept if the results are convincing. Discrepancies during the "digital implementation" become visible at an early stage and can be addressed together with you, so that expensive error corrections can be avoided during implementation.

Finally, all your questions are answered and you gain experience and know-how in handling your complex system at an early planning stage. This would be unthinkable with static planning using classic Excel tables!

BRING RELIABILITY AND EFFICIENCY TO YOUR TRANSPORT TASKS WITH US

If you also want to use a driverless transport system in your company, then get to know your future system in advance! Our process simulation experts will introduce you to each other and give you a feeling for the necessary number of vehicles and sensible control logic. This means that you are ideally equipped to negotiate with AGV suppliers on an equal footing or, as a manufacturer of AGV systems, you benefit when advising your potential customers.

REDUCING THE "CO2 RUCKSACK" IN VEHICLE CONSTRUCTION

If electrification of the vehicle fleet continues, this will mean lower CO2 emissions during operation. Alongside this fact, the focus is now turning to reducing the carbon footprint during production. And vehicle construction does indeed offer considerable potential for greater climate friendliness. The key words are durability, modularity and circular economy.

Electric vehicles, preferably fueled with "green" electricity, reduce emissions of climate-damaging (exhaust) gases during operation. Conversely, however, looking at the entire life cycle of this type of vehicle, the proportion of the "CO2 rucksack" from the manufacture of the vehicle is increasing. There are still major improvements to be made here, and these will not only help to limit emissions, but also offer economic advantages.

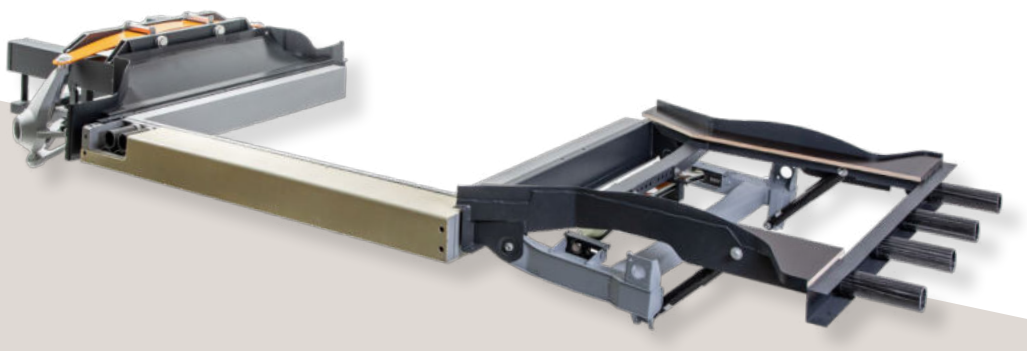
Long-lasting components capable of being used beyond the life cycle of the individual vehicle are the most important step in this direction. Other conditions, however, must also be met. One of these is modularity, which enables the simple replacement of components or complete modules. The other is a functioning concept for circular economy, in which parts are tested, conditioned, and fed into a resource-saving recycling system.

FEASIBILITY PROJECT

Minibus, enclosed transporter or open flatbed truck – the KOSEL modular system offers different external forms on a single platform

The KOSEL project has demonstrated that such a procedure is actually feasible. KOSEL stands for "Kreislaufgerechter Open-Source-Baukasten für elektrisch angetriebene Poolfahrzeuge" [recycling-oriented open source kit for electric pool vehicles]. The Fraunhofer Institute for Machine Tools and Forming Technology (IWU), the EDAG Group, Dresden University of Technology, Röchling Industrial SE, INVENT GmbH, the Emden-Leer University of Applied Sciences and BSMRG GmbH were involved in the project, the latter being a car sharing company which, with its "Carl and Carla" brand,operates using only minibuses and transporters in the 3.5 t class. The construction of such vehicles was therefore examined in greater detail in the course of the project.

As the name of the project suggests, an open source modular design is an elementary part of the concept. This means that there are defined interfaces between the individual modules, the front end, for example, or the battery box and rear end, and also with the superstructure. The modular principle enables the manufacturer to provide different external forms on a single platform – not just during production, but also when retrofitting the vehicle, meaning, for example, that a minibus, enclosed transporter or open flatbed truck can be built. As it is an open concept, providers of retrofit and conversion solutions are also able to access to the interfaces, and add their own individual solutions.





DURABILITY IS A MUST

If the modular system is to be not just open source, but also recycling-oriented, this calls for a set of components and modules capable of being used more than once – ideally beyond the life cycle of the individual vehicle. Instead of using metal carriers which are susceptible to corrosion, the consortium therefore opted for carbon fibre reinforced polymers CFRP). Although these have a comparatively high CO2 footprint in production, they can, if used correctly, compensate for this with their low mass and, in particular, their high fatigue strength over correspondingly long periods of repeated use.

The combination of transverse leaf spring and lever arm allows for a space-saving design with a low loading sill and level floor. This composite material is used, for instance, in EDaxle::LCV, the innovative semi-independent suspension with a transverse leaf spring developed by EDAG. The basic design consists of the transverse leaf spring acting on the axle beam via a lever arm. This concept allows the design of the rear end to be particularly flat, resulting in a low loading sill and level floor. This means that three standard pallets can be transported without restrictions. Great flexibility results from the possibility of changing the leverage ratios, so spring rates can be set for specific applications.

In order to guarantee operational safety during long-term use, INVENT developed a way of permanently monitoring this critical component. A network of piezoceramics monitors any material strains that occur. If small, invisible cracks appear in the material, they are detected as electrical voltage spikes. In the absence of such cracks, the component can continue to be used, with no need to replace it as a precautionary measure.

To guarantee the recyclability of components and parts, their durability must already be taken into account during the development phase – and this concerns not just the choice of material, but also a design which is open to future technological developments. In the present concept, one example of this can be found the areas in the front and rear ends which can be equipped with functional units and have been designed to enable the cameras and radar sensors needed for autonomous driving functions to be fitted. When retrofitting, there is therefore no call for the modification of the entire assembly.

PERFORMANCE IN CRASH SCENARIOS

Protecting occupants from accidents is one of the key design criteria for all vehicles on public roads. To this end, a large number of crash scenarios including the side pole crash test are simulated and tested. Use was made of crash absorbers based on tubes made of carbon fibre reinforced plastic (CFRP) in this concept. These were installed in the rocker panel designed by Fraunhofer IWU and Röchling Industrial SE. Tubes made of carbon fibre reinforced plastic (CFRP) create impact protection in the rocker panel.

The effectiveness of the crash protection concept was validated by EDAG in simulations using the finite element method. The results show that there is little intrusion into the vehicle at both 90° (C1) and 75° (C2). At the same time, the desired slightly progressive course of the counterforce generated becomes apparent. An impact in the edge region (C3) also leads to the expected behavior.

A COMPARISON OF ENVIRONMENTAL IMPACTS

The aim of the concept is to reduce the impact the vehicle has on the environment. In an examination covering three vehicle life cycles in the course of 30 years, the Chair of Energy Economics at the Dresden University of Technology was able to show that significant advantages result if the product life cycle of individual components is extended over several vehicle generations. The comparison dealt both with the different concepts and with the possibility of recycling. Please note that not all material combinations provide the required service life.

The results speak for themselves: The analysis of the modular system shows a reduction of more than 60 %, in particular as a result of recycling. This shows a distinct advantage for the environment, which can only be realized through circular economy.

Stefan Caba
Head of Competence Center for Sustainable vehicle development
EDAG Engineering GmbH

SCALEBAT: SCALABLE BATTERY HOUSING FOR FLEXIBLE ELECTRIC VEHICLE PLATFORMS

The scalable battery housing SCALEbat helps car manufacturers and startup companies to develop flexible electric vehicle platforms. As the basis for the development of this concept, the EDAG Group took the scalable floor assembly already being successfully marketed under the brand name SCALEbase.

Its scalability is not the only outstanding characteristic of SCALEbase; it is also an ideal means for the structural integration of various battery systems. Car manufacturers and startups can define and roughly design the various power levels for the eDrive and battery module with us – depending on local preferences and the size of the vehicle. The crash requirements in various markets were taken into account during development. The intensive use of steel roll-formed profiles for the frame structure of the battery housing results in enormous saving potential, especially where large quantities are involved.

ECONOMICAL LIGHTWEIGHT DOOR FOR COMMERCIAL VEHICLES

VALIDATED PROTOTYPE OF A TRUCK DOOR FOR THE NEXT GENERATION OF COMMERCIAL VEHICLES: 20% WEIGHT REDUCTION, MAXIMISED FIELD OF VISION, OPTIMISED AERODYNAMICS, AT NO EXTRA COST!

In the commercial vehicle segment, increased requirements in terms of road safety, aerodynamics, load case requirements, payload and economy are pushing existing truck door designs to their limits. New concepts are needed, but in the commercial vehicle industry must always be implemented in such a way that no additional costs are incurred.

In cooperation with Fischer Hydroforming and Muhr Metalltechnik, we have constructed and validated the prototype for a future-proof truck door. By using cross-section-minimised hydroformed (HF) profiles for the steel door frame, a thin-walled outer skin, a patented hinge connection concept with a tolerance-compensating, continuously adjustable clamping sleeve and flush design using frame-under-glass, the properties have been significantly improved.

The hydroformed door frame has made it possible to create an A-pillar with an optimised viewing angle, providing maximum visibility for the driver, to ensure that pedestrians and cyclists can be seen more easily, and serious accidents significantly reduced.

Selected tests were carried out on the WiLeitNu prototype under series conditions to establish the suitability of the concept, so WiLeitNu should be transferable to all manufacturers' cabs.

The project was backed by the Federal Ministry for Economic Affairs and Energy (BMWi), and supervised by TÜV Rheinland, the project sponsor. The WiLeitNu project won the German Innovation Award in 2020.

HIGH-QUALITY INPUT FOR AI FROM THE SMARTPHONE

More and more applications are leveraging the power of machine learning and neural networks for object recognition. However, how efficient artificial intelligence is at such tasks depends, among other things, on the quality of the training data. With the right tools, suitable data sets can be generated via tablet and smartphone.

Is the road clear or is there an obstacle crossing the travel path? Do the corn plants need more water? Where is the next screw for the robot to grab and insert? Automated analysis of image data has become a domain of artificial intelligence (AI). The range of applications extends from visualization solutions in industry through recognition tasks in medicine, agriculture and logistics to autonomous driving.

Neural networks, i.e. networks that are based on the structure of the human brain, are particularly suitable for object recognition. But the network architecture is only part of the secret to success. These networks first have to be trained for the specific tasks using machine learning. This requires suitable data sets made up of images and informative descriptions. The quality of this training data is one of the key factors in determining the subsequent recognition performance in real operation.

TRADITIONAL DATA ACQUISITION

For numerous everyday objects – people, animals, cars and many more – high-quality training datasets already exist and are freely available online. In logistics and industry, however, data sets are always needed for new objects. Until now, generating this kind of initial training data has been extremely complex. The underlying procedure is called data annotation.

This involves specifying certain conditions or representations that a data object must meet. These conditions are determined by the nature of the neural network and the training process. The annotations for the corresponding images are then generated. To do this, it is necessary to mark the desired object in the image material by means of bounding boxes and to supplement these images with further data, in particular object designation or object class, but also further data for describing the object or its context, such as size or position.

There are already a variety of solutions and approaches to data annotation. In particular, the following five procedures are the most common in practice:

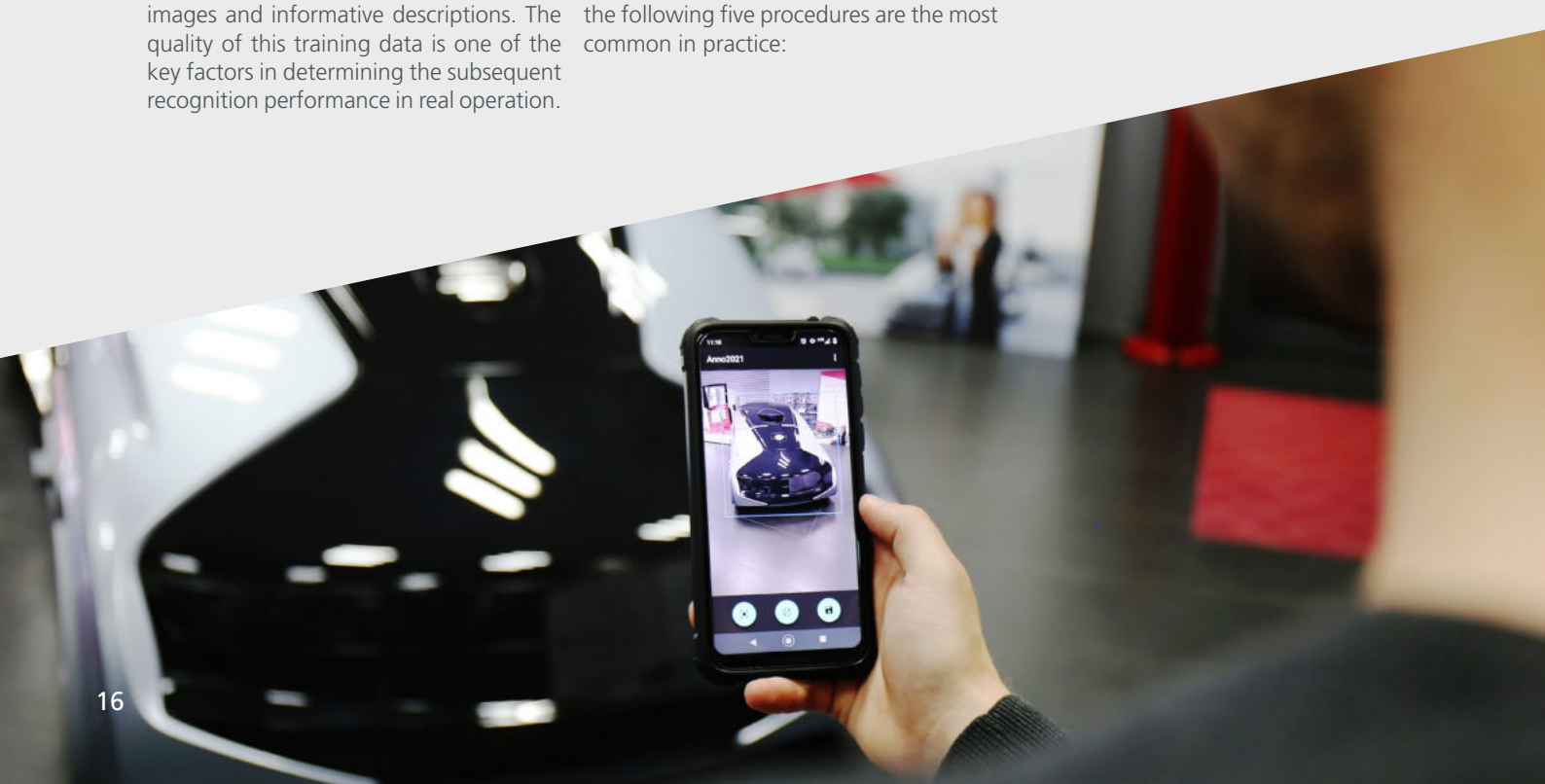
1. **Single data generation:** Manual annotation of individual images from a video, known as frames;

2. **Crowdsourcing:** Projects to merge data sets using single data generation across multiple sources;

3. **Partial automation procedures:** Data generation using propagation, copying annotations for static objects, or linear interpolation of moving objects from single frames of videos. Tools such as object trackers or pre-trained models provide more intelligent support - provided that suitable data and models for the objects in question already exist;

4. **Data augmentation:** Artificial augmentation of existing datasets, for example by rotating, mirroring, distorting, or blurring annotated images;

5. **Synthetic data:** Automated generation of random training data using modeled objects.



Maximilian Happel
Development Engineering
EDAG Engineering GmbH

In part, these procedures can only build on existing data. Others require too much time to generate sufficiently large data sets. Especially for areas and objects that need to be developed from scratch, such as new types of products in the logistics center, other ways of data annotation that allow the solution to be put into operation in a timely manner must therefore be found.

WAYS TO MOBILE DATA ANNOTATION

Mobile devices such as smartphones or tablets have at least one but sometimes several high resolution cameras, as well as constantly improving computing power. This makes them ideal for data annotation: they can take photos and videos of the objects and execute tools to support annotation, such as object trackers and segmentation algorithms. Thus, users can annotate the object shown in the camera image of the mobile device with a bounding box. The segmentation algorithm further adjusts the bounding box based on unique features. The object tracker can be used to track the object across frames, i.e. from image to image.

The object can therefore be photographed from various angles and distances, while the bounding box is defined just once, when recording is started or optimized by occasional re-segmentation and adjustment of the bounding box. Once an object has been photographed from every perspective, the process is repeated for the next object until a sufficiently large training dataset has been collected. Before uploading the data, for example to cloud storage, individual off-center annotations or blurred images can already be sorted out. In this way, the quality of the training data is improved at an early stage. Likewise, the training data can be used to pre-train a neural network and the result can be used on the mobile device. Firstly, to test the recognition quality, and secondly, for automated data annotation, which simplifies the further collection of training data.

CUSTOMIZED TECHNOLOGY

The technical specifications of the mobile device must be considered. As a general rule, a tablet is more suitable than a smartphone, thanks to the larger display and better performance. Similarly, greater success can be achieved by using different object trackers, segmentation algorithms, and machine learning models. This makes it possible to respond to changing situations - from lighting to object size and type to weather - while the system is in operation. This procedure promises greater efficiency and higher quality annotations.

There are also applications in which the integrated camera cannot be used, such as in medical imaging procedures. However, the basic concept can be applied here as well, with live data from ultrasound, MRI or PET-CT being highlighted by medical staff during routine examinations, in order to distinguish between healthy and abnormal tissue. In this way, the necessary training data can be generated for AI models that later assist in the detection of diseases.

TURBO FOR INNOVATIVE BIKE PROJECTS

Although the bicycle is enjoying a real boom, suppliers are under pressure from many different directions: Deliveries from Asia fail to materialize, customer requirements are becoming more exacting, and competition is essentially also a race to generate more innovations in less time. A greater real net output ratio is the order of the day: from more in-house developments to new manufacturing concepts. EDAG's bike pros can help out with additional know-how and significantly reduce the time to market.

Bicycles, eBikes and pedelecs have gained enormously in significance in recent years. Drivers were both the Corona crisis and climate change. As a result of the global pandemic and the absence of opportunities to travel, vacationing at home became more popular again – along with walking and cycling tours. In addition, many people avoided using public transport, preferring to venture out into the fresh air rather than expose themselves to the potential risk of infection in overcrowded trains and buses.

The popularity of the bike is also due to ecological reasons, as a fossil-free alternative to the car. The high cost of petrol and diesel, but also rising vehicle prices and the decline in supply in the small car segment are boosting the trend away from four-wheels to two. Cities and municipalities are supporting the development by expanding the cycling infrastructure. They are expanding cycle path networks, providing parking spaces for cargo bikes and planning more fast cycle routes, setting up bike parking garages and repair service points close to train stations, and promoting bike sharing.

BOOMING MARKET

The figures speak for themselves. While cycles valuing some four billion euros were sold in 2019, the industry generated sales of 6.56 billion euros in 2021 – an increase of 60 percent in just two years. Increasing quantities (4.7 million bikes in total) and an increasing proportion of eBikes and pedelecs, which are on average more expensive than "normal" bikes (2.0

million units), have promoted this leap in sales. Admittedly, the trend was broken this year, due to delivery problems on the one hand and to the general reluctance to spend owing to the enormous increase in the cost of living on the other.

Never has there been a better time to time to enter the market or acquire further market shares. If companies want to cement this trend in the long-term, they will need to work even faster and more efficiently, and become more technologically advanced, so as to keep pace in a fiercely contested market. In view of the risks caused by the scarcity of complete bicycles or their individual components on account of the fragility of supply chains from Asia, in-house development and production are once again becoming increasingly important.

As part of the EDAG Group, the world's largest independent engineering service provider in the automotive industry, EDAG Bike can provide support with the conceptual design and development of frames and other components. This enables the time to market to be significantly reduced while maintaining high levels of quality and innovation.

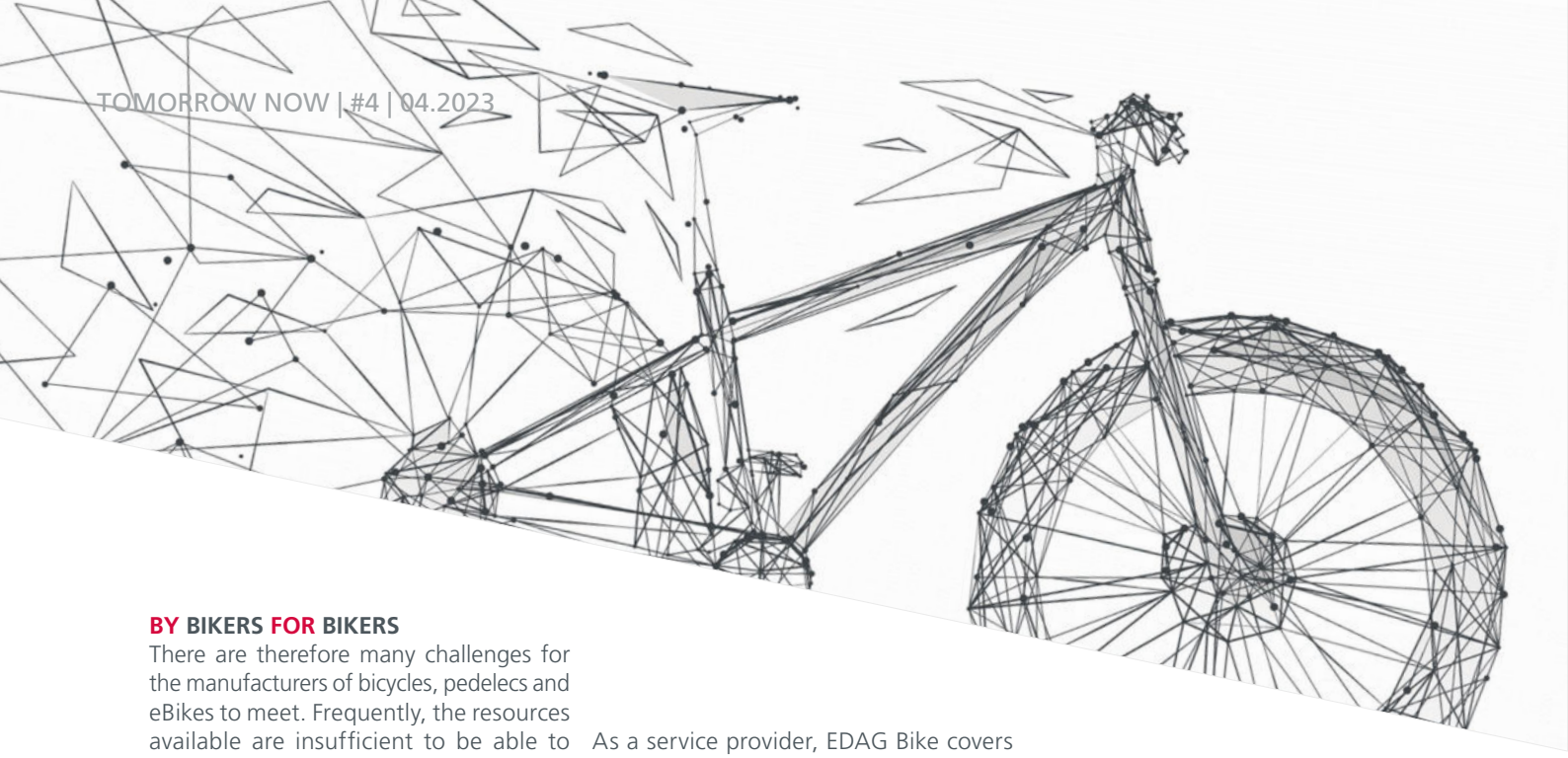
WHAT'S IMPORTANT

One of the key distinguishing features is the frame – it lays the foundation for the cycling experience, and so essentially determines the brand image. The development is based on factors such as styling, mechanical design, i.e. stability, rigidity and durability, first of all during simulation. Then industrial production, i.e. from the welding process to position layout or other new production methods, and finally approval of the entire development by means of validation and stress tests carried out on the hardware on the test bench. If required, all the components for the bicycle are developed and brought to market maturity by EDAG Bike.

Pedelecs and eBikes are moved by a "second heart" – the electric powertrain. The battery system, control electronics and electric motor form an inseparable whole. This could mean the development of a new electric powertrain, the battery system, from the housing to the cells, including cell mounts and arrangement, to the battery management system (BMS) and the charging socket.

In addition, a great deal of data is generated by electrically operated bikes, which, in addition to the route and evaluation, also provides interesting insights or can be used to optimize control and consumption. A significant proportion of users expect easy-to-use apps that will enable them to access this wealth of data and make cycling safer, more stimulating and more entertaining. So it is not just a matter of data analysis and evaluation, but also of an attractive user interface.

On top of this, additional classic hardware components such as brakes, dampers and handlebars are also needed.



BY BIKERS FOR BIKERS

There are therefore many challenges for the manufacturers of bicycles, pedelecs and eBikes to meet. Frequently, the resources available are insufficient to be able to promptly perform all the tasks needing to be addressed. In this case, an external service provider such as EDAG Bike can fill the breach and help to accelerate development and maintain a successful competitive position with a short time to market.

The EDAG Group is an established partner to the mobility industry, initially working for the automotive sector, but since 2011 with an additional focus on motorcycles, and more recently also on bicycle development. Due to the fact that more and more enquiries were being received, committed bikers pushed to establish such a department, under the motto "by bikers for bikers". Here, the bike experts can draw on not just their own know-how but also on the entire tool and methods portfolio of the EDAG Group with its more than 8,000 specialists, and so offer a genuine all-round 360 degree service.

Simulation models and methods that have been developed in-house are as much a part of EDAG Bike's test portfolio as its own test equipment for physical validation. Whether the frame or spring elements are concerned, or the cockpit or add-on parts, EDAG provides the appropriate development capacities with in-depth know-how and extensive technical equipment. This means that EDAG has access to its own brake testing equipment; at EDAG, spring elements for high-performance dampers are tested and matched in our own spring laboratory. On request, EDAG can also undertake the development of the entire powertrain, including the battery system and electronics.

Another domain is app creation, which includes both the development of an intuitive user interface and software programming.

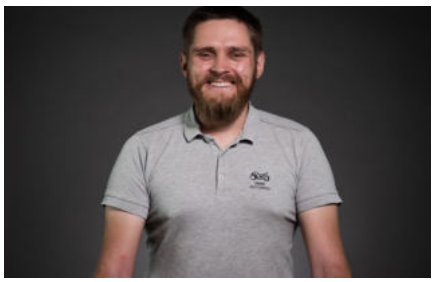
As a service provider, EDAG Bike covers the whole bike development range, from concept design and frame, component and powertrain development, through to prototype production and approval, for both the individual elements and the complete bike.

To optimize these and ensure a high quality capable of withstanding the stresses and strains of daily use, EDAG Bike offers a comprehensive testing and inspection program ranging from simulation models in the digital development process to the validation of prototypes and final confirmation of market readiness on its own test equipment, adapted to the components. This includes:

- Testing of the braking systems
- Suspension testing
- Validation and endurance tests on special test stands
- Stiffness and strength testing of the components and frames
- Environmental simulation tests (corrosion, sun, climate)
- Vibration tests
- Road trials
- Battery validation
- Powertrain testing
- Validation on the test stand
- Realistic validation during the road testing

Outsourcing development processes reduces the workloads of employees in-house, leaving them free for other tasks. The company's all-encompassing single-source development makes for smooth, perfectly coordinated processes which cut development times and therefore also development costs. The extensive tests help to avoid expensive errors before the parts go into production. And last but not least, the EDAG Bike experts contribute additional know-how and creative ideas.

Development alone, however, is not enough – the components still have to be manufactured. EDAG also has considerable expertise in setting up manufacturing plants, optimizing production processes for fast throughput and high efficiency, and ensuring production quality. The location of the production site plays no role here, be it in Germany, Europe or the Far East – EDAG has suitable specialists everywhere.



Niko Lehtonen
Team Leader
Motorcycle and Bicycle
EDAG Engineering GmbH

TOWNS ARE NOT DEFENSELESS AGAINST HEAVY RAINFALL

"Heavy rainfall events" are occurring ever more often as a result of climate change and they are causing more and more damage. Additional efforts are required to protect life, property and infrastructure of towns and cities. The heavy rainfall early warning system can help decisively minimize damage.

On May 19, 2022, Mundelsheim local council gathered in the meeting chamber of the historic town hall. The council began its deliberations at 7 p.m. while outside a hailstorm was approaching. Nobody inside knew anything about what was going on in the locality until a frantic local burst into the meeting with the news that "The entire village was flooding!". As the councilors then stepped outside, brown murky water was already raging through the middle of the village.

Localized storms such as this or even supercells are no longer isolated incidents. Eleven people lost their lives in the towns of Braunsbach and Simbach in 2016. In the summer of 2021, a violent thunderstorm struck Oberdorfen in the Upper Bavarian district of Erding – 50 liters of rain per square meter was sufficient to flood the entire village, leaving homes temporarily uninhabitable. And even "once-in-a-century-floods" occur every few years, as the multiple floods in localities such as Grimma (Mulde), Dresden (Elbe) and Deggendorf (Danube) demonstrate. And cities such as Cologne (Rhine) or Passau (Danube, Inn and Ilz) located on the banks of rivers are affected regularly.

URGENT NEED FOR ACTION LOCALLY

Improved weather forecasting on its own is of no use. In an attribution study produced after the Ahr Valley disaster, Hayley Fowler, Professor of Climate Change Impacts at Newcastle University, demands parallel measures. Besides cutting greenhouse gases as fast as possible to mitigate the trend, she points to the need to improve warning systems and disaster management. In addition, the infrastructure also needs to be made "climate-resilient." Her colleague Dr. Frank Kreienkamp, Head of the Regional Climate Office Potsdam at the German Meteorological Service, points out in the same study that local and national government agencies must take greater account of the growing risks due to heavy rainfall.

Because often the focus is on flooding and river management, the consequences of heavy rainfall tend to be ignored. This transforms not only "inconspicuous" watercourses, but also dirt tracks and streets into raging torrents. Such risks must be considered much more if we are to combat the changing threat situation with suitable measures. Here in particular the aim is to gain time: Detecting the dangerous situation, alerting people in good time and therefore facilitating preparations by the emergency services and allowing individuals to protect themselves.

This is precisely where the Smart City Team from EDAG Production Solutions (EDAG PS) comes in. Together with cooperation partner Spekter from Herzogenaurach, EDAG PS operates its heavy rainfall early warning system (EWS). The environmental tech company focused on heavy rainfall risk management has developed a comprehensive, multi-stage concept to identify heavy rain risks early on and to warn government agencies, emergency services and the population.

In an initial step, a risk analysis is produced for the area to be protected. A range of heavy rainfall events are analyzed and tested in 2D and 3D simulation processes to determine how the water drains away in the particular case. Based on these maps, construction measures and disaster management scenarios can be developed.

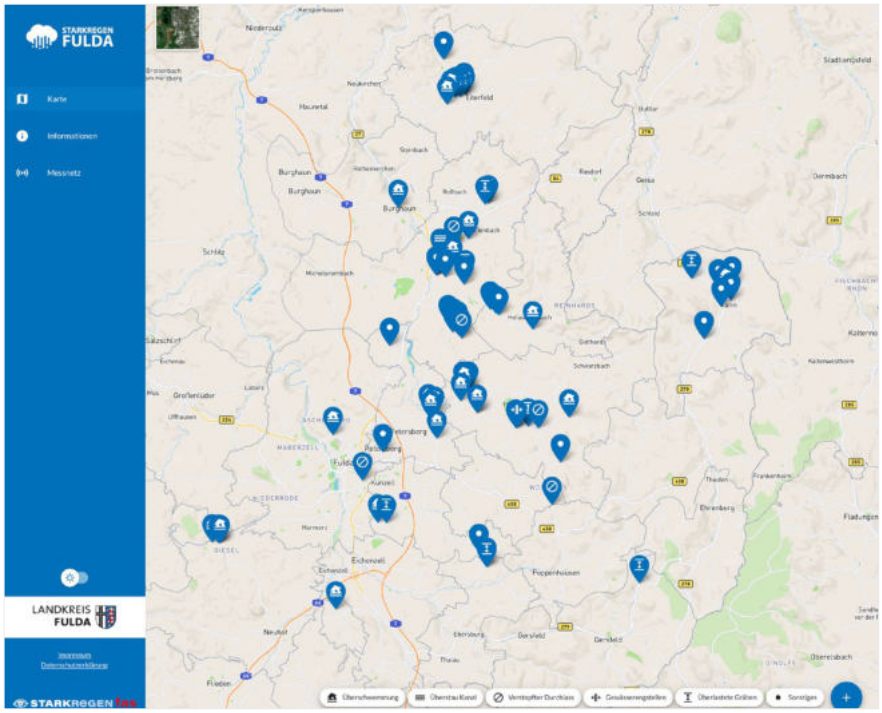
The heavy rainfall early warning system is based on sensors, on the one hand, that record live the levels of small and large rivers as well as neuralgic points in the sewage system. The recorded values are supplemented with meteorological data from the German Meteorological Service (DWD) and the Flood Warning Service (HND). The obtained information on the current and expected weather phenomena is analyzed in real time. When critical levels are reached, local residents are alerted along with those responsible in local councils and emergency services.

LIGHTHOUSE PROJECT IN THE DISTRICT OF FULDA

The EWS is already up and running in certain towns and cities in various configurations. At present, the multi-stage "eRisk management project for an early warning system for heavy rainfall" is being rolled out in the district of Fulda in Hesse. Initially restricted to the four pilot towns of Eichenzell, Ebersburg, Burghaun and Neuhof, the aim is to make the system available to all 19 towns and cities by the end of 2023. Extending the early warning system solution across the entire district also constitutes an unprecedented project size for the system manufacturer. Collaboration with EDAG PS as implementation partner made this kind of scaling possible in the first place.

EDAG PS has assumed project management for the EWS rollout as general contractor and is therefore the first port of call for customers, for instance with implementation of the sensors in consultation with the towns and the service yards. 200 sensors in sewers, on bridges, in public buildings and on rivers will be installed by the end of 2023. The sensors are fully automated, and make various measurements including rainfall, river levels and drainage behavior.

In addition, EDAG PS has developed an important element of the project with the digital heavy rainfall participation platform. The interactive website allows residents throughout the entire Fulda district to report hazardous situations that have already occurred. This further supplements the information from the installed sensors.



PROJECTS ARE FUNDED BY CENTRAL AND REGIONAL GOVERNMENTS

Central and regional governments have also been alarmed by the frequent tendency to underestimate heavy rainfall events, even though these will presumably become more frequent as part of climate change and cause even greater destruction. In response, a whole range of funding programs have been created to provide rapid remedies. The project in the district of Fulda, for instance, is being funded to the tune of €830,000 by the regional Hesse government as part of the "Strong Home Hesse" program.

Advice regarding potential financial support also constitutes an important aspect of the customer support at EDAG PS. The experts are familiar with the various sources of funding which help towns tackle such projects. Ultimately, EDAG PS has already garnered extensive experience. Over the past five years, the company has been supporting these concepts as part of its Smart City strategy, with many satisfied customers to its name.

"THE SENSORS ARE FULLY AUTOMATED, AND MAKE VARIOUS MEASUREMENTS **INCLUDING RAINFALL, RIVER LEVELS AND DRAINAGE BEHAVIOR."**

Karina Schäfer
Project Manager Smart City
EDAG Production Solutions

ABSOLUTELY CLEAN PROJECTS IN EDAG PRODUCTION SOLUTIONS'S CLEAN ROOM

Without clean rooms, the development and manufacture of many high-tech products is virtually inconceivable. Cleanliness requirements are becoming increasingly stringent, in the production of semiconductor components, for instance.

Considering that component structures in the single-digit nanometer range can now be exposed by lithography, it quickly becomes clear here just how much damage a dirt particle measuring 0.1-0.3 µm can cause.

But it is not only the manufacture of electronic semiconductor components that is carried out in the clean room. The plant technology for such products is also prepared and assembled in the clean room.

Other clean room applications can be found in medical technology and the food industry, for example, though each field does, of course, have different requirements.

There is one thing, however, that all clean room applications have in common: they mean considerable additional expense when it comes to the production and development of the products concerned.

ONE CLEAN ROOM – THE ANSWER TO PARTICULAR CUSTOMER REQUIREMENTS

In 2019, EDAG Production Solutions (EDAG PS) handled its first clean room project on its own premises. For the customer, system components were developed, assembled and qualified for subsequent use in the clean room. Work is currently being carried out on the twelfth project for this customer.

The clean room tent specially erected for this purpose will soon no longer be in use, because from November 2022, there will be an ISO 7 clean room (in line with DIN EN ISO 14644-1:1999) at Hutweide, the new EDAG site in Petersberg near Fulda, which, with a floor area of 160 m² (10 x 16 m) provides plenty of space for assembly and measurement applications. The inside height of 4 meters also allows for extended dimensioning in the z-direction. Access to the work area is via a clean room-specific personnel air lock and a corresponding material air lock. At present, a dozen employees have been trained to work in the clean room.

In addition to recording geometric parameters using a Faro® arm, the measuring technology also enables, among other things, UV-based detection of any dirt particles in an area which can be darkened.

The clean room itself is a modular in-house development realized by EDAG PS in cooperation with the system technology supplier Kanya Deutschland GmbH. This has led to a concept that can also be implemented quickly and effectively for indirect customers.

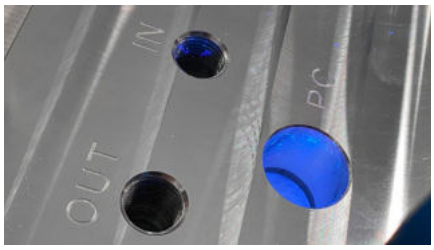
ONE CLEAN ROOM – MANY DIFFERENT PROJECTS

A plant manufacturer offering the possibility of assembling plants and components in a clean room is without doubt a unique selling point. Incidentally, an additional interesting piece of information is that, once EDAG PS has carried out the appropriate quality measures, it is also permissible for the ISO 7 class clean room to be used to manufacture production equipment that will later be used in clean rooms in the

Andreas Friedrich
Director Smart Factory Manufacturing Solutions
EDAG Production Solutions

much stricter ISO 6 class; one instance of this was the qualification of a heavy-duty robot (1,500 kg payload) for the high-precision and ergonomic positioning of components in an assembly application that was subsequently put into operation in the end customer's clean room (ISO 6 class).

A wide spectrum of projects can be handled in the EDAG-PS clean room. This ranges from purely rental applications, with the customers renting the workspace for their own applications, through contract assembly, to complete turnkey projects where, in addition to assembly, installation and commissioning, the complete development of a system is also carried out by EDAG PS as the general contractor.



ONE CLEAN ROOM – ONE PROCESS FROM AIR LOCK TO AIR LOCK
Working in a clean room requires the employees to adjust the way they think and act. This begins with the loading of components and tools, for which ultrasonic baths, among other things, are available, and ends with standardized packaging (for example, heat-sealing in three independent sleeves, each of which must later be removed again in a separate process at the installation site). Over the years, EDAG PS's clean room experts have internalized these special processes and incorporated them into their daily work.

ONE CLEAN ROOM – COMPLEX KNOW-HOW
Another aspect is the development of the components and production equipment themselves, which needs to comply with clean room standards. The right choice of materials and correct design are skills in which the EDAG PS developers are fully proficient. Components with no unnecessary undercuts, gaps or angles (where dirt particles could collect) and with surfaces that are easy to clean are important guarantees for clean room-compatible design.

ONE CLEAN ROOM – DIFFERENT NEW PATHS
Where are we heading? One important customer group is currently being served with plant engineering projects for the semiconductor industry. Additional sectors, for instance medical technology, the food industry, hydrogen/fuel cell technology or battery cell production, could follow. The experience EDAG PS has gained in turnkey plant projects coupled with know-how from clean room applications provides our customers with a sound basis for the implementation of their projects: scalable, fast and professional.

EDAG ENGINEERING GMBH AGAIN RECEIVES A

TOP EMPLOYER AWARD

COMPANY DEMONSTRATES STRONG PERFORMANCE IN THE CATEGORIES “PEOPLE STRATEGY”, “EMPLOYER BRANDING” AND “ONBOARDING”.

EDAG Engineering GmbH has once again received an award for its outstanding HR management. The independent jury of the Top Employers Institute testified to the outstanding working conditions offered by the world's largest independent engineering service provider in the mobility industry and technology developer for industrial solutions, and recognized its high level of employee orientation.

Cosimo De Carlo, director and CEO of the EDAG Group, is delighted at this latest award: "In our company, it is the people that matter most. The keen problem-solving skills and the high motivation of our employees are our added value on the market, and this certification shows that we can hold our own in a challenging and competitive environment with high demands."

The independent institute puts companies through an extensive validation process, taking numerous strategic and operative matters into account. Corporate strategy, HR development, sustainability, diversity, gender equality: this is just a small sample of the various fields that were subjected to the close scrutiny of the auditors during the certification process. The focus of validation is on internal processes - including talent strategy, apprenticeships, training, development and onboarding.

Throughout, EDAG Engineering GmbH was compared with numerous other companies from the same industrial sector. Worldwide, a large number of well-known companies took part in this year's Top Employer competition – including 150 in the category „Automobile". The results achieved are evaluated according to an international standard.

"This award shows that we offer an outstanding working and development environment, while at the same time giving us the opportunity to uncover further potential," says Wolfgang Fries, Head of Global Recruiting & HR Business Partner. "The renewed certification is no reason for us to sit back and do nothing: it substantiates our commitment to constant improvement, so that we can successfully take on the challenges of the changing world of work and ensure our employees a superlative environment not just now, but also in the future."

Holger Merz, CFO of the EDAG Group, underlines this idea: "We are constantly investing in HR development and in new working environments. These subjects are extremely important to us, to ensure that we maintain a consistently high level of attractiveness as an employer. We offer an environment of encouragement and development for potential applicants, but also especially for our employees."

As an engineering partner for complete vehicles and production plants, the EDAG Group offers its employees a wealth of prospects for their professional and personal development. Numerous innovative projects at national and international locations make the EDAG Group one of the most attractive employers in the mobility sector for both career starters and people with experience.

DTM 2023: EDAG GROUP AND SSR PERFORMANCE IN THE LINE-UP WITH LAMBORGHINI

LONGSTANDING VEHICLE DEVELOPMENT EXPERTISE MEETS PROFESSIONAL DRIVING SKILLS: PARTNERSHIP BETWEEN EDAG GROUP AND SSR PERFORMANCE GMBH ENTERS THE NEXT PHASE.

The EDAG Group is to support the SSR Team as its technical partner during the DTM – for the second time in a row. The racing team consists of Mirko Bortolotti, Franck Perera and Alessio Deledda. The first race will take place in Oschersleben, Saxony-Anhalt, on May 25 - 28. The team will be starting the season with three new Lamborghini Huracán GT3 EVO2s. After their successful debut last year and their victory in the race in Spa-Francorchamps, SSR will be starting their second year in the DTM this 2023 season.

"The kind of high-performance vehicles we see in motorsport have always been innovation drivers for series development – in terms of weight reduction, the use of new materials, hybridization or in the development and use of e-fuels. Future technologies are often first tested on the race track, especially with regard to vehicle attributes such as weight, power and aerodynamics," explains Harald Keller, COO of EDAG Engineering GmbH. "We are pleased to have found such a professional and dedicated team as SSR Performance for a technical partnership."

The EDAG Group has long-standing international development expertise in the mobility sector, and, as a premium engineering partner, serves many well-known vehicle manufacturers and Tier 1 suppliers worldwide. Founded in 1969, the company pursues an all-round engineering approach for vehicles, production plants, and also in the field of software and digitalization. Always with the ultimate goal of proactively developing concepts and solutions for the mobility of the future. In the high performance sector, too, the EDAG Group can look back on years of experience.

Stefan Schlund, Managing Director of SSR Performance GmbH, is certain: With the continuation of the technical partnership with the EDAG Group, the 2023 DTM season will once again be a joint success: "With the EDAG Group, we have for more than two years had a reliable and competent partner at our side. We are really looking forward to further developing this strong cooperation."

"WE ARE PLEASED
TO HAVE FOUND SUCH
A PROFESSIONAL AND
DEDICATED TEAM AS
SSR PERFORMANCE FOR A
TECHNICAL PARTNERSHIP."

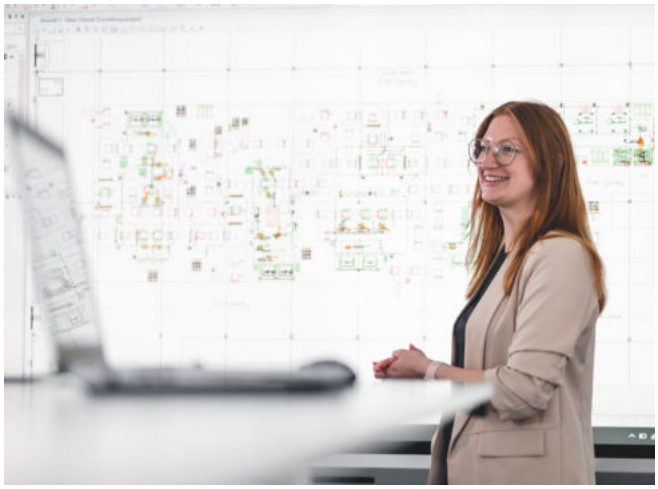
EDAG EMPLOYEE STORY

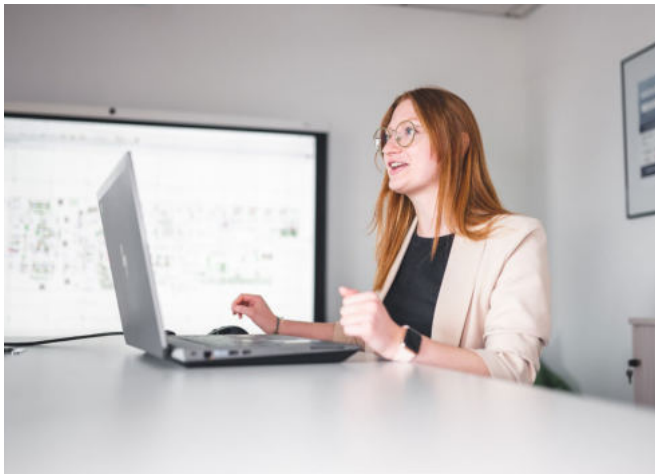
INTERPRETER BETWEEN BUSINESS AND TECHNOLOGY

Anna has always been fascinated by cars and fast engines, a passion she seems to have inherited: "Even as a child, I would always watch DTM races with my father on Sundays," and her grandfather and uncle were also actively involved in motorsports. To this day, the underlying engineering is something Anna can get really excited about. So it is not surprising that she opted for a career in this direction, and that she today works as a production planner for the automotive industry, especially in the battery environment. Only to begin with, planning was not really her thing.

What she actually wanted to study was mechanical engineering, of that she was quite sure, but then a careers advisor gave her the idea of switching to industrial engineering. A good idea: "I quickly realized that I definitely wanted to be the interface between business and technology, and take on a communicative role there. I just really enjoy coordinating and planning," says Anna, and you can hear the enthusiasm in her voice.

It was also clear at this point that she wanted to do a dual study course. As Anna grew up in Bad Brückenau, which is close to Fulda, she was already familiar with EDAG PS (Production Solutions). When she then learned that you can study industrial engineering with the focus on international technical project management at EDAG PS, this is what tipped the scales. "Bachelor degree courses do not often offer this focus." And it was exactly the right decision; she liked the course from the very beginning. There followed six semesters in the dual system. It was when, in the second year of her course, she was working as a project management assistant and planner during the long practical phase, that she really felt that she had found her place: "I was able to get involved straight away, and gain valuable practical experience in a large project."





THINKING OUTSIDE THE BOX IS A SCHOOL FOR LIFE

Looking back, what she benefited from most of all was the semester she spent abroad in Ireland: "For me, the language was an added bonus. The English you speak is completely different once you've been abroad at university for a while. In addition, you also learn to look after yourself, an experience which really helped me to grow. It also pays to think outside the box once in a while."

This helped her to cope when she started her new job in Ingolstadt after completing her Bachelor's degree. For six months now, Anna has now been working as a planner in the Engineering Assembly Technology team, and feels very much at home: "I had a very, very warm welcome here, and was immediately accepted. It feels good when, as a young woman coordinating projects, I can give people something new to think about: 'What do you think about us doing this differently?', and this idea receives a positive response: we work well together here."

Anna's team is responsible for the planning of production facilities in which the components for vehicles are produced. She supervises and coordinates processes that can be lengthy, sometimes taking one or two years. "We do the planning, design and simulation here at the site, and supervise the development of the equipment, focusing particularly on eMobility, i.e. battery assembly for passenger cars."

DIRECT COMMENTS ARE HELPFUL

The fact that, as a young woman, she is well received in what is still a male-dominated industry is probably also due to the way she communicates. She recommends being clear, objective and direct: "I have a pretty straightforward personality, and also give direct feedback. If I have something on my mind, I don't keep quiet about it, but prefer to confront it and say, `This and this is the problem and this and this might be solutions'."

Anna has a talent for communication; she speaks calmly and clearly if there is a hitch and things get difficult in her day-to-day work: "It's important to me that people talk to each other when they notice that something isn't working 100%, and then work together constructively to find solutions.

A great plus, because things do not, of course, always run smoothly. Perhaps it's to her advantage that she's always enjoyed solving puzzles; she's also keen on exit games. She frankly admits that staying calm is something you have to practice: "They say the trick is not to overestimate new information. I have learned that the most important thing is to keep calm, first talk to colleagues in-house, look for a solution, then communicate with the customer, and it's also OK to admit to having made a mistake. Of course, I get nervous if things are not going well, and I start to wonder how on earth it can possibly work out well, but in the end you always find a solution." Anna has found her place.

"EVEN AS A CHILD, I WOULD ALWAYS **WATCH DTM RACES WITH MY FATHER ON SUNDAYS."**

EDAG EMPLOYEE STORY

BUTTER, CHICKEN WING AND PANCAKE

Butter, Chicken Wing and Pancake are Felix' hobbies. But if you are thinking of culinary arts, you are wrong. The terms come from volleyball and stand for a game that goes like clockwork (butter), defensive techniques with an angled arm (chicken wing) and an impressive slide digger (pancake) - i.e. a leap towards the ground to stop the ball from hitting the ground at the last moment. Felix has been coaching a mixed volleyball team in Esslingen, Swabia, for many years. "The squad includes around 30 people between the ages of 20 and 60," explains Felix, Project Lead at EDAG.

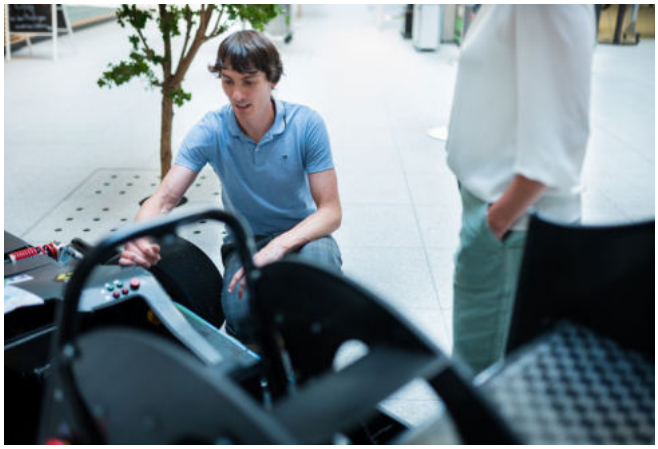
(DRIVING) DYNAMICS IN EVERYDAY WORK

"Simulator," as he calls himself. "I'm responsible for ensuring that cars drive safely and perform well on the road. And that the comfort is optimal, no matter what the surface."

Chassis are his thing. To be more specific, the graduate vehicle engineer has been on board at EDAG for three years in the Vehicle Dynamics Simulation department. This means working out the driving dynamics of vehicles, running through the application scenarios on the computer, changing components and parameters again and again until it fits and the customer's requirements are met. "It's a terrific feeling when the first idea on a blank sheet of paper becomes a finished car." According to the 30-year-old, this is exactly what characterizes his job at EDAG.

FROM SCHOOL INTERNSHIP IN THE WORKSHOP TO HIGH SCHOOL GRADUATION AND STUDIES IN AUTOMOTIVE ENGINEERING

Cars and technology have always appealed to Felix, whether touring cars, go-karting or later Formula 1. At 14, he got his hands dirty in his first jobs in car workshops during the school vacations. Changing oil, checking tires and brakes, replacing lamps - the full range of things a schoolboy is allowed to do. "But I quickly realized that wasn't enough for me," recalls the Augsburg native. "I wanted to know exactly what was behind it." Why is a chassis, a shock absorber constructed in this way, how do the parts and components interlock and



how does the interaction of the individual elements become a harmonious whole? In short: "I wanted to know how to get the horsepower onto the road."

No sooner said than done. After graduating from high school, he began studying automotive engineering in Ilmenau and completed his bachelor's degree at Esslingen University of Applied Sciences. Theoretical fundamentals are elementary for Felix. "I love developing complex models on the computer and finding solutions for the trickiest requirements." But without practice, this remains a paper tiger for him. That's why during an internship during his studies he got a taste of the air at a renowned racing team. From the Opel Adam in the rally version to the Formula 1 racing car - he got to know vehicle technology at a high-tech level first hand.

USING DIGITAL TWINS IN A TARGETED WAY

Whether SUV, roadster, family car or sedan - Felix is now the expert when it comes to developing a chassis. He is currently working on the chassis for an electric car that a start-up will be launching on the market. The basis, as is usual for projects, is a specification sheet that includes all requirements and features for the future vehicle: Comfort, safety, maintainability, sustainability and much more. For the so-called multi-body simulation, he builds models on the computer, a digital twin of the future reality. His most important tools for this are Adams Car, which he uses to build and test functional virtual prototypes of complete vehicles and subsystems. He solves mathematical problems with the tool Matlab.

For him, building the models on the computer is the be-all and end-all. How should the chassis behave kinematically, how do different bearing materials and preloads of the suspension affect the driving dynamics? "In my model, I put together all the components that are important for driving dynamics, test them and build the chassis in an agile, iterative way," says Felix. The front axle, rear axle, steering, brakes, and load are all individual components that he combines in the software and designs into the overall vehicle, in other words, from the rough to the fine. The materials and forces, which he allows to act on his model, are at first rigid and then increasingly more flexible.

"Of course, I don't develop the car in my ivory tower," Felix explains. He works very closely with his colleagues who are responsible for the vertical dynamics. And he is also in lively exchange with the test teams. "With my colleagues on the team, the quality of my work becomes apparent." The tough practical test then answers the question of whether his models and simulations actually represent reality. His claim: "Ideally, I save my colleagues an enormous amount of effort in development and thus accelerate the overall development."

FORMULA STUDENT MEETS EDAG

The chassis freak, volleyball coach and team player has a whole other side. "For several years now, I have been supervising students at EDAG in their final projects. I like to pass on my know-how and soak up the results of the work. They go into great detail, which is not possible in normal business, and I can often use this knowledge for my own work - a win-win situation." As part of a current bachelor's thesis, lap times for a DTM vehicle of a well-known motorsports team are simulated on the basis of vehicle and track data. How do changes in weight, chassis settings affect the lap times and temperature of the brakes? The results are made available to the racing team, which then tapes off the cooling ducts of the brakes, for example, so that they are always kept at the optimum temperature range between 400 and 600 degrees.

ALWAYS ON THE MOVE PERSONALLY AND PROFESSIONALLY

When Felix is not simulating chassis for cars, he is testing that of his sports equipment. When snowboarding or mountain biking, he pushes his personal physical limits and those of his fully. "Just the other day I rode the World Cup downhill course in Lenzerheide, Switzerland. Fierce." His biggest challenge last year was a 2-day bike enduro competition in Brandnertal, Austria. "Okay, I don't need that anymore," he grins. At EDAG, he has some plans for the future, as he puts on record: "I would like to explore how our experts can approach customers more actively in the future and acquire projects." Other goals include being present at trade fairs and preparing training materials to facilitate the onboarding of new colleagues. And maybe handing out a round of chicken wings and pancakes, and a cold drink - instead of butter.

EDAG INTERNATIONAL

NEW EDAG SCANDINAVIA LOCATION STOCKHOLM

On October 1, a big step was taken for EDAG Scandinavia as we established our second office in Sweden. We see a growing interest in our services in the region and with important customers centred around Stockholm, the expansion was a natural step. Now we can offer the same preconditions and arrangements as in Gothenburg where we can combine local engineers with global EDAG presence and competence.

The operations in Stockholm are led by Regional Director Anders Svensson and cover the entire EDAG portfolio, serving clients with the ability to deliver large project responsibilities within automotive and other industries.

EDAG's legacy in Scandinavia goes decades back and in various constellations, most recently under the name HRM EDAG Engineering AB replaced by EDAG Engineering Scandinavia AB in January 2020.

NEW CFO AT EDAG CHINA

EDAG Engineering and Design (Shanghai) Co. has had a new Chief Financial Officer since February 1, 2023. Nils Hansen took over from his predecessor Arnim Rohns, and is responsible with immediate effect for the Finance, HR, Purchasing, Legal Divisions and for other admin functions. Nils brings with him extensive experience in financial reporting, tax and compliance, which he acquired in Germany and China while working for PwC, Siemens and Siemens Gamesa. He first got to know EDAG in 2012, in his capacity as an auditor.

The 45-year-old was born and grew up on the North Sea coast, studied at the University of Applied Sciences in Kiel, and has a degree in Business Administration (Diplom-Kaufmann (FH)) in Accounting & Taxation, as well as being an accountant and (former) auditor. His spare time is given over to his hobbies, which include handball, golf, art & design and traveling. Nils is married and has a cat.

As a creative person, he loves the diversity of his job as CFO. He enjoys constantly developing new solutions for the wide variety of challenges he faces. He plans to spend the first two months in his new position getting to know the organization and bringing a positive dynamic to his sphere of responsibility.

PERSONNEL CHANGES IN EDAG ITALIA

Franco Baraghini takes over EDAG Italia as Managing Director and follows Giovanni Pulina, who left the company.

Franco Baraghini's career speaks by itself. His experience in an international and multicultural context is wide as well as his ability to define strategic paths in complex markets. In the past he showed his ability to develop engineering and digital services for various industrial sectors and customers. His deep passion for innovation, automotive and mobility in general, together with his skills, led him to grow in Altran/Capgemini up to reach the top managerial positions.

In his new role, Franco will focus on the development of EDAG Italia by strengthen the position in the local market and the international cooperation with the Group. Under his lead the Italian team will further expand customer and project portfolio. Strategic customers and their specific requirements will be analysed, and strategies will be developed locally and with the cooperation of the EDAG Group. He sees this task as a team effort involving everyone in the company and he looks forward to lead the colleagues to new challenging objectives.

Franco is 56 years old and he likes to spend his free time good music, especially 80's music, and hi-fi systems in general, he likes books and films based on true stories, visiting cities of art and going to the theatre. He also told me that he's also a sports lover, especially if they are practised by others.

IMPRINT

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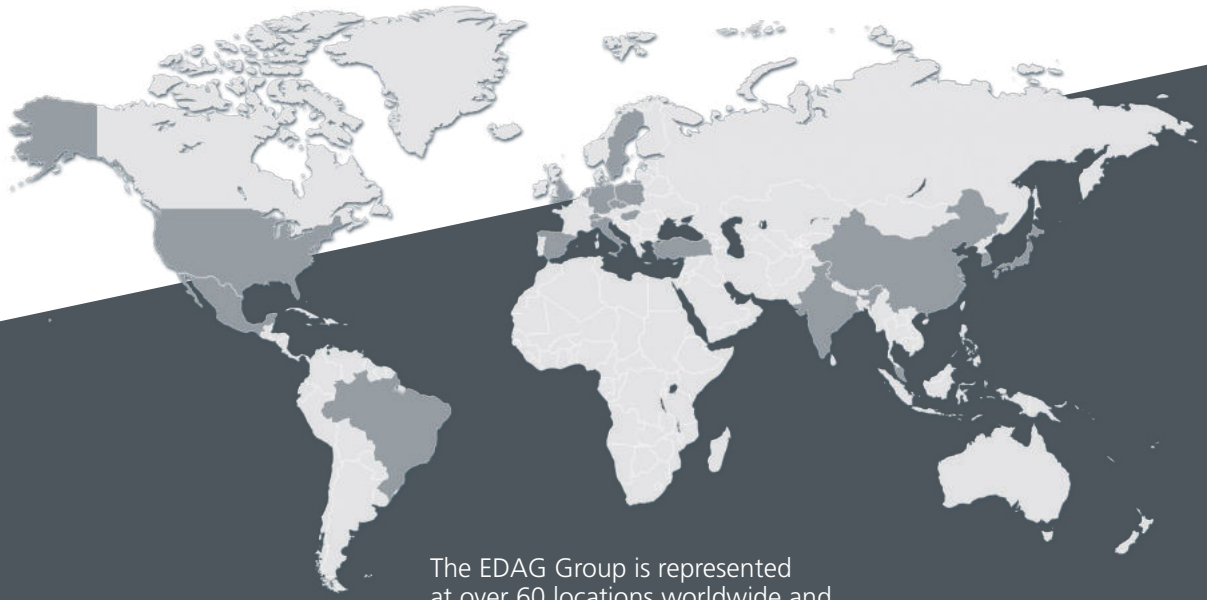

The EDAG Group is represented at over 60 locations worldwide and has a global network.

YOUR GLOBAL MOBILITY ENGINEERING EXPERTS

EDAG is an independent engineering service provider working for the global mobility industry. The company has a global network of some 60 branches at the world's major automobile centres to serve leading national and international vehicle manufacturers and technologically discerning automotive suppliers.

In addition, EDAG also offers engineering services in the vehicle engineering, electrics/electronics and production solutions segments. This extensive competence enables EDAG to provide its customers with allround support, from the original idea to design, through to product development, prototype construction and even turn-key production systems. As an innovative technological leader, the company also has competence centres for ground-breaking future technologies for the automotive industry: sustainable vehicle development, safe mobility, digitalisation and drive and storage technologies.

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