ESSENTIAL

FREUDENBERG SEALING TECHNOLOGIES

ARTIFICIAL
INTELLIGENCE

EFFICIENT OPERATIONS
Artificial intelligence is changing everyday work in companies.

DIGITAL SHADOW
AI can determine a material's quality.

AUTONOMOUS DRIVING
AI is the precondition for advanced driving functions.

the magazine **1_24**

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IN 50 WORDS

Intelligence is something deeply human. But what about artificial intelligence (AI)? It is a human creation that has the potential to make our daily routine easier, in our personal lives and in every business sector. We examine the many different options that AI offers to us in manufacturing and research.

WATCH THE TRAILER

THE MAGAZINE online:
www.fst.com/corporate/magazine

The cover of this edition was composed using generative AI. The following prompts were used:

Front: huge mix of library and server room, futuristic, photography, lightful, modern.

Back: an old library central perspective lightful.

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Welcome to the AI Era

By Claus Möhlenkamp, Chief Executive Officer,
Freudenberg Sealing Technologies

Everyone is talking about it: artificial intelligence (AI). It is certainly not new. But since ChatGPT was launched in late 2022, AI has entered the public consciousness. Today, nearly everyone can use the text-based chatbot and many other AI applications. We may even take them for granted. Experts describe the introduction of ChatGPT as an iPhone moment. It's an analogy that should highlight AI's importance for all of us – after all, no one would do without a smartphone today. And its introduction was just 17 years ago. But in an instant, it became an anchor in our daily life. It is so much more than a telephone. It puts the Internet within reach at any moment. It is a camera, a medium for entertainment, an appointment calendar, a navigation device, an alarm clock, a flashlight and a means of payment, to name just a few of its uses. The smartphone's triumphant advance is an indication of how quickly we

With some exaggeration, you could say searching was yesterday, finding is today.

are getting used to AI and how unwilling we will be to abandon it. We can already adapt applications such as ChatGPT to our needs and let others participate in it. For example, you can select a comprehensive manual in a foreign language. And then, a short time later, get the answers to specific questions, in your own language. With some exaggeration, you could say searching was yesterday, finding is today.

Companies recognized the advantages of artificial intelligence long before ChatGPT. Consider generative AI. It helps to glean valuable information from large quantities of data, perhaps for a marketing campaign. There also is predictive AI. It is helpful for making forecasts for maintenance purposes, for example. At Freudenberg Sealing Technologies, we are also turning to AI in sub-units of our business. It helps us accelerate processes and monitor them better. One example: AI has helped take automatic visual inspection to a new level. Another system shows the moisture content of material granules in a silo. We are not only starting to recognize the value of our data – we are actually leveraging it to our advantage. And that means to the advantage of our business partners, too.

If data is the oil of the 21st century, then artificial intelligence is the drilling rig, refinery and filling station all rolled into one. But only if we toughen up AI. Before artificial intelligence can bring insights to light, it needs a structured database, a clear-cut algorithm with precise instructions, and in-depth training.

That is the only way that AI can compile information that we can use. It is up to us to evaluate the insights and figure out the right steps to take.
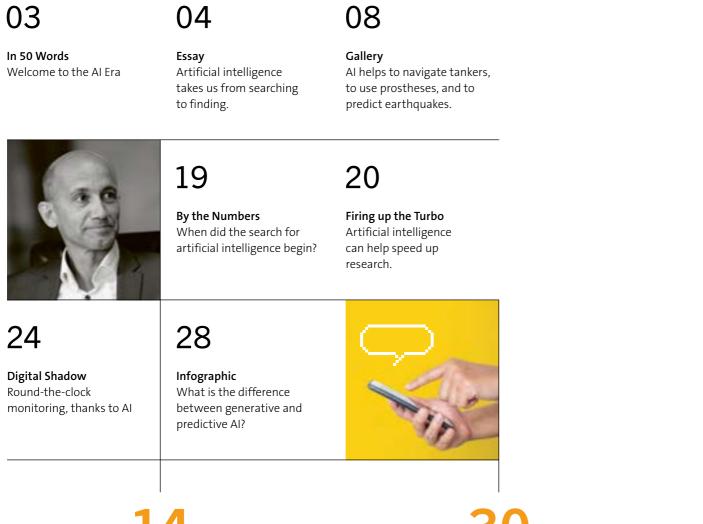
AI helps us bring light to the darkness. But there are shadows wherever there is light. AI is a powerful tool. Still, we shouldn't trust it blindly. We should continue to use common sense. AI requires a responsible approach. People must always be involved in the decision-making. That is not the least important concern for companies such as Microsoft, IBM, Mercedes, and Bosch as they grapple with the impact of AI and come up with guidelines for its development and use. The European Union is attempting to regulate certain applications – not the technology as such – with new guidelines. I think this is a desirable approach, especially from a sociopolitical standpoint. The World Economic Forum stood up and took notice of AI for good reason early this year. In its risk report, the organization classified the spread of false, AI-generated information as the greatest potential source of a short-term global crisis. I am reminded of The Sorcerer's Apprentice, the poem that Johann Wolfgang von Goethe composed in 1797. The apprentice uses one of his teacher's spells while he is away. But he loses control of what he has unleashed. "The spirits that I summoned," the distraught apprentice exclaims, "I cannot now rid myself of them."

On the other hand, I believe that artificial intelligence has stirred positive spirits as well, and they are prevalent in indus-

If data is the oil of the 21st century, then artificial intelligence is the drilling rig, refinery and filling station all rolled into one.

try. AI is a tool that can help us be better at what we do. It can help us understand processes and design them more efficiently – from logistics to production all the way to research and development. This allows us to keep improving our products and the quality of our work. It will help us continue to be successful and innovative in our highly industrialized world, despite the shortage of skilled workers. And not least of all, AI helps us work more sustainably by reducing the consumption of energy and resources. That shows that AI is not just a topic of conversation today. It ought to be on the mind of every corporate decision-maker. These developments started long before ChatGPT. Welcome to the AI era. ◎

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Better Navigation

In May 2022, the natural gas tanker Prism Courage was completing a feat unmatched in the history of shipping. The 122,000-ton ship crossed the Pacific from Mexico to South Korea totally on its own. An autonomous navigation system took control during the voyage, with an AI system helping to select the best possible route and speed. The technology enabled the Prism Courage to undertake more than 100 evasive maneuvers without the crew becoming involved. The interaction between the navigation system and AI also allowed the ship to react independently to weather conditions and wave heights. The tanker not only made the crossing without a hitch – the autonomous system boosted fuel efficiency by 7 percent compared to manual navigation. ◎

The tanker depicted here is not the Prism Courage.

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Improved Prostheses

When someone loses one or both forearms, arm prostheses make a huge difference in the person's quality of life. The use of artificial intelligence can make the experience of wearing and using prostheses even better. In a sense, they can be controlled with the power of thought. The prosthesis manufacturer Ottobock is considered a pioneer in the field. Using electrodes on the residual limb, AI helps to classify and strengthen nerve signals as they arrive. Over time, the prosthesis learns to translate the signals into the right movements. That means people wearing the prosthesis no longer have to learn to interact with it. The learning process is turned over to the prosthesis. Movements become faster, more precise and more intuitive in short order. ◎

Reliable Forecasts

Earthquakes are a reminder that the forces of nature can strike unexpectedly. Scientists have not been able to forecast earthquakes so far. But now researchers at the University of Texas at Austin seem to be on the right track. According to a study in September 2023, the team succeeded in forecasting 14 earthquakes over a period of 30 weeks. And they did so in southwest China with a one-week lead time. An amazing feat even though the locations turned out to be about 300 kilometers (186 miles) off. AI also sounded eight false alarms and failed to signal an additional earthquake, suggesting that the system still needs improvement. It was trained to identify statistical anomalies in the earth's electromagnetic field and geo-acoustics. ◎

Dr. Matthias Sckuhr

As Chief Operating Officer (COO) and Chief Technology Officer (CTO), Dr. Matthias Sckuhr is responsible for Operations; Lean; Supply Chain Management; Purchasing; Quality Management; and Health, Safety and Environment (HSE). He also oversees Innovation Management; Process Technology; and Product and Material Development.

STRATEGY TALK

Efficiency

Is artificial intelligence changing companies' everyday life? In an interview, Dr. Matthias Sckuhr, Chief Operating Officer (COO) and Chief Technology Officer (CTO) of Freudenberg Sealing Technologies, talks about data, risks, and optimism. He also explains how AI can support quality control and material development in the future.

> "There will be tasks that AI can handle better than us. But we shouldn't be worried. We would, otherwise, merely march in place."

DR. SCKUHR, HOW DO YOU DEFINE ARTIFICIAL INTELLIGENCE?

The exciting question is what is intelligence? It was recently described by someone as the capacity to handle tasks whose solutions are not obvious. I liked that a lot. In turn, artificial intelligence formulates large volumes of data and then makes a decision or prediction based on learned patterns. But that's only a technical definition. What I consider crucial is the fact that AI helps us handle tasks more effectively, and quickly. A Large Language Model (LLM) such as ChatGPT was certainly a revelation for many people.

BECAUSE AN LLM OF THIS KIND CAN DO MORE THAN JUST GENERATE TEXTS?

It can take over tasks for us, such as those of a programmer. Consider the programming of the control elements in our machines. They always have something that needs to be reprogrammed. We gave an LLM a user manual as a test, and in half an hour it was capable of writing programming code. People have to spend time learning this skill and being trained. This shows that AI offers extraordinary options: We will be able to use the results of AI to make the finishing touches, perhaps changing a few lines of programming to get the results we want.

WHAT IS IMPORTANT WHEN USING AI?

When the decisions are made, there must always be a human to critically assess the outcome. Our company has to make sure that the specifications have been sufficiently defined if we have code co-developed by software. We have all had experiences with AI prompts that are formulated in different ways but are seeking the same information. They lead to different results. The use of AI does not eliminate the need to watch out for risks. How do we guarantee that the system has not violated trademark or intellectual property rights? How do we guarantee that AI is always fed the right data? How do we ensure that our data remains in our company? These are all important questions.

BUT YOU ARE CONVINCED THAT THERE WILL BE ANSWERS?

I am convinced that we have to recognize the opportunities and take advantage of them because there is a growing shortage of qualified personnel. There will be tasks that AI can handle better than us. But we shouldn't be worried. We would, otherwise, merely march in place. There have been anxieties and misgivings every time a technical innovation comes along, including the advent of robots and the invention of the automobile.

HOW WILL AI CHANGE THE WORK OF FREUDENBERG SEALING TECHNOLOGIES?

First off, we are focusing on how AI can improve work, not on how we can replace people. With AI, we will be able to increase the amount of automation, speed up processes and become more efficient in both administration and production. Take our Failure Mode and Effects Analysis (FMEA) document. It requires continual updating. It enables us to minimize risks and improve our quality. AI could help us with that. I also see considerable potential in reassessing and reevaluating old test data with AI. That is a treasure trove that we can leverage. Risk management can also benefit from AI. So can quality control. We can optimize sales and supply chains. We can forecast demand more precisely, to cite just some aspects of the technology.

SO PROCESSES WILL IMPROVE?

Yes. Our machines are already storing a great deal of data that we aren't using yet. Process chains are really connected and even today, AI can propose improvements in sub-sectors. The sustainability piece is exciting: When we use our machines more efficiently and with fewer interruptions, less CO_2 is released. And if we set our parameters correctly from the outset thanks to AI, we produce less scrap, since one-third is generated when machines are started up or adjusted.

WILL AI SUPPORT MATERIALS RESEARCH IN THE FUTURE?

Yes. We have been working on that for quite a while and have already been successful with polyurethanes. In the future, we

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Today it is impressive how you can teach AI to tell the difference between a flawed and a zero-defect part."

will try even harder to take advantage of the structured data in our elastomer database by using AI. The goal is to find new ideas for recipes and processes. Materials are always a compromise among various factors such as longevity, tensile strength, compression and other physical characteristics of polymers. Good chemists need a great deal of expertise and fundamental knowledge, plus long experience. AI will help to accelerate statistically valid tests and identify connections.

DO YOU SEE THE RISK OF NEW IDEAS EMERGING AT THE END FOR WHICH WE CAN NO LONGER UNDERSTAND THE CONNECTIONS?
No, our chemists' knowledge will not be lost. You don't have to make AI learn new physical connections. Everything that chemists and engineers know, can be shared with AI. In this way, we benefit from the interplay of AI and physical knowledge. In the end, you get data-based proposals that can then be examined and understood.

HOW DID FREUDENBERG SEALING TECHNOLOGIES BECOME SO SUCCESSFUL WITH OPTICAL AI?
Because we began to invest in optical inspection systems more than 20 years ago. Vision control is a prerequisite for improving processes. That's no surprise when you have 6 billion seals being produced annually and rising quality standards. Today it is impressive how you can teach AI to tell the difference between a flawed and a zero-defect part. You once needed thousands of examples to train systems. Less than 100 are now sufficient.

DO CUSTOMERS EXPECT THE USE OF AI?
Customers expect us to use innovative technologies to improve their products and services. They expect us to be efficient and fast. They want us to be good. AI helps with all of this.

YOU ADDRESSED THE DATA ISSUE EARLIER. WHAT DOES A COMPANY HAVE TO DO TO PREPARE ITS DATA FOR AI?
When we talk about AI, we actually mean Advanced Data Analytics in many cases. AI interprets data. That's why every company has to consider how it gathers and stores data, how it integrates the information into the environment, how data quality is ensured, and how access to the data is regulated, and so on. The IT infrastructure has to be scalable. You basically have to think of AI as the tip of an iceberg — and the great vastness beneath it is extremely important, meaning the safeguarding, storage, integration, structuring, transforming and extraction of the data. Without all that, we won't get anywhere with AI.

WHAT ROLE WILL AI PLAY IN THE AUTOMATION OF THE FACTORIES OF FREUDENBERG SEALING TECHNOLOGIES?
With the automation of our processes, we are achieving a more efficient utilization of our equipment and even better quality. When machines run continually, we need fewer of them overall and can harmonize our energy consumption. We become more sustainable.

IS AI OVER- OR UNDERESTIMATED?
You can overestimate the technology if you have unrealistic expectations for its capabilities. But you can also underestimate it if you fail to consider the time factor. When I think about how quickly ChatGPT caught on, compared to Google establishing itself, that is an incredible acceleration curve we are on.
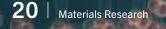
COULD AI TAKE OVER YOUR JOB?
I don't think enough of my job is routine for that to happen. But AI can definitely help me analyze data or structure a way of looking at problems. ◎

BY THE NUMBERS

1950

The question has been raised since 1950: At what point is artificial intelligence deemed to be intelligent? 1950 was the year that computer scientist Alan Turing developed a test that was supposed to answer this very question. The Turing test has a simple premise: If you have a five-minute conversation with a machine without noticing that you are talking with one and not with a person, it has passed the test. But this yardstick has a problem: Just because a system acts as though it understands a question, that doesn't mean it necessarily does. This is not a reliable way to determine whether a machine is intelligent. The year 1950 marked the start of a journey that is still underway today. There is still no clear indication of the exact point when a system is considered intelligent. Mankind has not yet found a way to draw a sharp line between apparent and true artificial intelligence. How long will it take? ◎

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Firing up the Turbo

In the materials field, research and development takes time. Artificial intelligence is a promising tool for accelerating the process.

E arly periods in human history vividly illustrate how mankind has adapted more and more materials to suit its own purposes. The materials improved everyday life and gave their names to entire epochs. In the Stone Age, people were still limited to natural materials – whether it was stone, wood, bone or ivory. Then people began to deliberately produce materials such as bronze, which is made from copper and tin. Iron, which is extracted from ore, followed later. The idea behind all these developments is still valid today: People were experimenting with available materials, gaining experience that paved the way to new ones.

Steadily Improving Processes

In the beginning, the advances occurred over many centuries, but materials research and development began to take off in the 19th century, at the latest. This was largely due to increasingly sophisticated processes. The experimental synthesis aimed to produce new compounds using defined chemical reactions. The newly created materials were designed to have exceptional, made-to-order characteristics. Success depended on choosing the right starter materials and subjecting them to predetermined chemical reactions. Experimentation has remained the basis for developing materials with the desired characteristics, albeit guided by an

Research will continue to depend on work in the lab. But AI can greatly accelerate processes.

32 million

That's the number of materials that Microsoft investigated, with the help of AI, in nine months to find an appropriate candidate for innovative new batteries.

impact on material properties. Friederich says the goal is to produce the most promising candidates in the lab to validate the predictions. AI's ability to suggest additional experiments based on automated experiments is another strength, he adds.

Huge Time-savings with AI

Artificial intelligence clearly has what it takes to reduce the effort and time required for materials research and development. That's an appealing prospect for departments and institutes that do research and development – especially in sectors with strong competitive pressures that shorten the development timeframes. Google subsidiary Deepmind got people's attention on the question of AI's potential in late 2023. It announced that it had identified two million new materials in one year with AI's help. The company drew on a database containing the descriptions of about 50,000 materials from researchers around the world. It believes that 400,000 of the new compounds could be produced in short order under lab conditions. They could prove helpful with the production of faster computer chips, more efficient solar panels or higher-performance batteries.

A team from Microsoft has advanced further along these lines working with one of the U.S. Department of Energy's research institutes. Using several AI models over a nine-month period, the staff analyzed 32 million substances with the goal of identifying the most promising material to improve battery performance. By comparison, the development of the lithium-ion battery took about 20 years. The cooperating research institute is currently testing a recipe proposed by AI that consists of lithium, sodium and other elements. If successful, it could reduce the lithium content in batteries by up to 70 percent. Microsoft Vice President Jason Zander was euphoric as he described how quickly the highly promising battery material was identified with AI's help. "We are at the dawn of a new era of scientific discovery." ◉

We are at the dawn of a new era of scientific discovery."

Jason Zander, Executive Vice President of Strategic Missions and Technologies at Microsoft

expanding store of experience and more expertise than ever before.

In the 20th century, the application of new technologies gave materials science another boost. The electron microscope made it possible to explore the structure of materials down to the atomic level, which led to new developments. High-tech processes resulted in completely new possibilities for research and led to a sudden increase in the availability of materials. The introduction of computers gave science another effective tool, enabling the simulation of characteristics, among other things.

More Effective Methods Thanks to AI

And yet, even more opportunities are opening up in materials research. There is an endless supply of materials waiting to be discovered, according to Dierk Raabe, Director of the Max Planck Institute for Iron Research in Düsseldorf. "We are still using 'only' a few thousand of the various types of metal alloys out of a seemingly infinite universe of 10^{60} or more potential combinations," he said in an interview published in 2023. He believes that scientists and engineers need a better understanding of basic interrelationships. They especially need new, much

more effective methods to discover novel materials. It is clear to Raabe that this means using artificial intelligence.

A researcher's knowledge and experience are still key factors for recognizing and evaluating the potential of new materials. But Big Data analyses, text mining and machine learning can simplify research processes in many ways. AI can scour thousands and thousands of technical articles for certain topics and terms, exposing the target connections more quickly. Artificial intelligence also can develop materials virtually before the physical experimentation takes place in a lab. This raises possibilities that sound like fantasies. For example, Prof. Pascal Friederich of the Karlsruhe Institute of Technology (KIT) says that AI can predict "the characteristics of several million materials" based on the results of about 1,000 simulations. In the process, he says, AI took different formulations into account, along with the production conditions that have a major

A Shadow Brings Light into Darkness

Materials are sensitive. If the granule of thermoplastic polyure-thanes is a bit too moist, the quality of the parts made from it suffers. Freudenberg Sealing Technologies is putting a stop to the problem, with the help of a digital shadow.

Sometimes it is the small things that make all the difference. Process engineers at Freudenberg Sealing Technologies are aware of this. Thermoplastic polyurethanes (TPUs) are among the main materials used in the manufacture of hydraulic and pneumatic seals like those found in excavators' mobile hydraulics. Their quality contributes to the functionality of crucial components. If the TPU granule is only slightly too moist, its flow behavior changes during the injection-molding process. The result: Polymer chains are unable to form sufficiently. Then qualities such as tensile strength and elongation-at-break are not as good as they should be.

The Goal: 24-hour Monitoring

So, if you don't want to find out at a quality inspection that an entire batch of manufactured parts is defective, you have to start with the storage of the materials, in this case, TPUs. At the company's Schwalmstadt plant, north of Frankfurt/Main, Germany, they are stored in 6-ton silos. The determination of granular moisture is carried out manually. The silos must be opened for the samples to be extracted. But the process is only a snapshot. "What we needed was 24-hour monitoring," recalled Armin Hermann, Manager of the Material Lab at Schwalmstadt. He has recently attained that level of monitoring as head of a 12-person project team.

Artificial intelligence was the key to success. But there was plenty of work ahead of the participants before they reached that stage. Process engineers in Schwalmstadt and a team of Freudenberg Sealing Technologies IT experts first had to learn to speak the same language. "Perhaps putting it a bit too simply, you can think of it as Analog 2.0 meets Industry 4.0," Hermann said. "Two worlds came together in one project team." Although communi-

cation was an obstacle at the start, the two groups were soon getting along better and better. To write an algorithm, it was important for the IT experts not only to understand certain plant processes – they had to completely immerse themselves in them. "We asked question after question to comprehend the problem and the process," said Data Scientist Anna Lüders, a member of the in-house Advanced Analytics Team. It was her job to create the simulation model that enabled precise forecasts of moisture levels in TPU granules.

The Solution: a Digital Shadow

A machine-learning model had to be developed to determine the TPU's residual moisture. The model was based on the construction of a structured data transmission and storage system. Experts on a Freudenberg team devoted to MES and IIoT systems were responsible for the model. The database's foundation was data that had been collected

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Digital Twin vs. Digital Shadow

A digital twin and a digital shadow allow real-time monitoring of a real object (for example, a silo). Both gather information and analyze events and processes relating to the object and provide collections of data. An interaction with the real object is only possible with the digital twin, however.

manually. To enrich the information with current data, the team installed sensors inside and outside the silos. They capture temperatures and atmospheric humidity in each case. Other parameters such as storage duration go into the database as well. The moisture content of the granules can be derived from these indicators. Manual measurements have been reduced. But they continue to be needed to compare real figures with the values from the algorithm that IT expert Lüders developed. It quickly became clear that the work had paid off. "Our samples show that AI forecasts of moisture content in the granules deviate by merely 0.005 percent from the results of the manual analytic measurement," Hermann said. Certainly a negligible difference.

By the way, "digital shadow" is the technical term for the kind of system set up in Schwalmstadt. It took the team a year to develop it from an idea to a successful implementation. Today, the moisture of the granules is calculated and visualized automatically. If limits are exceeded, the system triggers an alert so that the process technician on site can promptly intervene. This ensures that TPU granules with the proper quality reach the production process – a fact that one major customer has been able to verify multiple times. Before production, the company always gets a sample from the batch it is due to receive. Since AI has been part of the monitoring process, the material has not been rejected a single time. "This has added to our customer's confidence in us," said Hermann, the project manager, "even though we have not changed the recipe for the material. With AI's help, we are simply optimizing physical features."

The Benefits: Identifying Interfering Factors More Easily

Yet another benefit was drawn from the visualization of the processes. Some materials have to be aged artificially. This involves feeding warm air into

the silos over a specified period. Measurements of the exhaust air have now shown that the heat generated there is never reached. Tests showed that the insulation of pipes and a part of the silo was sufficient to achieve the same aging effect with the input of less hot air. This insight will help save energy. As its next step, the team will tackle a different topic: dust development in silos. Dust particles promote the formation of foreign bodies that pose problems in injection molding.

"We are completely satisfied with the simulation model," Hermann said. "For one thing, because we finally have answers to the questions that have been unanswered so far. For another, because we see some of our theories being confirmed." Lüders sees successes being achieved that fulfill the early promise of AI. "With the help of a digital shadow, we are identifying process deviations earlier and we are improving process stability as a whole. The sources of disruptive factors are easier to identify today, and our process expertise is increasingly growing in a structured way." This is all clearly added value – thanks to the use of a digital shadow. ◎

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>
> ## With the help of a digital shadow, we are identifying process deviations earlier and we are improving process stability as a whole."
>
> Anna Lüders, Data Scientist,
> Freudenberg Sealing Technologies

Right: The granule stored under perfect conditions arrives in the injection molding machine.

Below: The granule is stored in these silos where AI records its moisture content in real time.
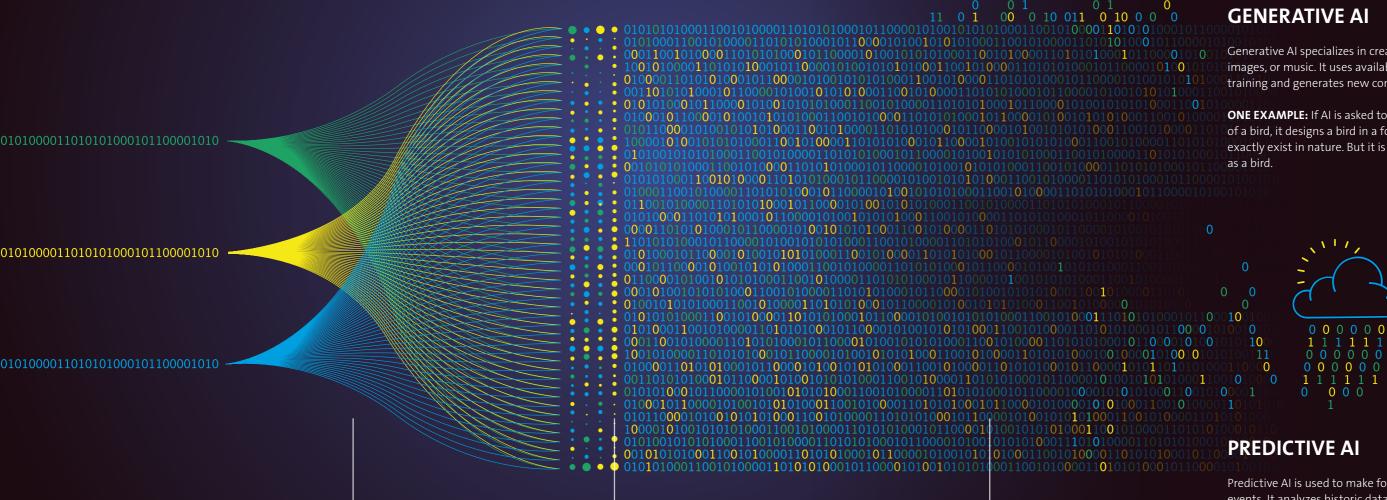
Generative AI vs. Predictive AI

At first glance, generative AI and predictive AI are quite different. We already encounter both types in our daily life. Yet, even if they pursue very different goals, they have much in common.

GENERATIVE AI

Generative AI specializes in creating new texts, images, or music. It uses available data for its training and generates new content from it.

ONE EXAMPLE: If AI is asked to generate an image of a bird, it designs a bird in a form that doesn't exactly exist in nature. But it is clearly identifiable as a bird.

PREDICTIVE AI

Predictive AI is used to make forecasts about future events. It analyzes historic data and draws on the information to compute probabilities, and they, in turn, become the basis for predictions.

ONE EXAMPLE: Historical weather data is used to train AI. In turn, it computes probabilities that it uses to predict the weather.

Captures Data
During training, both types of AI are fed large volumes of data. The purpose behind the use of AI determines the type of data.
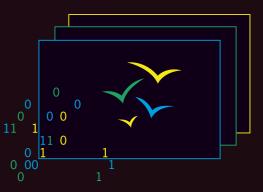
Recognizes Patterns
Both forms of AI use machine learning to identify patterns in huge volumes of data. The more data they get, the clearer the patterns become.

Makes Assumptions
Based on these patterns, both types of AI make assumptions. The main difference is what they do with these assumptions.

Turnkey Digital Intelligence

Cloud services are a common way to make artificial intelligence more widely available. They offer flexibility, save time and money, and make AI use possible in the first place for many users.

Artificial intelligence (AI) is penetrating many aspects of life. The technology is fascinating. When you give it a task, the work is completed and returned within minutes. Both companies and private individuals are using specialized providers, whether you see them or not. They mostly develop the solution with the help of AI models operating in the cloud. The results are then delivered to the user.

"Artificial Intelligence as a Service" (AIaaS) is the common term for the process. It has changed the way artificial intelligence is used – it's user-friendly and flexible. Some examples are voice assistants such as Amazon's Alexa, Apple's Siri and Google Assistant. They seem to understand questions spoken to them. In reality, they recognize the patterns of words and convert them into a task that a computer can solve. Simple acts are performed right on the device, without a deeper AI connection, such as "Set the timer for 15 minutes for me." More complex requests, such as "What will the weather be in San Francisco next week?"

are whisked into the cloud via a data line. After the solutions are created in the cloud, they are sent back and delivered as audio output.

There are special services for companies that use cloud-supported AI. The possibilities vary widely, ranging from image recognition to machine learning, data analysis, and speech processing. A few examples from the business world: An online dealer generates product recommendations based on customer behavior with the help of AIaaS. Or a bank lets AI check to see whether financial transactions show evidence of fraud. Advanced analyses and forecasting by AI are helpful in both cases. Telephone hotlines can also be based on AIaaS and operate with the help of AI.

Flexibility from the Cloud

"Cloud computing platforms are almost always the option because it takes a major technical effort to set up AI technologies on your own," said Pascal Sütterlin, Digital Business Development at Freudenberg Sealing Technologies. "Individuals or companies can benefit from the services as needed. They send over the tasks and then get the results back over the Internet in just a few seconds."

AIaaS has several benefits. In many cases, the services are making the use of AI possible for a user in the first place. Companies, developers and private individuals are turning to artificial intelligence without creating and maintaining AI models themselves – which is very expensive.

> ## Data security and data protection must be in place. That is the only way we can have full trust in the services."

Pascal Sütterlin, Digital Business Development, Freudenberg Sealing Technologies

By app: communication between the customer, AI provider and systems.

AIaaS thus saves time and money because there is a considerable amount of expertise built into the models. The software also requires extremely powerful computing centers. The requests don't come in one by one – many thousands arrive at the same time, and the senders want them all to be processed as quickly as possible.

There is another important feature of AIaaS: Customers are always using the latest AI. The providers are continually improving their AI models – at a fast pace. In many cases, they are using AI themselves. This allows them to keep up with the latest advances in machine learning.

Another crucial aspect is flexibility. Customers tap into the AI services when they need to. AI is always available at the level required for their current data needs or for the number of inquiries to be processed. If their needs increase, they assign more tasks. The experts call this scalability.

Multiple AI Services on One Platform

Consider Freudenberg Sealing Technologies: The company works with the cloud computing platform Azure. It offers numerous services, including AI. "We can very easily integrate the applications available via Azure into existing programs and platforms," Sütterlin said, describing a key benefit.

Major advances have been made in generative artificial intelligence over the past few years. For example, OpenAI is active in the field and made a splash with ChatGPT a while ago. Its latest Large Language Model, called GPT-4, is available on Azure. In addition, Copilot contains an AI-supported assistant for a wide array of everyday tasks. "We are monitoring these possibilities very closely. AI can certainly enhance many processes. Test projects are already underway here," Sütterlin said.

How can AI services be integrated into a company's own applications or infrastructure? Most AIaaS platforms make so-called APIs (Application Programming Interfaces) available for this. These are software interfaces, that is, programmed pathways for communication among customers, AI providers, and systems. They allow companies to use AI solutions easily and conveniently and access AI functions.

Since cloud-based systems routinely handle sensitive content, experts always keep data privacy and security in mind. "When they are in place, we can put our complete trust in the services," Sütterlin said. "That is the only way we can benefit fully from all the opportunities that artificial intelligence offers." ◎

"I am here."

NOW IT'S MY TURN

Leica M11-P

It takes credible photos to communicate news, and tell a true story. But digital content can be easily manipulated. Fake photos and artificially generated images are the result. They destroy trust in visual media. I am the answer to the problem. I am the world's first camera with a special chip to provide proof of authenticity. When my shutter release is pressed, I immediately store both the photo and a digital certificate directly into the image data. It contains camera and image information in encrypted form. Authenticity that a photo is an original capture can be verified at any time. Or whether it has been edited, and, if so, what changes were made to it.

I am a pioneer in the technology, although other camera manufacturers are turning to it as well. The process offers an added level of transparency and builds awareness of the origin of the image data. Authentic image material can be differentiated from manipulated content. The idea dates back to Adobe's Content Authenticity Initiative (CAI). About 2,000 members have already signed on to it, including media, image and news agencies, publishers, and software and hardware manufacturers. Credibility is of tremendous importance to everyone.

The first Leica camera was invented a century ago. Its M-series arrived 70 years ago, and my digital version has been around for nearly two decades. They document world events with authentic, meaningful photos, bringing them to life. This is still important work. ◎

Harvest of Data

Farmers today have to do more than operate machinery — they must also manage data. Artificial intelligence, Big Data and similar trends are turning farming into a high-tech business.

Farmers have to produce more and more today — and do it with less. The world's population is growing and the demand for food is rising. As a result of growing prosperity, meat and milk products are increasingly in demand. The problem is that resources are not keeping pace with demand. On the contrary: Climate change is spawning extreme weather, including drought and water shortages, that is endangering crop yields. Monoculture farming is degrading soil quality. To guarantee food security, the agriculture sector has to increase yields while consuming fewer resources.

High Tech for Maximum Precision

"The only way to meet the challenges of the future is to bring technology to agriculture," said Deanna Kovar, John Deere's Chief Executive for Europe, in her keynote address at the Consumer Electronics Show (CES) in Las Vegas in January 2023. John Deere is a leading global manufacturer of farm machinery. Kovar highlighted the company's latest smart technology — "See and Spray"— which can automatically identify weeds. The system that uses AI and high-speed cameras is installed directly in the boom for plant protection spraying. It scans the terrain during one pass over the field and calculates how much of the plant protection agent is required. As an alternative, the information can also be fed into an autonomous hoeing machine. With the help of highly accurate GPS controls, it hoes weeds out of the crop rows. This makes it possible for crops to be treated exceptionally early, substantially reducing herbicide use.

Smart Agriculture

With high technology, farmers can maximize their yields, cut costs and reduce their consumption of resources. Innovations such as artificial intelligence, Big Data and precision farming are important drivers, as are robotics and predictive analysis. The market for smart agricultural technologies grew to about US$15 billion in 2022. It is expected that this figure will at least double by 2027. For more than two decades, a lively start up scene has been developing in the ag-tech field. Smart people all over the world are working on ways to make farming more efficient and sustainable, in fields ranging from monitoring tools and financial systems to renewable fertilizer. In her keynote speech, Kovar made it clear that John Deere is more

than just a manufacturer of agricultural machinery — it is becoming a smart industrial company. "The leap forward is not just crucial for companies but for every farmer, the entire industry and future generations."

From Tractor Driver to Data Manager

Although autonomous tractors are already cultivating fields in the United States, no one is talking about the widespread use of smart machines. Why not? There are still some technical challenges. For example, systems and applications must be harmonized so they can communicate smoothly with one another. Network coverage must be able to expand into remote areas, and data protection must be seamless. Human factors can present additional obstacles. As with any invention, people have to believe in and trust the technology before they will take advantage of it. Farmers also have to rethink the way they plan their work: While autonomous machines are cultivating their fields, they must be programmers, quality inspectors and data managers. Their decisions are no longer solely based on their personal expertise — they are data driven. To evaluate the data, farmers have to draw on their own understanding of the information. It also takes human reasoning to decide how the information is ultimately used — whether to maximize yields, to conserve resources or to keep the soil in good condition. And that is the crux of the matter. If you want to produce more with less, you have to keep two things in mind: economy and the environment. ◉

3rd Place

on the list of most influential agricultural innovations goes to artificial intelligence. Robotics comes in second, and the Internet of Things takes the coveted honor of first place.

"A Great Deal of Unused Potential"

Artificial intelligence and sustainability are two of the most critical issues of our time. They are crucial to the economy as well. But how can they be combined?

David Koch is confident that "it will be increasingly normal for companies to use artificial intelligence." He is a researcher at the Fraunhofer Institute for Manufacturing Engineering and Automation (IPA), specializing in digital sustainability management. "We wondered how companies were already using AI to make improvements in this field. And we wanted to know how businesses could use it in the future," he said. What emerged was the study "Sustainability through AI – Opportunities and Action Guidelines for Manufacturing Companies." In it, Koch and his colleagues identify current cases where AI has had a positive impact on sustainability. The study also has recommendations for companies who are considering using AI to meet their sustainability goals.

Improving Sustainability

"The companies that we studied are not using AI to improve their sustainability as often as they could. There is still a great deal of unused potential out there," Koch said. "In any case, using AI is an option whenever high data volumes go hand-in-hand with complex applications." It is not just a matter of limiting CO_2 emissions in environmentally conscious industries. "Sustainability encompasses much more," he said. It involves the more efficient use of energy, less scrap and better use of resources. "There are many opportunities to improve a company's sustainability with AI," Koch said.

The Fraunhofer IPA study cites many cases where the use of AI has helped a company use fewer resources in its operations. For example, AI supports predictive maintenance, that is, the proactive maintenance of machines in manufacturing. The applications help to predict precisely when a machine will need maintenance, or a part will have to be replaced. This results in fewer replacement parts

David Koch

David Koch studied mechanical and industrial engineering as well as environmental science. He has held various positions in development and certification at Daimler Trucks and Mercedes-Benz. In 2022, he moved from practice to theory, becoming a research associate at the Fraunhofer Institute for Manufacturing Engineering and Automation (IPA). The focus of his work and research is on digital sustainability management.

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>
> The use of AI is an option wherever there are complex applications with high data volumes."

being installed, and unplanned machine shutdowns occurring less often. AI applications are also helping to optimize production processes. For instance, AI can help a machine operator reset parameters when recycled material has to be used in injection molding. This may be needed to meet regulatory requirements. "With the help of AI, a machine can be adjusted to changes in a material's composition – quickly and during ongoing operations," Koch said.

Reducing Energy and Resource Use
The study sees still more opportunities for using AI in quality management: Optical monitoring systems in combination with AI-based image processing can quickly detect product anomalies. Quick corrections make it possible to reduce scrap. When used during the planning of manufacturing facilities, AI can help to boost the energy efficiency of production lines. The same is true in logistics, where the new technology is now enabling dynamic route planning. In purchasing, AI can keep an eye on the company's entire supply chain and predict purchasing risks. This can lead to more stable and flexible supply chains and reductions in resource use.

Koch says that anyone thinking about improving sustainability must first consider two questions: "Is AI really the right tool to solve my problem? And, if yes, do I have enough data in the right form?" Without the right bank of data, AI cannot be trained. "During training, the application has to be fed company data," he said. "So, the first step is to find out whether there is enough data in a form that AI can process." If not, it will take a lot of work to get the data structure that the company needs. "The training of AI can only begin when it is in place," Koch noted.

i

Measuring Sustainability

How does one measure if AI applications improve a company's sustainability? The study from Fraunhofer IPA provides some ideas on this: First of all, companies should develop a general sustainability strategy from which concrete goals can be derived. The goals must be analyzed to see which of them can be met with the aid of AI applications. If the decision to use AI is made, there must be an inventory of previous resource use before AI is introduced. Once AI is operational, it is important to track resource use again. The difference shows how effective AI actually is in improving sustainability and whether the goals have been met.

CO₂ Emissions from Training
Yet the training itself can be a weakness. Under certain circumstances, the AI application may consume a great deal of energy and cause high CO_2 emissions. "Of course, this always depends on the type of application," Koch said. The models vary in terms of the amount of effort and energy it takes to train them. The training of large, generative AI systems is very resource intensive. "But relatively small applications, focused on a specific area, are mostly used in industry," he said. "When they are trained, they normally produce no more CO_2 emissions than streaming a one-hour video." So, if you want to cut down on emissions or become more resource efficient by using artificial intelligence, you invariably have to ask yourself: How much CO_2 from the use of AI is worth it to me? "These are two entirely different dimensions that cannot be set off against one another very easily," Koch said.

Greater Energy Efficiency in the Future
But it is clear to Koch that "every company must increasingly consider sustainability issues in its cost-benefit calculations. This will make the use of AI an ever more important consideration." Koch has a positive attitude about the future, even regarding resource-intensive training. "I am sure that substantial gains in efficiency will emerge from further research – both in processor technology and in the algorithms that are used." Despite all these prospects, Koch advises companies to act with a sense of proportion. "AI support won't be needed when there are other easily achievable ways to improve sustainability." But when all the conditions are met, AI can do a lot to make business more sustainable in the future. ◎

FASCINATION TECHNOLOGY

Reliable Sealing for Busbars

Copper or aluminum busbars ensure the flow of electricity in the drive-trains of electric vehicles. However, their rectangular cross-sections make these conductor rails hard to seal. But that concern is a thing of the past, thanks to an innovation from Freudenberg Sealing Technologies.

Initial Situation

Busbars are built into many different applications to handle high levels of electric current. Manufacturers of electric vehicles like to use these robust rectangular conductor rails. For example, in the car's charging system, battery management system and the electric drivetrain. Since electric cars often have oil-cooled electric motors, the sensitive power electronics of their inverters have to be protected against leaks. One potential entry point for the oil is the conductive busbar, which is encased in a plastic housing. So, it is important to seal the gap between the two components effectively.

The Problem

As a matter of fact, the busbar's rectangular cross-section is technically challenging for manufacturers of conventional seals. Unlike round designs, the corners of the conductor rail make it harder to compress the sealing material evenly onto the surface. The seals, therefore, remain susceptible to leaks as the copper heats up and expands while conducting electricity, and contracts when it cools. The process of constant expansion and contraction occurs more quickly for copper than with plastic and sealing materials. This makes it easier for fluids to slowly penetrate the part.
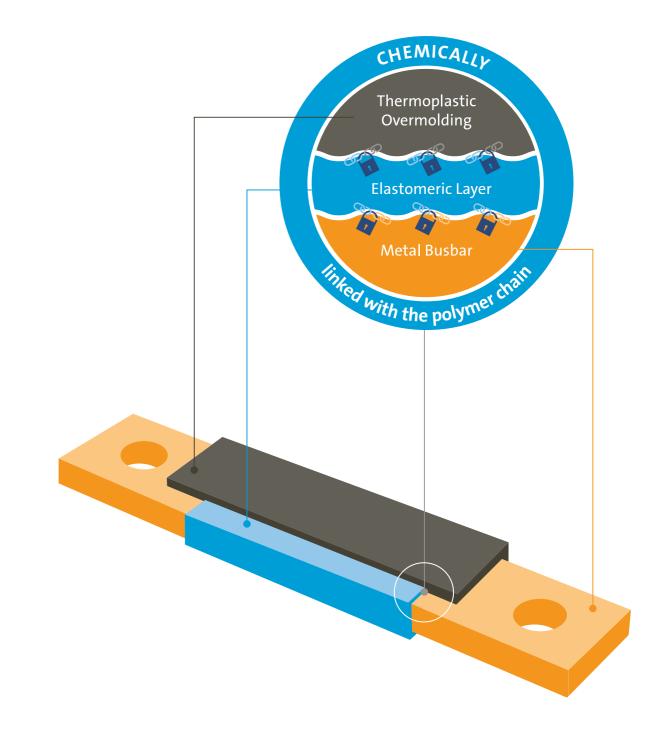
The Solution

Previous sealing solutions have not been sufficiently reliable in preventing leaks. They have also required extra space, which has an impact on the design of the busbar module. That is changing with the innovative elastomer seal from Freudenberg Sealing Technologies. The highlight: It doesn't produce a mechanical connection – it brings about a chemical bond between the components. With the application of heat, the molecule chain of the sealing rubber bonds integrally with the copper and the plastic. Three components become one part, which prevents the intrusion of oil even at temperatures far above 100°C (212°F). ©

CHEMICALLY

Thermoplastic Overmolding

Elastomeric Layer

Metal Busbar

linked with the polymer chain

Learn more about innovative elastomer seals at FST.com

> "
>
> Thanks to AI, we have improved our ability to detect whether a rejected part actually shows a deviation from the norm."
>
> Dr. Helmut Hamfeld, Senior Engineering Specialist,
> Freudenberg Sealing Technologies

I See What
You Don't See

If a product is identified as flawed and discarded after final inspection, and it's not even defective, that has an impact on costs — and, in lean terms, qualifies as waste. With the help of AI, Freudenberg Sealing Technologies is significantly reducing its pseudo-scrap rate.

It goes without saying that products leaving Freudenberg Sealing Technologies plants must function flawlessly. Aside from smooth-running manufacturing operations, it takes reliable quality control to guarantee high performance. But ostensibly defective products may be rejected even though they are actually problem-free. To reduce the scrapping of these parts, the seal maker is turning to the use of artificial intelligence in automatic visual inspection at some plants. The results are gratifying, according to Dr. Stefan Geiss, Vice President, Process Technology. "The use of AI in our final inspections helped us reduce pseudo-scrap by 50 percent, leading to a decline in total scrap," he says. "That translates into fewer wasted resources."

This shows that automatic visual inspection can be significantly optimized by using AI. "Thanks to the adaptation, we can more easily discover whether the rejected product actually deviates from the norm, or whether a shadow has produced a false result," says Senior Engineering Specialist Dr. Helmut Hamfeld. "AI allows us to better differentiate between subtle differences." Here it was in Freudenberg Sealing Technologies' best interest to harness the added value of artificial intelligence.

Building an In-House AI Expert Team

Five years ago, the company began to build up its own AI resources by forming an advanced analytics team. One of its first tasks was to tackle the implementation of artificial intelligence in final inspections. The team worked on a pilot project at the Oberwihl plant in southern Germany in close cooperation with an expert group on site. This collaboration is crucial for the successful introduction of AI. Dr. Steffen Wissmann wrote the algorithm that makes sure that less pseudo-scrap is generated. "To start with, the basic decision was the choice of a suitable AI model that could be easily integrated into our processes. Then it was a matter of working with the expert group and carrying their requirements into the algorithm," he says.

The classification of the image material – which shows what a good or a bad part is – took place in Oberwihl. This type of data set is the basis for training AI and is essential to its performance and improvements in final inspections. Each participant learned something from the introduction of the system. Wissmann summed up the lessons learned: "We noticed that it can be a disadvantage when a specific product is evaluated as good or defective by different people. Inconsistencies in the data can result, and AI ultimately doesn't know

Above: Thanks to artificial intelligence, pseudo-scrap has noticeably declined.

Below: In some plants, AI is now supporting final inspection and production processes.

what to do with them. So, we are proposing that the complete data set used for training AI be based on the judgment of a single competent person." In the end, a simple set of rules resulted from these experiences. They include the rule that people should not change parameters on their own. This is important during normal operations, and even more crucial when AI is involved. The AI solution is now being used at two additional plants.

Identifying Errors When They Appear

At its North Shields facility in northern England, Freudenberg Sealing Technologies has adopted another AI-optimized, automatic visual inspection system. But in this case, it involves a molding machine during the production process. The system recognizes whether the mold or the cavity into which the sealing material is pressed is free or still occupied. When an alarm quickly sounds, the part still in the mold can be removed quickly. "We are identifying errors as they come up and not at the very end of the production chain," Hamfeld explained. "This leads to less mold damage, and we were able to reduce the need for replacement parts. Moreover, we are reducing machine downtime significantly. For one thing, because errors can be rectified quickly, and for another, because there is less damage to repair." Another positive side effect is that production processes can be accelerated. Thanks to the latest experience, the system is due to be introduced at plants in Spain, Mexico, and Turkey.

Freudenberg Sealing Technologies has developed extensive experience and expertise in the use of AI in automatic visual inspection. The company is now turning to machine controls to test another AI application. This involves the use of up to 3,500 measuring points and sensors to capture the heating time or pressure conditions in seal production processes. If the data is within a range that does not guarantee a good result, there is an immediate prompt to adjust the parameters. It will take some time to implement the process. But it would be a step toward reaching a desirable goal: a zero-error, automated process chain that would make final quality inspections unnecessary.

50%

less pseudo-scrap is generated at the Oberwihl plant thanks to the use of AI in final inspections.

Less Pseudo-Scrap, More Sustainability

"We are aware that we now can solve a great many problems with AI that we were unable to solve before. But AI is not a silver bullet," Hamfeld says. "We are still seeing that our engineers have such specialized knowledge that we are unable to configure it into an AI application." Gaining an understanding of how AI makes its decisions continues to be a challenge as well. But the advanced analytics team and AI expert Wissmann are making progress in this area. "We are now using algorithms that allow us to check the correlation underlying AI with regard to causality," he says. In any case, the advantages of AI use at Freudenberg Sealing Technologies are uncontested, as Geiss points out: "We are gradually moving toward sustainable production thanks to AI. We are producing less pseudo-scrap and discarding less material as a result. This is improving our CO_2 footprint. That's also impressive." ◎
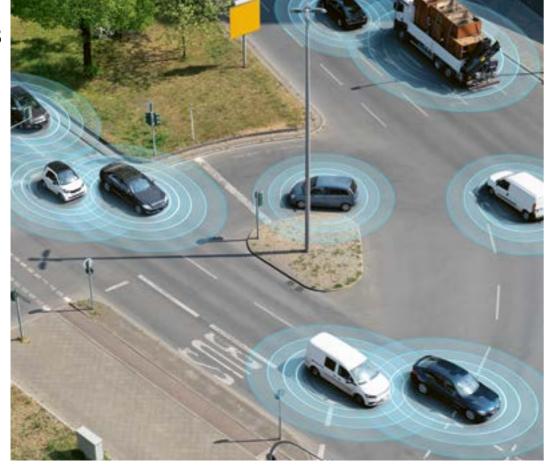
The Decade of Autonomous Driving

Autonomous driving represents a huge technical challenge. After all, its model — the human being — is remarkable in many respects. With their eyes and ears, humans have outstanding sensors, they process information on complex traffic situations effortlessly, and they guide the vehicle to its destination. What is the current state of autonomous driving? How important is artificial intelligence to the next steps? An appraisal.

Highly automated driving — that is the formal term for situations where a car travels through traffic independently, leaving the human free to perform other tasks. Technology is progressing in stages towards its most advanced capabilities. The American Society of Automotive Engineers (SAE) has defined five of them. Systems at SAE Levels 1 and 2 are widespread and on the verge of becoming commonplace. They are capable of parking the vehicle or maintaining a safe following distance in congested traffic. They are so smoothly integrated into daily life that they are not perceived as automated driving in many cases. Drivers must constantly monitor these systems and correct malfunctions. If there is an accident, they are held responsible — even if their vehicle fails to report a failure.

The state of the technology has now reached Level 3. At this stage, drivers can turn away from driving and the traffic environment for limited periods and under the right conditions. The first systems, such as the Personal Pilot L3 from BMW and the Drive Pilot from Mercedes-Benz, are on the market. The cars are capable of driving up to 60 km/h (37 mph) independently on appropriate stretches of highway. At this level, the driver can perform secondary activities, such as answering emails. A crucial difference from Level 2: The responsibility falls to the manufacturer.

Artificial Intelligence for Complex Driving Functions

Today, the control software can no longer do without artificial intelligence for complex driving tasks. "Classic programming

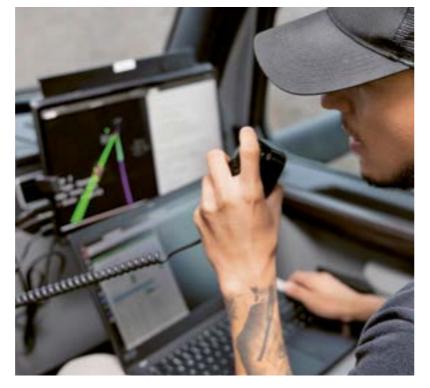Two demanding tasks are environment recognition and object classification.

"
Unlike the situation with humans, the technology for autonomous driving is uniformly responsive."

Harald Kröger, Sales Director and President, Automotive, at the American startup SiMa.ai

Advanced delivery transport: In the future, truckers will let the computer do the driving.

has reached its limit at this level. On the other hand, a combination of artificial intelligence, machine learning and neuronal networks understands the world more like a human being does and can understand abstractions – for example, the technology can recognize objects that it has never seen before," says Harald Kröger, Sales Director and President, Automotive, at the American startup SiMa.ai. "This is gradually expanding the capabilities of automated driving and enabling it to function flawlessly under difficult conditions or in unexpected situations." Kröger is confident that Level 3 systems will be in routine use by the end of the decade, and people will see significant benefits coming from safer roads and reduced driver strain. "In the cars of the past, the human being has been the least reliable link. In contrast, the technology's response never varies."

The scenario doesn't just apply to passenger cars, and higher degrees of automation may even be reached more quickly than many observers expect. Working with its Torc Robotics subsidiary, Daimler Truck wants to offer an autonomous truck at SAE Level 4 in the United States by 2027. It would operate between freight centers (hub to hub). "We are working with our partner, Torc Robotics, to develop autonomous driving for use on U.S. highways. For some time, Torc has been testing autonomous Freightliner Cascadia trucks with our freight customers," says Joanna Buttler in a Daimler Truck Blog. Buttler is in charge of the company's Autonomous Technology Group. "I am convinced that autonomous trucks will improve everyday life. Technology is no longer pure fiction or just an idea. It will become a reality this decade. And it has the potential to transform the transportation sector and offer huge opportunities."

Camera, Radar and Lidar

Freudenberg Sealing Technologies has many automotive customers, and Marc Knapp, Director, Division Product Pre-Development, is keeping a close eye on the market. He believes that autonomous driving will become routine. "Three types of sensors in particular are crucial for monitoring the environment and thus, for autonomous driving: cameras, radar and lidar. A lidar system certainly generates very high resolution, making it good at object classification. But it is expensive," Knapp says. "Radar by now provides enough resolution to identify and classify objects at a much lower cost. In addition, the use of different wavelengths compared to lidar makes it possible to see in fog, rain and snow and detect potential obstacles. Cameras and radar also work together very well. They complement each other in bad weather, and data fusion is very feasible, all at a lower cost than in combination with

"
The sensors will go into mass production. The most important development steps have already been completed.

Marc Knapp, Director, Product Pre-Development Division, Freudenberg Sealing Technologies

lidar. The latter is thus reserved for the higher vehicle classes and levels of autonomy."

There is still room for improvement because of the urgent need for high precision and robustness in some sensor components. Still, Knapp is impressed by the opportunities in the market. "Scaling the production process to very high volumes offers customers real added value, overall," he says. At present, development advances offering technical and commercial advantages are in the works. They will lead to widespread use of the technology in series production. "The most important development steps have already been taken," Knapp adds.

Systems Independent of Cloud Data Centers

Data paths, signal processing, and chip performance also have a crucial impact on the quality of the system. "Due to the high security requirements for autonomous driving, it makes sense to have the computing power inside the vehicle and to keep the artificial intelligence independent of cloud-based processing," Kröger says. "After all, what if the data connection is disrupted in a critical traffic situation and the technology fails? With a delay of just a millisecond, it could be too late to ask the driver to take over." Advanced chips and AI would create intelligence in the vehicle itself, operating without support from a data center. High-performance processing units for these applications are now reaching the market. "They will revolutionize the use of AI across the board," Kröger says. The chips also work very energy-efficiently.

After Level 4, the highest stage of development, Level 5, will follow. What will it look like? There will be no driver, and the technology will handle every traffic situation by itself. This scenario may still be off in the future, but it is coming – with the help of artificial intelligence. ◎

AI is opening up new possibilities in particle physics at CERN.

Correlation ≠ Causality

Artificial intelligence makes research and development extremely efficient. But in some cases, it becomes a black box. Why it's important to understand AI.

When artificial intelligence analyzes data, it's important to take a close look at the results. AI is looking for patterns and drawing conclusions. But not every pattern and not every correlation is necessarily an expression of a causal relationship. Consider a test of a medicine on a group with the same number of men and women. It shows that the medicine works better than a placebo. Then the test is separately repeated with female and male subgroups, and then the placebo works better. Thus, a blind combination of the data could suggest a causal connection that doesn't really exist. That might be the conclusion based on pure

common sense. So far, artificial intelligence is incapable of making that call.

Intelligent Particle Accelerators in Nuclear Physics

CERN, the European center for nuclear research, has worked with intelligent technologies for more than 30 years. When particle accelerators make atoms displace and collide with one another at the speed of light, detectors reconstruct their trajectories and a variety of other information that the experiment generates. This requires an enormous expenditure of computing power. Algorithms trained with machine learning help

make this possible. In 2012, with the use of artificial intelligence, the elementary Higgs-Boson particle was shown to exist for the first time. The discovery was important to understanding the standard model of particle physics. With AI's help, it was possible to simulate the collisions in advance on a computer and forecast what to expect. The systems use data from software libraries at CERN and the other labs around the world, compiling everything known about the interaction of particles and matter.

AI-supported research processes are highly efficient. They are also changing how

scientists look at data. Instead of creating standalone models and checking them with data, they can now give algorithms the job of creating a model. Deep-learning algorithms that simulate the neural pathways of the human brain are extremely promising for this task. One benefit is that AI considers data without human biases based on researchers' understanding of physics or their expectations. Thus, the researchers can stimulate new ways of thinking or research approaches that a human would be incapable of imagining.

Finding Explanations with "Explainable AI"

AI is also transforming the way research is done – everything from insights, theories and explanations to the data and applications. Even if the result is progressively improved efficiency, AI raises a range of ethical challenges. One example is the loss of trust when an AI system becomes a black box and the results can no longer be explained. Or when correlations point to connections that don't exist. "Explainable AI" is a way around this dilemma.

Researchers use transparent models such as decision trees to document a pattern from AI. Another tactic is to use a simpler model to depict a complex AI model and generate explanations with its help. This makes it possible to explain how AI operates before or after the fact.

A Focus on Researchers?

The use of AI involves exploiting the potential of intelligent technologies without making people or their creative output obsolete. The job of a physicist is considered one of the most secure when it comes to AI-related risks to employment. After all, much of the work already takes place on computers. But other fields of research may be affected. They include genetic and climate research, areas where artificial intelligence is already being used successfully. But even these fields require the capacity for causal thinking, in order to trace genetic patterns back from diseases or weather patterns to climate change, for example. The human being is still needed at the center of research to recognize the connections that really exist. ◎

Genomic Analysis in Days, not Years

Artificial intelligence is a game-changer for genomic research. AI makes it possible to carry out the analysis of human genetic material within days instead of over several years. Genetic diseases can be investigated with greater precision and be identified more quickly – at a fraction of the earlier costs.

Decoding human genetic material is still a puzzle to researchers. Artificial intelligence could help to solve it.

Carbon-neutral Plant in Spain

Freudenberg Sealing Technologies has inaugurated a new, state-of-the-art production facility that combines sustainability and efficiency in Parets del Vallès, Spain. For example, the completely CO_2-neutral factory is powered by renewable energy. One-quarter of the green electricity comes directly from the photovoltaic system on the plant's roof. The exhaust air cleaning takes place ecologically by using microorganisms. At the same time, the plant can manufacture 15 percent more shock absorber and steering components than the previous plant, which the new facility is replacing. Shock absorber seals have been produced at the Parets del Vallès site since 1973.

About 80 percent of the output remains in Europe, mainly going to Spain, Poland and Germany. The rest is shipped to the Americas and Asia. The new, innovative plant concept moves Freudenberg Sealing Technologies one step closer to its goal of becoming a climate-neutral company by 2045. ◎

New Material Class

Freudenberg Sealing Technologies is helping to significantly improve fire safety in electric-vehicle powertrains with a new class of materials. Quantix® ULTRA does not melt or ignite at temperatures of up to 1,200°C (2,192°F). The filler-reinforced thermoplastic can be processed economically, and in various ways, with injection molding. Its lower density compared to metallic materials is another advantage for the lightweight designs that are preferred today. Since February of this year, an automaker has been using a Quantix® ULTRA flame barrier in the cooling systems of the lithium-ion batteries that go into its vehicles. ◎

Insulin Pumps Sealed

Wearable insulin pumps make it possible for people with type I diabetes to live an active, mobile life. A space-saving pump from the Swiss medical technology firm Ypsomed weighs just 83 grams. It enables the correct dosage of insulin to be delivered into the individual's body. This makes it especially important that these pumps function reliably over a long period of time. For several years, Ypsomed has been incorporating a special rod seal from Freudenberg Sealing Technologies into the pumps. A new purchase agreement for significantly greater quantities shows the customer's high confidence in the technology. ◎

New Design for Cobot Seals

Freudenberg Sealing Technologies has developed a new, innovative seal that significantly expands cobots' range of applications. In today's industry, robot arms are taking over a variety of tasks, from welding to packaging on the line. The seals installed inside them have to be flexible and wear-resistant while withstanding enormous forces. Freudenberg Sealing Technologies has now developed a seal for a cobot manufacturer that has proven itself in several real-world tests. The solution is a Z-shaped seal equipped with a special coating. ◎

State-of-the-art Test Lab for Batteries

Industry experts are assuming that sales of electric vehicles could rise to more than 100 million by 2030. That means vehicle manufacturers must deal with challenges such as range, performance, safety and charging times. Lithium-ion batteries are a solution with relatively high energy and power densities. But the risk of thermal runaway is greater for these batteries than for others in the past, since they generate more heat and pressure. To avoid these hazards and generate insights to improve batteries, Freudenberg has built a state-of-the-art test lab for batteries in Plymouth (Michigan, USA). The facility includes two roughly 14.5-cubic-meter (512-cubic-foot) steel chambers where researchers investigate the consequences of battery breakdowns, overheating and overcharging. Explosives experts designed the chambers to withstand thermal events in individual cells, modules and battery packages up to 25 kilowatt hours – which corresponds to the power of several kilograms of TNT. Test labs are expanding Freudenberg Sealing Technologies' expertise in electric mobility and supporting product development in the company, as well as at the customer. Shorter development cycles are just one benefit. ◎

Feedback and Contact

More Information
Would you like to learn more about Freudenberg Sealing Technologies, our products, solutions and services? Then take a look at **www.fst.com** and discover our wide-ranging portfolio. On our Internet site, you can also download all the issues of our company magazine as PDFs or subscribe to the magazine at no charge.

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We look forward to a dialogue with you!

Isolde Grabenauer
+49 6201 960-7467
isolde.grabenauer@fst.com

Ulrike Reich
+49 6201 960-5713
ulrike.reich@fst.com

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Trailer, Videos – Promotion

Internationaler Deutscher PR-Preis 2021 – Finalist
Category Corporate Media
(Print and Online)

Videographer 2019 – Gold
Trailer Thirst, Category Video
Production | Video | 43. Other

Videographer 2019 – Gold
Trailer Digitalization, Category Video
Production | Video | 43. Other

BCM Award 2023 – Silver
Category B2B – Pharma / Chemistry

BCM Award 2022 – Silver
Category Magazine Industry,
Chemistry, Pharma, Health

BCM Award 2022 – Silver
Trailer, Category Moving Image Fiction

BCM Award 2022 – Gold
Trailer, Category Audience Award

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