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AI Changes the Rules of the Game

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Preface

Dear Readers,

how do we approach a topic whose effects range from the payment process at the supermarket checkout to the depths of medicine? A topic that experts have already described with every superlative. That is changing work and private lives alike. Our suggestion: we approach it with an eye for the feasible.

When we planned this book, this was our guideline. When putting the topics together and writing them, we had in mind the people driving Artificial Intelligence (AI) in their organisations. People who want to understand the possibilities of the technology. Who are in charge of setting up projects, and restructuring organisations. Our goal is to make AI tangible. That is why we do not engage in theoretical discussions such as philosophizing about strong AI, applications attempting to rival the human mind in intellect and flexibility. As interesting as such mind games are, they do not help in the here and now. Anyone deciding on AI projects today has little use for a view of the distant horizon of development. They want tangible information.

Tangible means something different for each business sector: a car manufacturer is driven by other issues than a bank. A pharmaceutical company has to meet different regulatory requirements than a trading company. The prerequisites and conceivable application scenarios are correspondingly diverse. We take these differences into account in the chapters dedicated to individual sectors. Experts shed light on industry peculiarities and possible uses of AI. They show how data-driven applications change the existing and enable the new.

But for us, tangible also means picking out AI topics and relevant issues for every decision-maker – regardless of specific sectors. Communication with customers is one such topic: AI allows a personal approach on a large scale that was previously unthinkable. Chatbots are one manifestation of this development. In the second part of the book, we present a whole range of these cross-industry topics: from communication to preconfigured AI applications to AI-influenced work models. The keyword here is “New Work”.

At the beginning of the book, there are some basic considerations about AI. The focus is on the changes that data-driven applications bring for management, companies, and projects. Our authors introduce you to “Building AI-based Systems” (BAIbS) and the “Interaction Room” (IR), a

project procedure model and project tool, respectively. Two concepts that reflect the view of what is feasible as described at the beginning. They allow companies to systematically discover their AI potential and turn it into applications.

No one can say with certainty where AI is heading. Who would have predicted ten years ago how smartphones and apps would change life and the economy? At some point, cars will drive themselves. Algorithms will work in contexts we can hardly imagine today. But we know where the journey is about to start. We surveyed over 300 corporate executives and 1,000 end-customers about their attitudes, plans and expectations for AI. Among other things, this revealed: consumers are open to new applications. More open than the reporting of recent weeks and months in the media would suggest. An analysis of the survey results rounds off our look at AI.

Two themes run through all of the following contributions, regardless of their content: data and people. Data has become the stuff of entrepreneurial dreams. Be it personal data, usage data, environmental data, sales data, production data, or machine data: companies that handle it professionally, draw the right conclusions from it, and offer new services and products on its basis are among the winners. Data is what fuels many new business models or use cases. There is no AI without data.

In all of this, humans must find their role anew. How the cooperation between humans and AI will be shaped is one of the most exciting questions of the coming years. Skills such as creativity, methodological knowledge, or the provision of transfer services will become increasingly important. These are competencies and skills that AI applications will not be able to copy in the foreseeable future. At the very least, any AI application is hopelessly inferior when it comes to small talk at the coffee machine. It is often here, where the next big product idea is discussed.

I hope that when you are done reading this, you will have a better understanding of the role AI can play in your company. A sense of how data can become business. And that you enjoy reading it as much as we enjoyed writing it.

Best regards

Volker Gruhn

05

AI in Manufacturing: Data – the Material, from which Products are Made

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People are shaped by their everyday surroundings. The same applies to companies and industries. In a metaphorical sense, companies have a "DNA". At the very core, there is a set of values and a way of thinking. Processes determine how people think and act. Engineers in the manufacturing industry think every day about how they can build better machines. These professionals are the creators of their companies. Their training, their expertise, their way of tackling things shapes all processes. The "tackling" is meant literally. Whether machines, components, or end products – the companies produce things. This physicality of work is an essential factor for their self-image and their processes. It is a distinguishing feature compared to other industries. Bankers are used to handling data. Account movements, payment flows, or foreign exchange transactions are purely virtual processes. There are links to the real world, for example, when evaluating a company. But at the core, it is all about data.

It's different in the industry. Here, it's about natural objects that are in the real world. With all the complexity that reality brings. From sudden interruptions in the supply chain to the failure of a machine. But digital processes are also playing an increasingly important role in this industry. The term "Industry 4.0" is the buzzword for this development. Politics and business have been pushing the networking of processes in and between companies with great vigour in recent years. Companies can hardly escape this trend. The potential for more efficient processes and better products that digitalisation opens up is huge. Companies that build machines by nature now deal with Cloud infrastructures, Big Data applications, or Internet of Things solutions.

In this mix of self-image, technologies and expertise, AI is yet another, still relatively new aspect. AI-based processes and applications can influence the entire value chain from the initial product idea to maintenance. The prerequisites for the use of AI solutions are good in the manufacturing sector. Admittedly, companies still do not feel that familiar when dealing with data, despite the initiatives described above. But the data itself is available or can easily be made available.

Data sets are the basis for the use of AI applications (cf. Chapter 2). The following discussion focuses on the role of AI in the manufacturing industry, the challenges companies face and how

they can benefit from these technologies. Descriptions of use cases take up the majority of the chapter. Sample tasks show how data and AI processes improve the workflows in central departments. First, however, the question is which topics in the IT and AI context move the decision-making management. These topics determine the speed with which companies seize their opportunity. They also determine the success the companies have with it.

5.1 A Sector Unlike Any Other

The engineering mindset shapes all aspects of entrepreneurial activity. Virtues such as predictability and reliability determine the requirements. Innovation usually has little to do with digital issues or data. It is often about optimising processes or performance parameters in machines and components. With the increasing importance of digital topics, a different perspective is taking hold. There are still classic IT projects that are organised according to the waterfall method. A detailed gathering of requirements is followed by an exact definition of specifications and a long-term planned processing. This is an environment in which many engineers feel comfortable.

In contrast, developing AI applications is often a discovery process. In the beginning, it is not yet apparent whether existing data are even sufficient to achieve the desired goal of an application. Or whether the chosen process is the right one. The developers think in short development cycles and work with Minimum Viable Products (MVP). The idea behind MVPs is to quickly bring the first functional versions of a product or service to the market. The project team then improves these step by step based on user feedback. This is a course of action that does not quite fit in with the familiar, classic approaches.

Digital topics such as the development of AI applications require cooperation across departmental boundaries. Design, production, quality assurance, logistics, sales, service, and IT must all collaborate. Only together will the experts work out which data accrue where and which data are relevant, for example, for the development of new service offerings. This requires communication between departments that have

had little or nothing to do with each other. When it comes to AI, processes and structures that have been learned, tested, and practiced for decades in industrial companies collide with an agile understanding of projects.

The manufacturing sector differs from other industries because of its way of working and its economic structure. A few large companies dominate the finance and insurance sector. Mechanical engineering is known for its medium-sized structure. The names of world market leaders are sometimes only known to industry insiders. Company headquarters can be found all over the country in Germany, not only in urban centres. In the competitive, skilled labour market, many companies in the sector lack the appeal and the attractive location to keep up with global players and start-ups. This applies in particular to IT or AI-related skills such as Data Scientists or Machine Learning experts. AI applications can help companies alleviate the tense personnel situation. A typical use case is the automation of processes. Manual labour had previously dominated because of the complexity of the processes and the wealth of variants. AI solutions can help to align the demand for labour with the available supply.

Companies operate in a highly competitive environment, both in labour and in sales markets. The pressure on prices, triggered among other things by competitors from abroad, is noticeable. Suppliers find it difficult to find additional optimisation potential in established processes with economically justifiable effort. The classic business model of building and selling a machine, maintaining it at regular intervals and repairing it when necessary is increasingly coming under pressure. Customers demand availability guarantees for machines, as the online world knows them for servers. However, providers can only guarantee a maximum downtime of 0.1 percent by permanently monitoring their machines. They forecast critical developments with a high degree of probability – a typical scenario for AI applications.

The possibilities that AI opens up for manufacturing companies are almost unlimited. The means to address the issue are not. IT departments are often limited to their role as service providers. In order to break out of this role and to position themselves as strategic sparring partners for management on future issues there is often a lack of expertise and equipment.

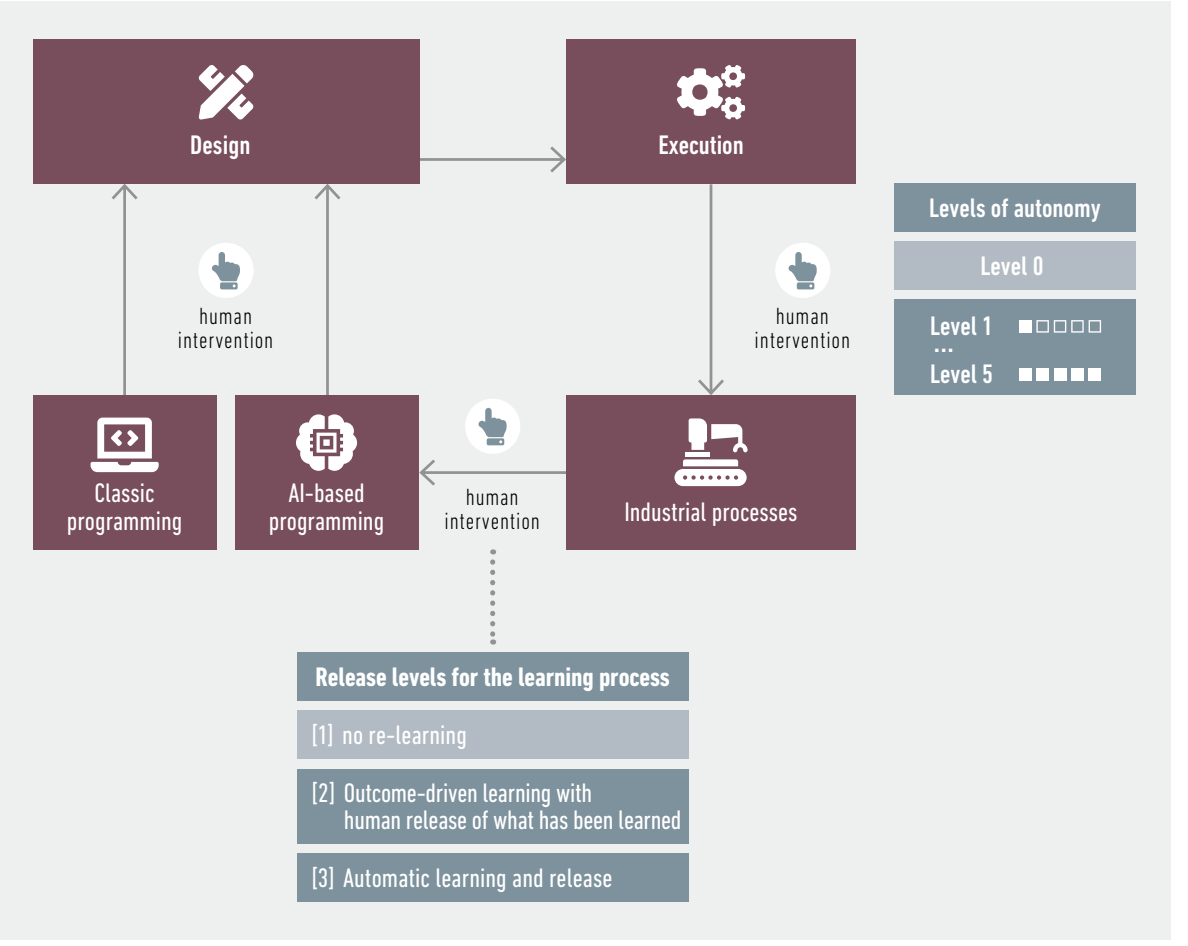

Figure 5.1
Control loop for a classic and AI-based execution of an industrial process (German Federal Ministry for Economic Affairs and Energy, BMWi)

These are the conditions under which companies in the manufacturing industry are establishing the primary requirements for AI applications.

5.2 About the Real and the Digital and AI in Between

Artificial Intelligence is a subfield of computer science. AI aims at enabling machines to perform tasks "intelligently". It imitates a part of human intelligence. Instead of telling a programme precisely what to do, an AI system is given a task that it solves independently. For the following, this definition will be supplemented by an aspect that is particularly relevant for manufacturing: the perception of the environment. Mechanical engineering is closely linked to the "real world". AI applications bring such great potential to this industry because they open up a way for machines and devices to perceive their environment. "From the industry's point of view, AI technologies are to be understood as methods and procedures that enable technical systems to perceive their environment, process what they perceive, solve problems independently, find new solutions, make decisions, and in particular learn from experience, thereby becoming better at tasks and taking action." (German Federal Ministry for Economic Affairs and Energy, BMWi, 2019).

Only AI solutions can enable companies to work with the amounts of data described above and set up new processes, products, and services. By processing, analysing and recognising patterns, opportunities arise. Opportunities that humans do not recognise due to the sheer number or complexity of the correlations. This is where methods such as anomaly detection, classification, clustering, or reinforcement learning play a role. AI applications exhibit their strengths in image recognition and in identifying target groups with similar characteristics.

Among other things, AI technologies allow an unprecedented level of autonomy and flexibility in areas where automation dominated in static processes or manual labour.

The issue of autonomy is critical to understanding AI deployment scenarios in industrial

settings. Following the working paper "Technology Scenario 'Artificial Intelligence in Industry 4.0'" of the German Federal Ministry for Economic Affairs and Energy (BMWi), different levels of autonomy can be distinguished. From level to level, the autonomy and thus the automation potential increases.

- Assistance
  Humans are responsible for the entire process. They intervene in the operations and make all the decisions. AI applications serve to support these tasks. They prepare and provide information, make forecasts and show possible courses of action.
- Limited autonomy in (larger) sub-areas
  AI applications monitor systems, warn in case of deviations and develop proposals for solutions. Humans must confirm or approve these suggestions before the system implements them. Humans must also be available as the final authority. If problems arise for which the AI cannot develop solutions – for example, because it has not been trained for the scenario – they intervene in the process.
- Autonomous operation in all areas
  AI-supported systems operate autonomously. This concerns both the work within a process and the cooperation between systems. The presence of a human is not required anymore in this phase.

To illustrate these gradations, it is helpful to look at developments in the passenger car sector. Ten years ago, cars were still combinations of sheet metal and engines controlled by humans. Gradually, assistance systems were added, such as distance warning systems. Today, vehicles can drive independently in specific environments, for example, on motorways. However, a human driver must always be available to intervene. Numerous companies are working on fully autonomous vehicle concepts where the driver no longer has to sit behind the wheel. There may not even be a steering wheel. Similar to road traffic, different levels of autonomy will coexist in manufacturing companies.

Initially, companies often go for AI applications with low levels of autonomy. Learning effects, better technologies and an improved understanding of data ensure that more and more processes become suitable for AI. Step by step, the autonomy of the applications increases. Companies are transferring ever more significant parts of the value chain to partially or fully autonomous processes.

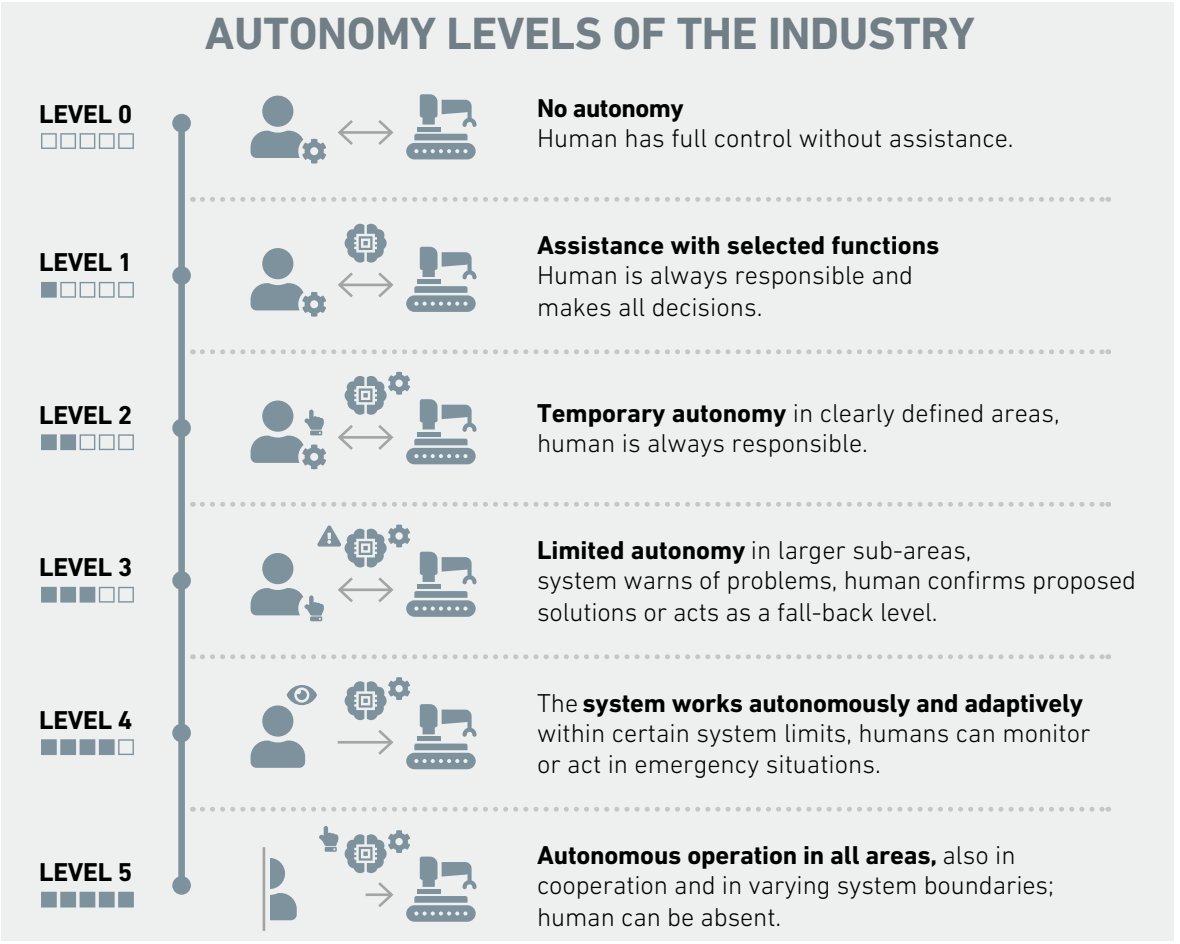

Figure 5.2
The six levels of autonomy in the manufacturing industry regarding Artificial Intelligence (BMWi)

For the development of AI applications it is critical to have a professional handling of data. A task in which many companies still have to do essential work.

5.3 The All Importance of Data

For companies in the manufacturing sector there is no lack of data. They have data in abundance. An aircraft turbine, for example, generates data in the order of 20 terabytes per operating hour. The sensors installed throughout a company ensure an endless flow of data internally, externally between companies and with customers. A stream that is constantly growing. As a matter of fact, it is hardly possible to read out everything that is conceivable in theory. There might be a lack of interfaces. The transmission infrastructure on-site might be insufficient. There may not be standardised data formats that regulate the exchange. The risk of networking might be too high. A machine park that is connected to a Cloud Platform for maintenance purposes is potentially vulnerable to external attack. But the more valuable the work with the data becomes, the greater the willingness to remedy these deficiencies or to implement secure infrastructures. The main concern is often about the location of Cloud servers and the potential for access by foreign governments and competitors.

Breaking down data silos and creating an end-to-end data stream is crucial for successfully using AI applications. The data stream should digitally map the entire value chain. Data availability, quality, sovereignty, access, and legal aspects are all relevant (cf. Chapter 4 “On the way to a data-driven company”). Only if the processes within the company are seamlessly linked to processes in the field, will the data necessary to develop and train AI applications be available.

The flow of data through the company is just as important as the flow of materials through production. For many this is still something to get accustomed to.

AI applications are still a largely unknown entity for many decision-makers. There is hardly any experience with technologies and projects. And there is a lack of standards, certificates or

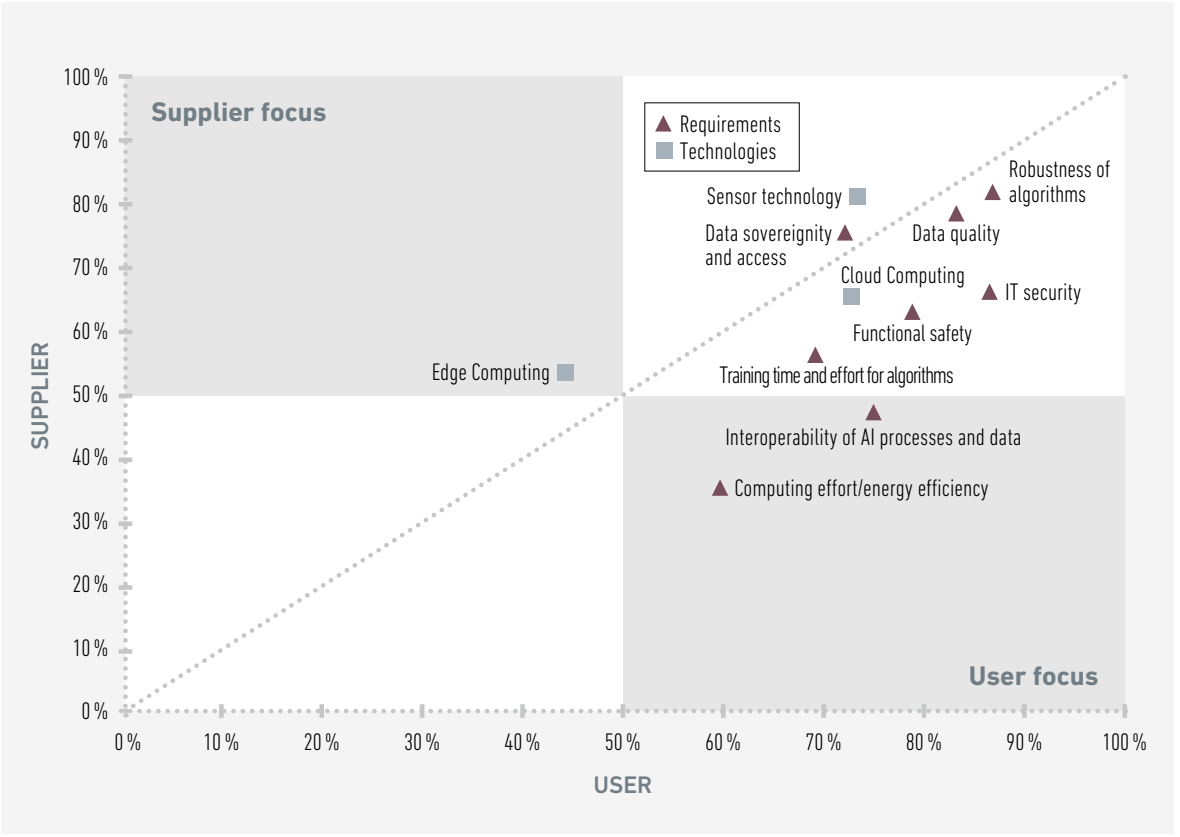

Figure 5.3
Proportion of surveyed providers and users who rate the respective system requirements for the use of AI as significant to very significant (iit)

guidelines that regulate their use. For instance, it is largely unclear what impact the use of AI-based solutions has on the design of occupational safety and health. This aspect is gaining importance with the increasingly close cooperation between humans and AI systems in collaborative processes. The questions range from liability for malfunctioning self-learning applications to ethical aspects in attempting to avoid accidents.

These issues need to be resolved if companies want to deploy AI applications on a broad scale successfully. However, for the following considerations they will be left aside. The task now is to identify AI fields of application in the industry.

5.4 "All theory, dear friend, is grey…" (Johann Wolfgang von Goethe)

From order processing to cutting, there are potential applications for AI technologies in the industry. A systematisation allows a distinction based on possible fields of application.

AI Based Product Add-on or AI as Integral Part of a Product

In the world of production, AI technologies act as a digital layer that covers reality. New processes and business models emerge at the interface between the digital and the real. At the centre of this is the manufactured product. Whether machine, component or vehicle: AI applications enable integration into digital processes. They are the starting point for many improvements.

AI applications and products can be linked in different ways. First, the product enables new, AI-powered business models. For example, sensors collect data about the utilisation of a ma-

chine. Based on this, a trained algorithm predicts the optimal time to repurchase the machine. AI applications do not change the product itself. They change the services and processes around it. Accordingly, the AI applications are not used in the product but, for example, in IoT platforms.

The second possibility is that AI applications enable a product in the first place. A self-driving truck that independently searches for the optimal route across the company premises as part of an autonomous delivery network is unthinkable without AI. In this case the technology is not an accessory. Data and algorithms are just as crucial for building the product as are raw materials or machines.

AI in the Production Process

From Predictive Maintenance based on real-time data about the utilisation and condition of machines to the use of autonomously working robots: Processes in production offer numerous approaches for AI applications.

AI in Process Optimisation

AI systems optimise internal processes as well as workflows between companies. Potentials range from production and capacity planning to early anomaly detection in quality control to supply chain management, including intralogistics.

AI in Customer Relations

AI technologies have an impact on specialist departments that are not directly linked to production. They help marketing and sales departments to identify potential customers better and to reach them faster (cf. Chapter 12 "AI & customer"). In service and customer support, they ensure better-informed employees who help customers more quickly.

Batch Size 1

This category is not included in the previous system, as the idea of batch size 1 involves a whole bundle of processes, measures, and technologies. However, it must be mentioned due to the importance of the concept and the role that AI technologies play in this context. Individualisation and flexibilization are among the significant trends for manufacturers. Development can be seen in the manufacturing sector that can also

be found in a similar form in many B2C markets (cf. Chapter 14 “AI & Personalisation”). Instead of reaching large target groups with a standardised offer, the personal requirements of individual customers are increasingly the basis for products. Converting the entire process chain to a variant or even one-off production and producing economically at the same time requires rethinking. AI applications bring the necessary flexibility to the respective processes. They can be used to support configurations or to automate and accelerate resource and material requirements planning.

With respect to industrial AI applications, one can distinguish three possible technology levels for the digital infrastructure: the device, the IoT platform and the actual AI application level. Devices include sensors or Programmable Logic Controllers (PLCs). They that collect, regulate, and control processes in a manufacturing plant with machines or robots and generate information in the process. An IoT platform networks the devices with each other. The data from the different devices flow together via standardised interfaces. The AI application-level works on this data. This is where the actual analyses and calculations occur. Optimally, they are enriched with domain-specific know-how. It is on this level that Machine Learning processes work and patterns are recognised. In this layer, dashboards visualize the results and findings, while control signals are sent back to the devices via the IoT platform as needed.

Anyone developing AI applications in mechanical engineering has to deal with a wide range of economic, organisational, cultural and technical challenges. But dealing with the technologies and their possibilities is worthwhile. There are business cases in company data that can change the individual company and the entire industry.

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