



# INDUSTRY 4.0

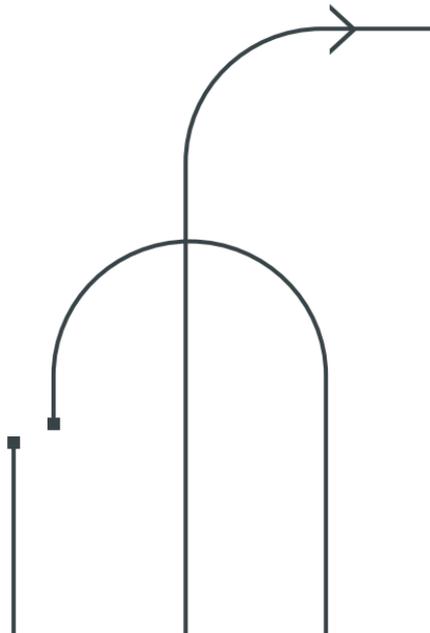
A White Paper by SEW-EURODRIVE



# INDUSTRY 4.0



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### Industry 4.0. What's it all about?

The characteristics of socio-industrial revolutions have one thing in common – the focus is always on changes to production processes. The aims of these revolutions are also the same – greater productivity, increased flexibility and optimization of value creation have shaped innovation and continue to do so. Industry 1.0 represents the transition from muscle power to physically generated energy using steam and water. Industry 2.0 is the start of mass production using electrical energy. And Industry 3.0? This describes the age of computer-aided automation that generated major growth in productivity and flexibility from the 1970s onwards.

#### **Digitally networked production**

Factory 4.0 covers all the new opportunities related to digitally networked production, such as assembly, maintenance, repair, marketing and disposal. These include machinery and components that are no longer just networked and centrally controlled – as in Industry 3.0 – but also make independent decisions decentrally, based on digital information, and then incorporate these into the overall production system. Over time, adaptive systems will emerge that will redefine much of what we regard as tried and tested.

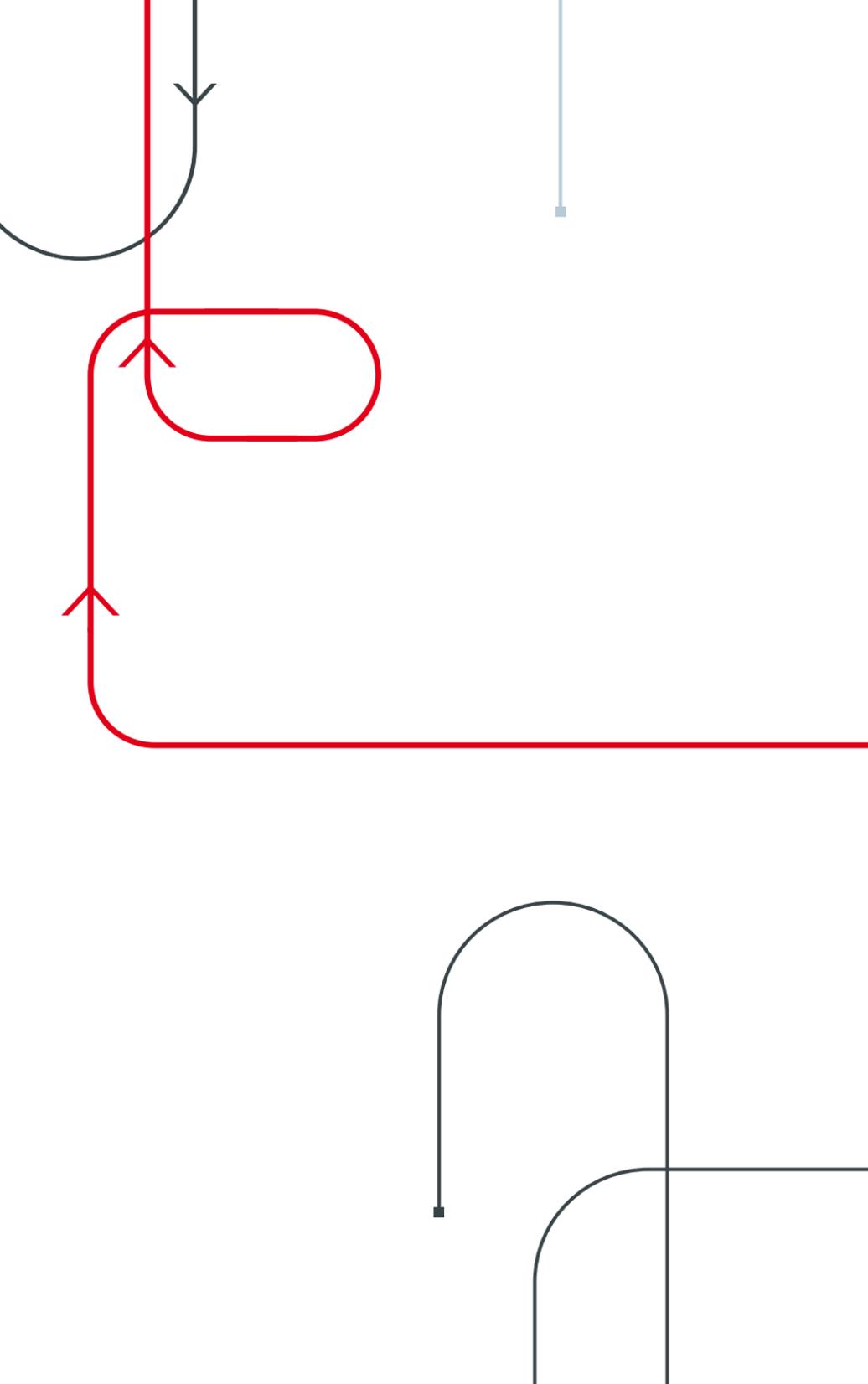
Vast data volumes that can be stored and analyzed as big data are already a reality. In the future, global competition will be decided in the data room. Intelligent analysis programs will enable predictions of how technical processes can be made more efficient, reliable and fail-resistant. This predictive analytics is about much more than looking in a crystal ball. SEW-EURODRIVE is already turning this know-how into reality. Predictive maintenance of machines and systems is a major goal.





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## **Industry 4.0 –**

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more than just changing  
production processes



# Opening up a world of possibilities – including personalized products and services

Terms such as Industry 4.0, integrated industry, M2M communication and the digital factory make most people think of the radical changes in the fourth industrial revolution. When considering the overall complexity, this ultimately seems correct. However, in a detailed analysis of industrial production, it's evolutionary processes in particular that stand out.

## **Digitalization and smartization are the drivers of Industry 4.0**

While previous industrial production strategies were based on central, hierarchical control entities, it's machines, components and workpieces that will themselves be smart in the era of the “Internet of Things.” In other words, they can now organize themselves. This trend is referred to as “smartization” and describes the fusion of conventional physical products with cutting-edge information technology.

If things become smart and digital, this opens up a great many new possibilities for the future.

- Networking and M2M communication
- Autonomous, decentralized control mechanisms
- Intelligent use of big value data streams
- Additional services, for example in the servicing or monitoring of facilities

However, it also means shifting the value creation process toward software engineering. The digitalization of machines is being followed almost inevitably by their “IP-ization.” The separation of mechanics, electronics and software that applied in the past already no longer exists.

### **Marketing 4.0 – customized products and services**

Networking as part of Industry 4.0 enables much more comprehensive decentralization of all processes. When combined with the greater autonomy of the individual components, this results in more than just a boost to cost-effectiveness. For the first time, it can also produce economies of scale for single quantities, all accompanied by a strong focus on the specific needs of customers.

To enable production of single quantities, SEW-EURODRIVE applies the modular principle to its products. Customized finishing is performed after installation of the basic hardware. This results in short throughput times, without the need for extra design-to-order input.

Completely customized products and services are no longer a utopia. As seen so dramatically with smartphones, it's users themselves who personalize their devices. Manufacturers provide them with apps via platforms and thus also increase the added value by involving the users themselves in the personalization process.

### **Intelligent automation – key role in smart production**

Yet is the move toward integrated industry really as radical as many people make out? For the most part, the technologies for Industry 4.0 already exist in the highly developed automation technology used for production systems. Computer-integrated manufacturing and lean production have led to lean processes based on efficiency, simplicity and reliability. Now the question is how the proven technologies can be networked and combined into new autonomous systems.

SEW-EURODRIVE is adding intelligent automation to the methods and processes of lean management. This includes assistance systems for delivering logistics and complex adaptive systems that automatically recognize procedures, learn independently and can be integrated into existing systems. The SEW-EURODRIVE product portfolio – with its modular design – is kickstarting the evolutionary transformation to the smart factory. New procedures and processes are only possible with drive, control and automation technology, navigation and tracking, power supply and storage, visualization, object-oriented parameterization and simulation.

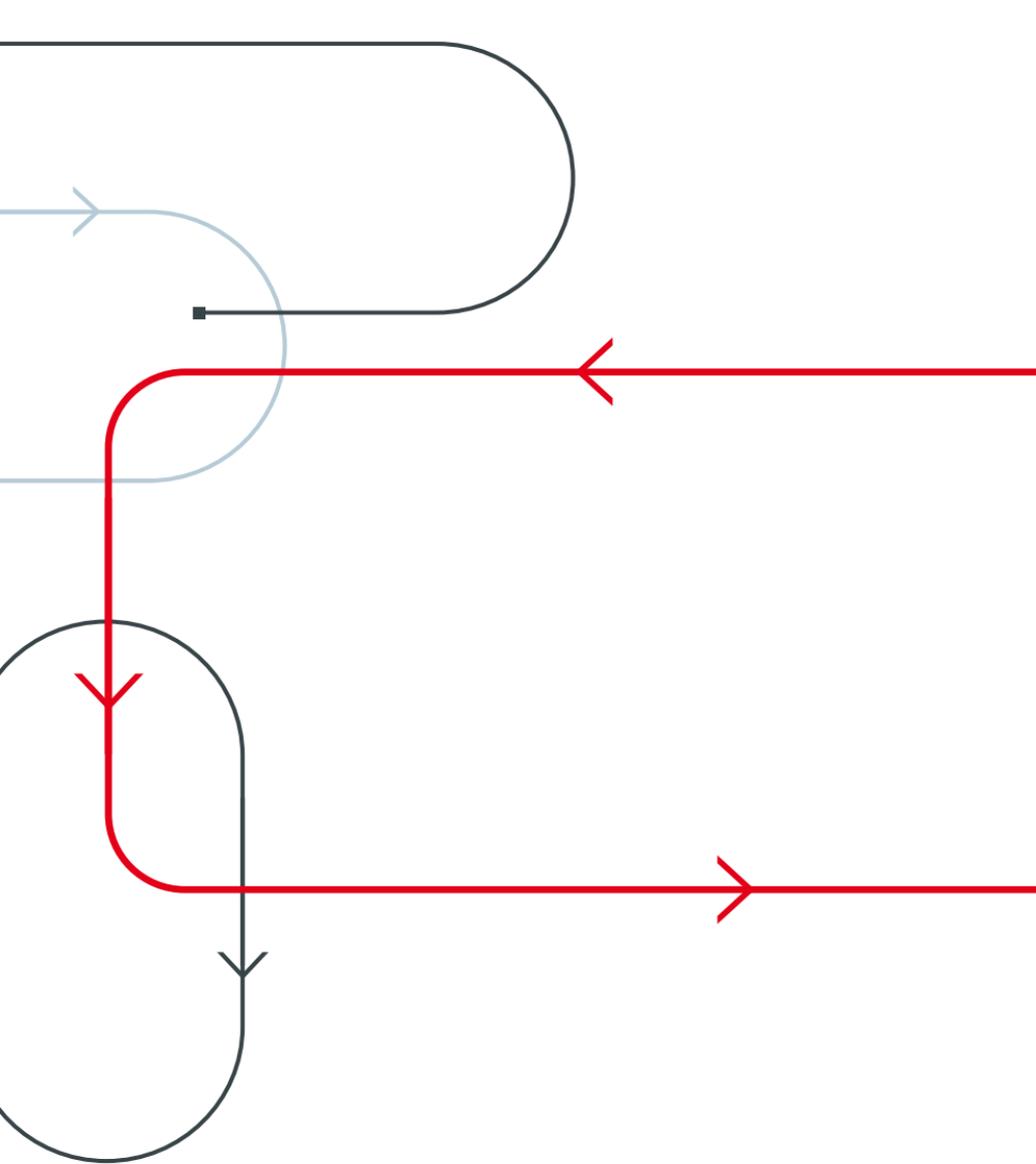
### **Digitally networked – with suppliers and partners**

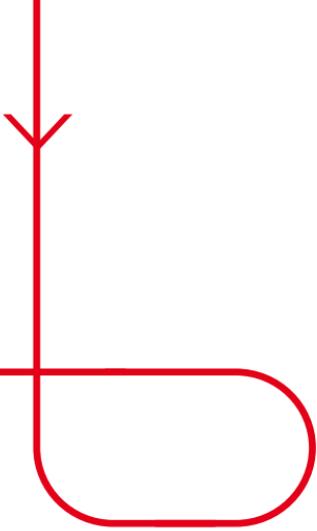
One of the key tasks in Industry 4.0 is to redefine traditional data handling structures. Everyone involved in the value creation chain will need access to all necessary data in the future, starting with product development and extending all the way to the customer. The status of the individual components used and their entire history will be accessible in real time.

Thanks to digital networking as part of Industry 4.0, production companies will be able to equip and start up entire factories on a virtual basis. In the future, it will be possible in real time to monitor systems and products throughout their lifecycle, to calculate their energy consumption reliably and to optimize this to meet relevant needs.

### **Competitiveness and new business models**

While mechanical engineering has to date been largely defined by mechanical technologies and further developments of these, this is set to change in the future. Innovations will now be propelled forward via software. This creates options for new offerings such as additional services. These are exactly the types of services that SEW-EURODRIVE will be developing and offering. New business models are also being created as part of Industry 4.0. Digitalization of processes will blur conventional industry boundaries and enable the creation of disruptive industries. Only companies that anticipate these developments will be able to remain competitive and optimize the value creation process, even in a changing environment.





## **Big value data –**

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the basis for the fourth  
industrial revolution



## **Industrial intelligence – risks or benefits?**

Many companies still have an extremely ambivalent view of big data. They consider the risks to be too great, with hackers and the threat of data misuse spreading fear and alarm. Yet there is surely a much greater risk of letting others take advantage of the economic opportunities offered by analyzing and evaluating big data. Ultimately, severe competitive disadvantages could harm business. In the worst case, companies will lose their direct contact with their customers and thus the key players in their value creation chain.

Digitalization is continuing apace, with structured and unstructured internal and external data converging. Every second the rate increases. When analyzed and processed in a targeted way, the vast quantities of digital data reveal previously unknown patterns, relationships and facts. This enables companies to not only operate more efficiently but also make faster decisions and more accurate forecasts.

### **Harnessing hidden know-how**

The opportunities created using big data analyses are just as varied as the data itself and its relationships. Maintenance forecasts prevent machine downtimes, for example, and raise productivity. Sales forecasts provide precise answers on sales of specific products for

weeks ahead. Real-time analyses enable sound decision-making in terms of quality and damage management and in prioritizing supply contracts. Production keeps flowing thanks to predictive logistics. Companies can deliver their advice to customers more effectively and make tailored offers. However, the data also provides a systematic tool for examining all cost options, minimizing risks, optimizing business processes and even identifying and harnessing completely new market potential.

### **A question of interpretation**

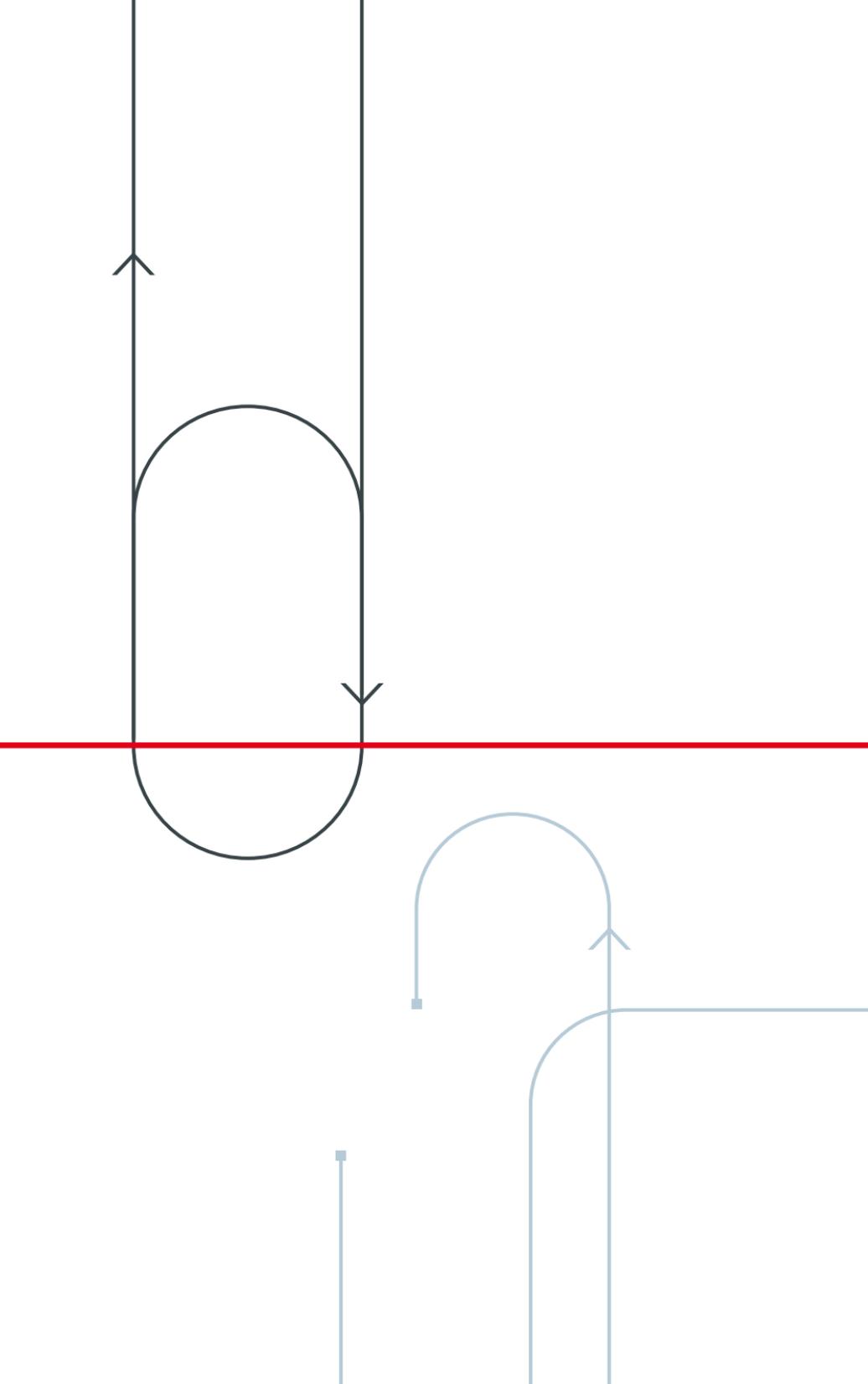
Yet in order to obtain useful information for companies from this data, it ideally needs to be processed in real time and, first and foremost, interpreted correctly. In other words, the quality of data itself is a source of risk that must not be underestimated. Good decisions and accurate forecasts can only be achieved if data is complete and its quality assured. This makes it all the more important to get the right partners on board – big data experts that extract, process and interpret the correct data from the excessive flood of information using the correct systems. Many companies can soon be overwhelmed given the variety, speed and quantity of data. This calls for a strategy, and those looking to take part in the gold rush need to plan carefully and, as well as using external advisors, develop appropriate know-how in their own companies across all levels and departments.

### **Disruptive business models**

Many companies are still shying away from this outlay in terms of manpower and other resources. Studies show that just one percent of data generated in production is currently being used. This highlights the enormous untapped potential offered by the manufacturing industry. However, this also presents the greatest risk for many companies. It isn't the supposed lack of security for corporate data that is becoming a risk – this can be eliminated using the IT technologies available on the market – but rather the unused opportunities. The consequence is then that new players with new business models suddenly dominate the market, squeezing out the offerings of established companies and reducing them to niche products. To combat this, manufacturers need to use data and their platform-based networking to develop completely new services with real added value for customers.

## **Will machine manufacturers become software houses in the future?**

**In the years ahead, companies will be faced with profound structural changes in implementing Industry 4.0 and the 4.0 factory. SEW-EURODRIVE is helping shape the transformation to the smart factory. As well as new technologies and products for industrial production and logistics of the future, the innovation leader is also developing a series of innovative software solutions for its customers based on big value data analyses. Initial offerings in predictive maintenance are already a reality, as is also the case in customized configuration of drive and automation components. Further web-based services and apps will follow – for example, for optimizing production processes. But new systems for billing services are also possible. Will customers continue to buy mobile transportation systems in the future? Or will they only pay for the services these perform in the assembly hall? Companies such as SEW-EURODRIVE already increasingly employ more software developers and fewer mechanical engineers, and the trend is growing. Knowledge is the most important resource in the 21st century. And this needs to be marketed – with innovative products, enhanced by innovative services.**





## **Cyberphysical systems**

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are revolutionizing the development of products and their areas of application

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# **New core competence for companies – the enduring ability to deliver creative destruction and innovation**

Networked processes and cyberphysical systems (CPS) are set to be the focus of factories in Industry 4.0. These cyberphysical systems – which are defined in the interaction between IT/software components and mechanical and electronic parts and communicate with each other via a data infrastructure, such as the web – will make rigid, traditional production processes seem outdated in the future. Continuous evaluation of both existing and continuously generated new data, and its evaluation as part of a data mining process based on algorithms, will create a new core competence for companies. This involves nothing more and nothing less than the enduring ability to deliver innovation and optimize products and processes.

## **A creative destruction process is called for**

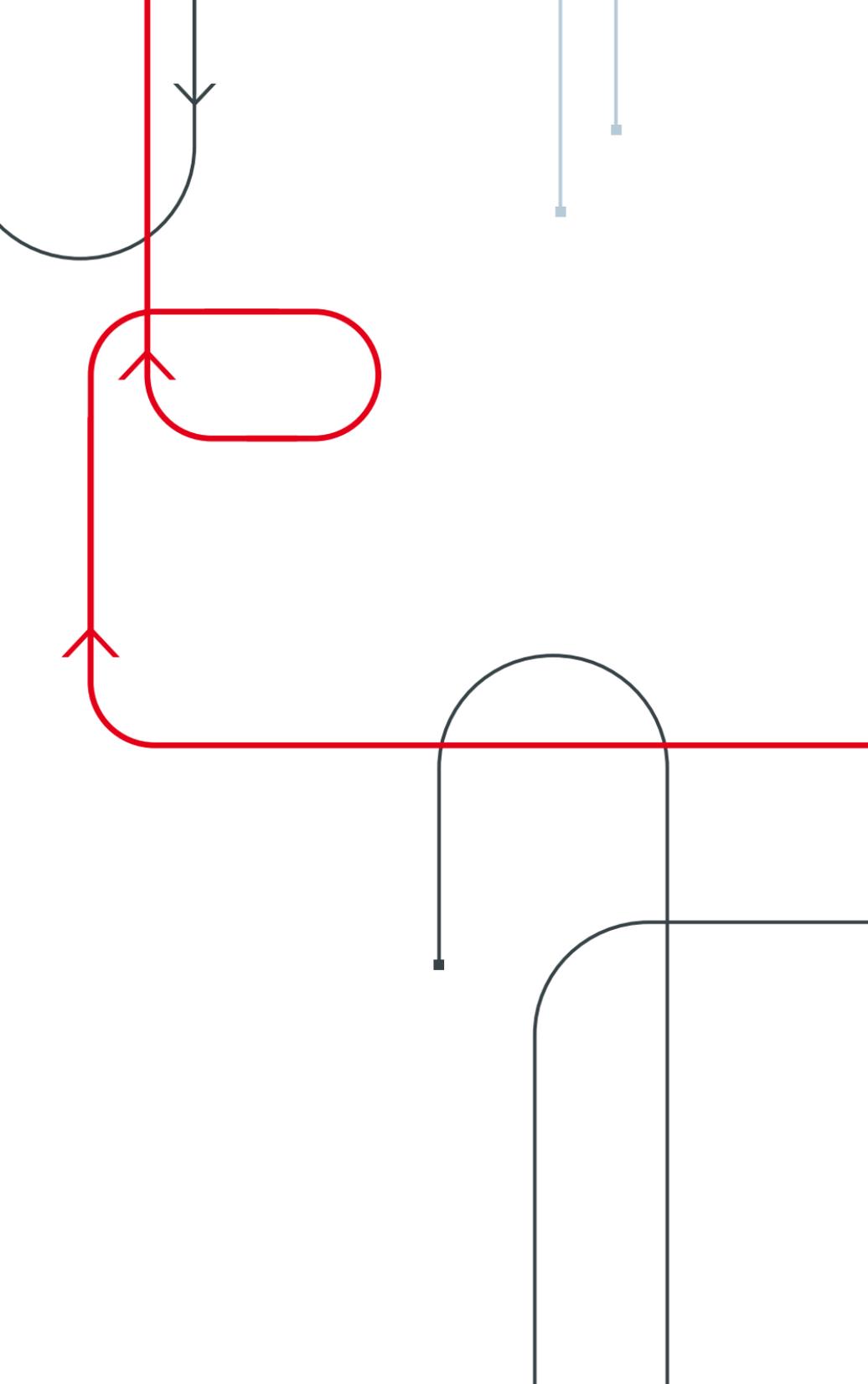
It's no longer enough for companies of the future to have an innovative product with outstanding unique selling points. The previously unique guarantee of value creation now needs to be regularly re-examined with the focus on creativity. Innovation is produced from the creative destruction of the status quo. Ultimately, the focus in the Industry 4.0 factory is on interlinking products and processes in such a way that added value can be generated for companies, their customers and employees, and society as a whole.

### **Development and optimization of processes and products is based on knowledge**

Optimization of processes in Industry 4.0 is based largely on analyzing data collected in real time using sensor technology. This needs to be evaluated using data mining based on algorithms so as to highlight the potential for optimization. Using microcontrol systems as early as the product development phase offers opportunities to define a variety of areas for action and to collect and interpret data.

Development of new 4.0 products is based on process data and expert system data evaluation. This evaluation gives detailed information about process-based influences and mechanical weaknesses. A data model is created at the start of every new product development. A large measure of reliability is then provided by a simulation that takes into account processes, their active and reactive elements, and known or previously only simulated potential consequences of reactions.

Product optimization is largely concerned with predictive maintenance. Expert systems play a crucial role in this area. Here, too, it is algorithm-based data evaluation that makes it possible to identify faults and influencing factors at an early stage. Ensuring errors are eliminated before they become a reality is a key principle that involves a large volume of knowledge. SEW-EURODRIVE has extensive expertise when it comes to the automation technology used and the processes employed by its customers. The drive for creative destruction and constant innovation is generated by this continuous balancing act between product and process.



# The SEW-EURODRIVE

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4.0 showcase factory

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# Employees, process modules, assistance systems and logistics capsules

Much has already been written and reported about processes, networking, control and the role of employees in the 4.0 factory. At its showcase factory at the Graben-Neudorf plant near Bruchsal, SEW-EURODRIVE has already turned the 4.0 factory into reality. This automation specialist views the path toward Industry 4.0 as an evolutionary process. Basic technologies from CIM (computer-integrated manufacturing) and lean production are the foundations of the new worlds of production at the showcase factory. The focus is on predictive maintenance. New business and billing models for networked use of automation products have also been defined. SEW-EURODRIVE thus already sees itself in a position to shape the intelligent smart factory of the future.

## **New technologies, products, business models and services**

SEW-EURODRIVE started implementing a 4.0 factory by clarifying future challenges, as dictated by the nature of the task. The question as to the form the production technologies and products would take for Industry 4.0 very soon became the key focus. One of the responses involved the creation of new mobile assistance systems. Technologies were created that were totally new. As a result, SEW-EURODRIVE now has hybrid energy storage devices and special automation controllers, for example. These controllers support flexible automation and enable the processes to be monitored. New business models and services will help ensure successful product placement on future markets. A modular technology

system, based on innovative technologies, now enables the creation of products that will be networked in the smart factory of the future.

An application software package is already able to turn customized solutions into reality in next to no time. Parameterization rather than programming delivers intelligent interfaces that help people in the 4.0 factory to map and control complex processes. Simulating these in a virtual world then produces final certainty for actual implementation.

### **The 4.0 factory is modular**

The factory of the future has a modular design. It can be flexibly adapted to changing market needs and is segmented and streamlined. Small factories within the factory are the new reality and are the organizational units of Industry 4.0. Employees, machines, data streams and processes are networked. The aim is to boost productivity in the collaboration between people and technology. The SEW-EURODRIVE showcase factory features cyberphysical systems with integrated microsystems and RFID chips that maneuver themselves through the smart factory. And this is all done using standardized interfaces and cutting-edge information technologies that support plug and play solutions.

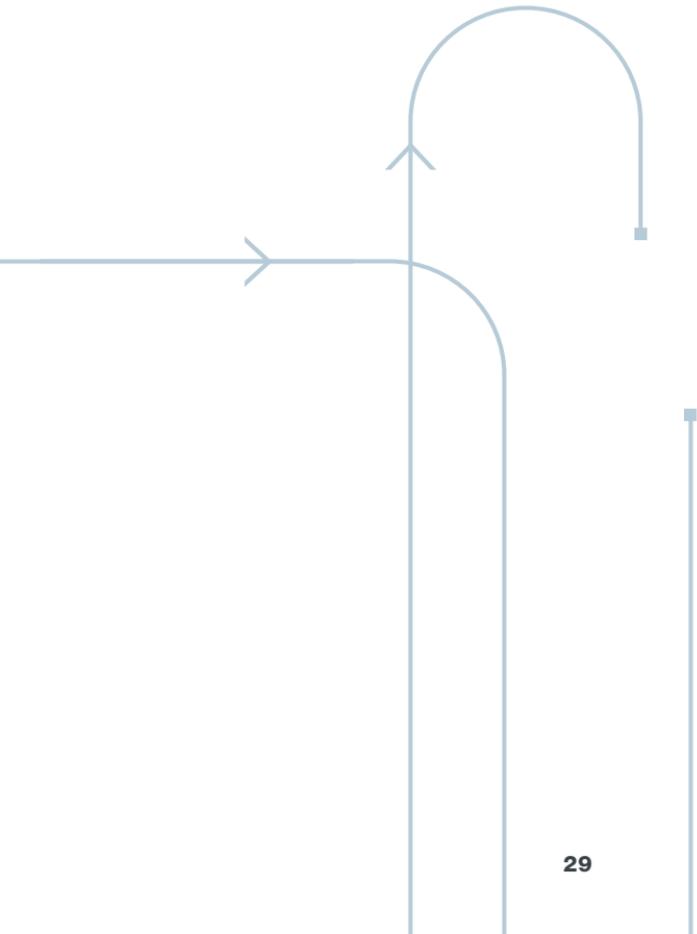
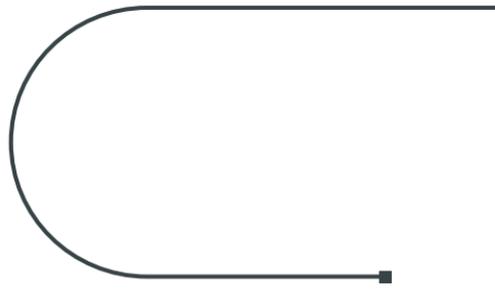
### **The intelligent combination of people and technology is key**

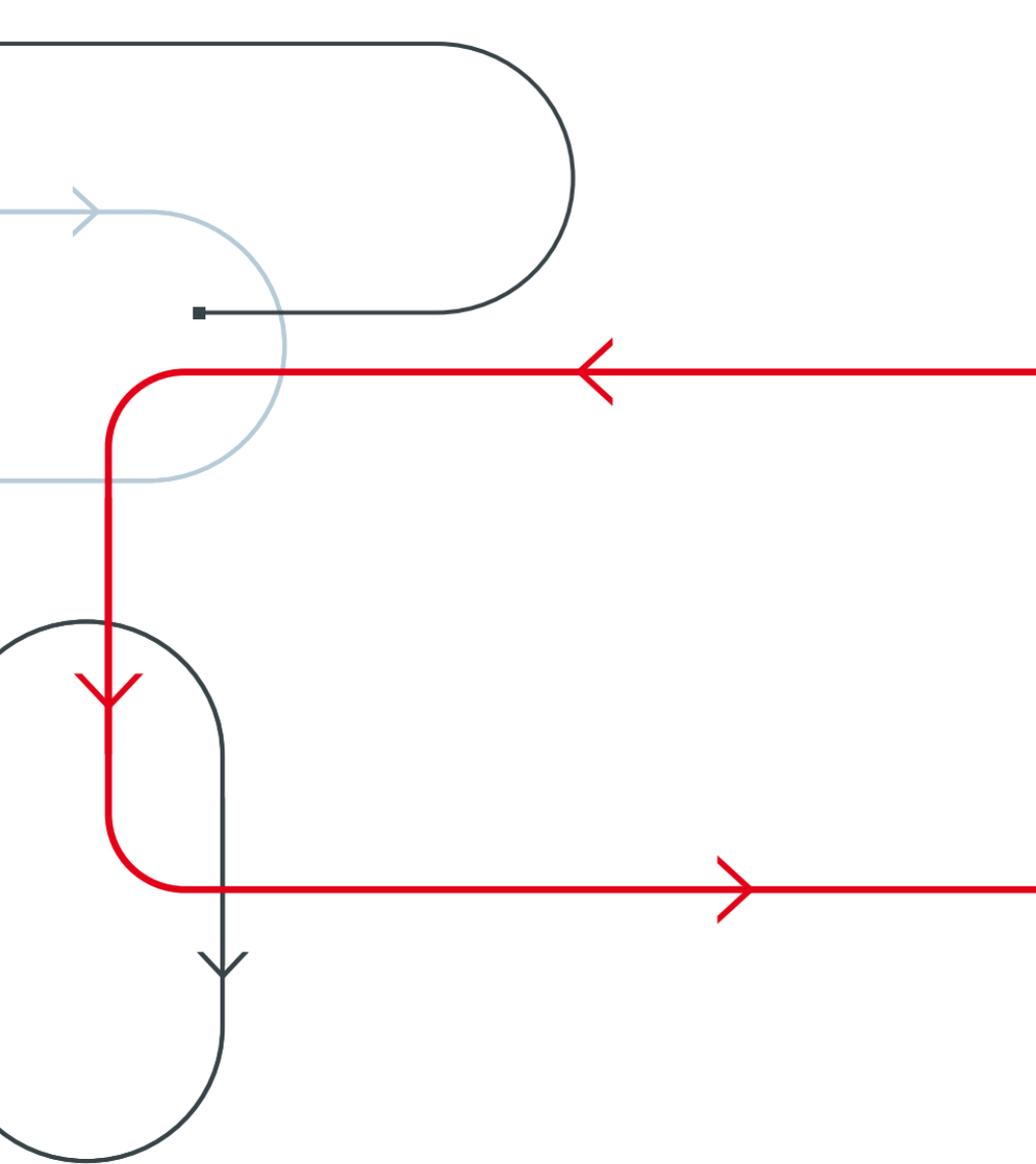
In the 4.0 factory, the individual process modules are networked with cyberphysical assistance systems that help people carry out their work. Mobile assistance systems take the parts from product manufacturing just in time to the assembly cell. A mobile assistance system – the cyberphysical assembly assistant – travels through this cell. The assembly assistant finds its way through the factory to the next defined process module, which needs to be controlled to

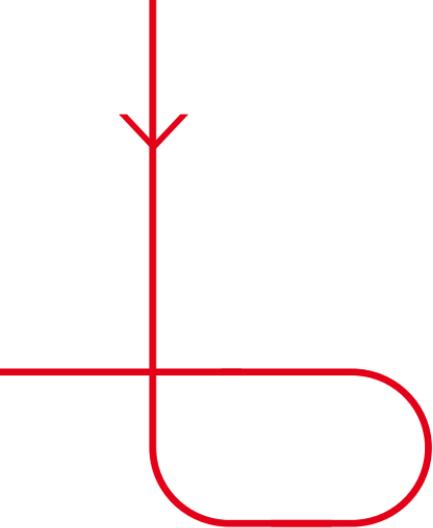


ensure the job's customer specifications are met. Intelligent product carriers – logistics capsules – then transport the finished products to the goods receipt and transfer zones at the specified time. The cyberphysical system – the logistics capsule – knows what products it contains and automatically loads the truck or is taken to another production plant.

The SEW-EURODRIVE 4.0 factory intelligently combines people and technology. It is operated by architects of value creation and represents a small factory unit of the future. The 4.0 factory controls and configures itself, with reconfigurable, scalable systems adjusting themselves automatically and impressing with their exceptional versatility and adaptability. The interaction between people and technology enables optimum use of decentralized knowledge and employee expertise, plus the creation of a stable, fault-free production system.







## **Complex adaptive systems**

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recognize procedures,  
learn independently and  
can be integrated into  
existing systems

# Eliminating errors before they become a reality

Products and systems that detect faults, maintain themselves and adapt to new situations are key in Industry 4.0. The modular 4.0 factory is networked, and decentralized knowledge is available beyond the individual production centers. Adaptive systems recognize procedures, learn, adapt and eliminate future errors. The vision of an adaptive production system is paramount. Standardized subsystems and an equally standardized software structure are designed to help processes adapt independently to new conditions in the future. Ultimately, it's a matter of eliminating errors before they become a reality.

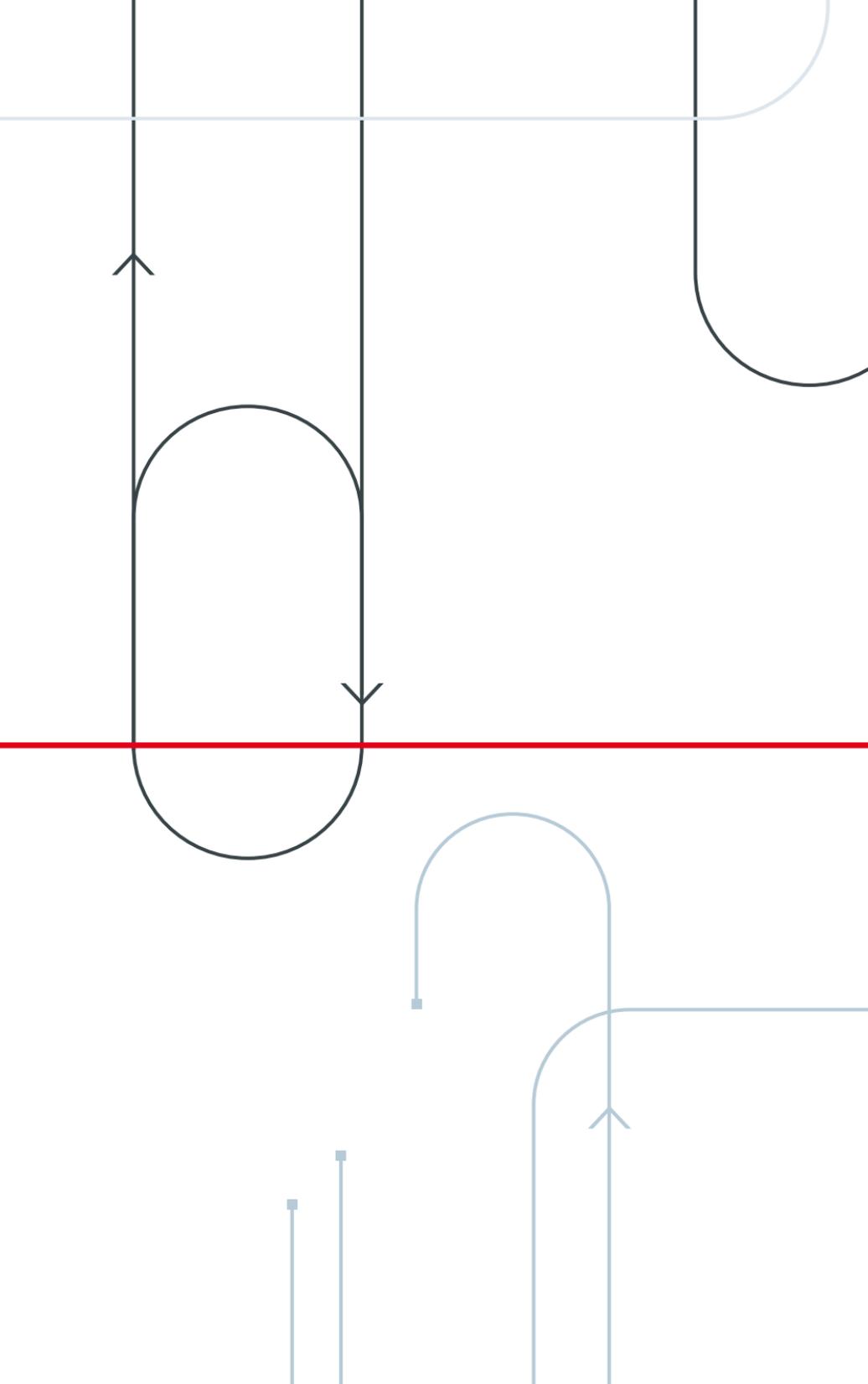
## **New dimensions – plug and produce – plug and play**

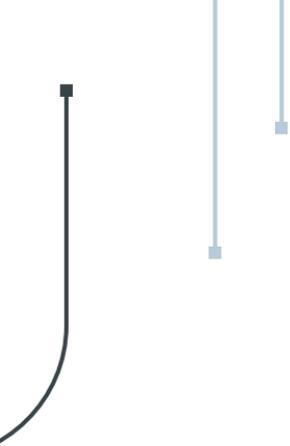
Flexibility, adaptability and the ability to perform self-maintenance are an integral part of the 4.0 factory. Wide-ranging sensor technology ensures monitoring of processes, products and the environment. The actual situation is mapped exactly in a digital shadow. This virtual representation of reality can be used to identify changes in processes and products. In a second phase, the impact of these changes is simulated, and new, fault-free processes are approved and turned into reality.

The 4.0 factory also calls for self-configuring machines, the key words here being “plug and produce.” The machines have chips that they use to communicate with other components in production. Printers and keyboards that configure themselves independently operate in a similar way. However, this is then “plug and play” rather than “plug and produce.” All these processes save time – companies can convert their production faster and also, for example, produce smaller volumes.

### **Intelligence is in the cloud**

Far from being simple, the solutions mentioned here are highly complex. They can only function if access to a cloud is available. The cloud offers precisely the functions that support the adaptivity described above. It isn't the individual systems that make the machines in the 4.0 factory intelligent. While part of the intelligence is transferred to the component, i.e. the drive and sensor, the ability to plug and produce and a large proportion of the overarching intelligence is located in the cloud. Only now is it possible for each system to log in here to share this intelligence and use the software services offered by the cloud. Fast and adaptive changes to systems and processes are now a reality.





## **Networking,**

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data security and  
standards

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## **Does total networking expose easy targets?**

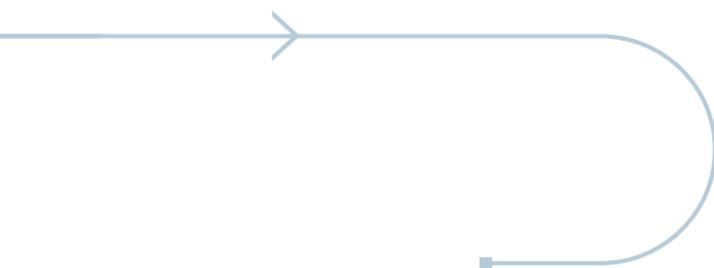
Networking with customers, partners and suppliers does not automatically result in an organization's own systems and facilities becoming less secure and thus open to cyberattacks. In fact, quite the opposite is true – if implemented professionally, networking makes the companies involved more aware of the need to handle their data more responsibly and securely. Only those companies that take an open-minded approach to networking issues in the Industry 4.0 context have the chance to succeed in the new industrial marketplace.

When industry talks about networking, the issue of data security soon comes to the fore. Are my data and documents in the cloud adequately protected? Doesn't opening up IT bring with it significant potential risks from hackers and unauthorized access? The concerns are understandable, and yet a wide variety of security solutions now exist on the market to provide effective protection for corporate and customer data in the cloud. The technology is not the problem. The greater risk factor in networking is people and their frequently careless handling of data.

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Outsourcing IT security to external companies thus pays off in particular for small and midsize companies, who cannot generally afford in-house IT security experts. It is essential to develop an appropriate security concept at the outset – what data is absolutely critical to the business and must not get into the wrong hands? What are the potential attack scenarios I want to protect myself against? What data can be shared in an open community? What know-how in my own company – in collaboration with partners and suppliers – helps develop value creation ecosystems, establish standards internationally and thus safeguard my own access to the market?

Companies that opt to benefit from the enormous opportunities offered by networking don't have to start on a large scale right away. It makes perfect sense to gain initial experience in the manageable and closed space of a private cloud. If networking is intended to optimize production, for example, all the necessary data is available in-house. Once companies recognize the benefits, further business processes and cooperation models in the networked world will soon follow.



## **Global communication standards are needed**

### **Industry 4.0 – the language of digitalized production**

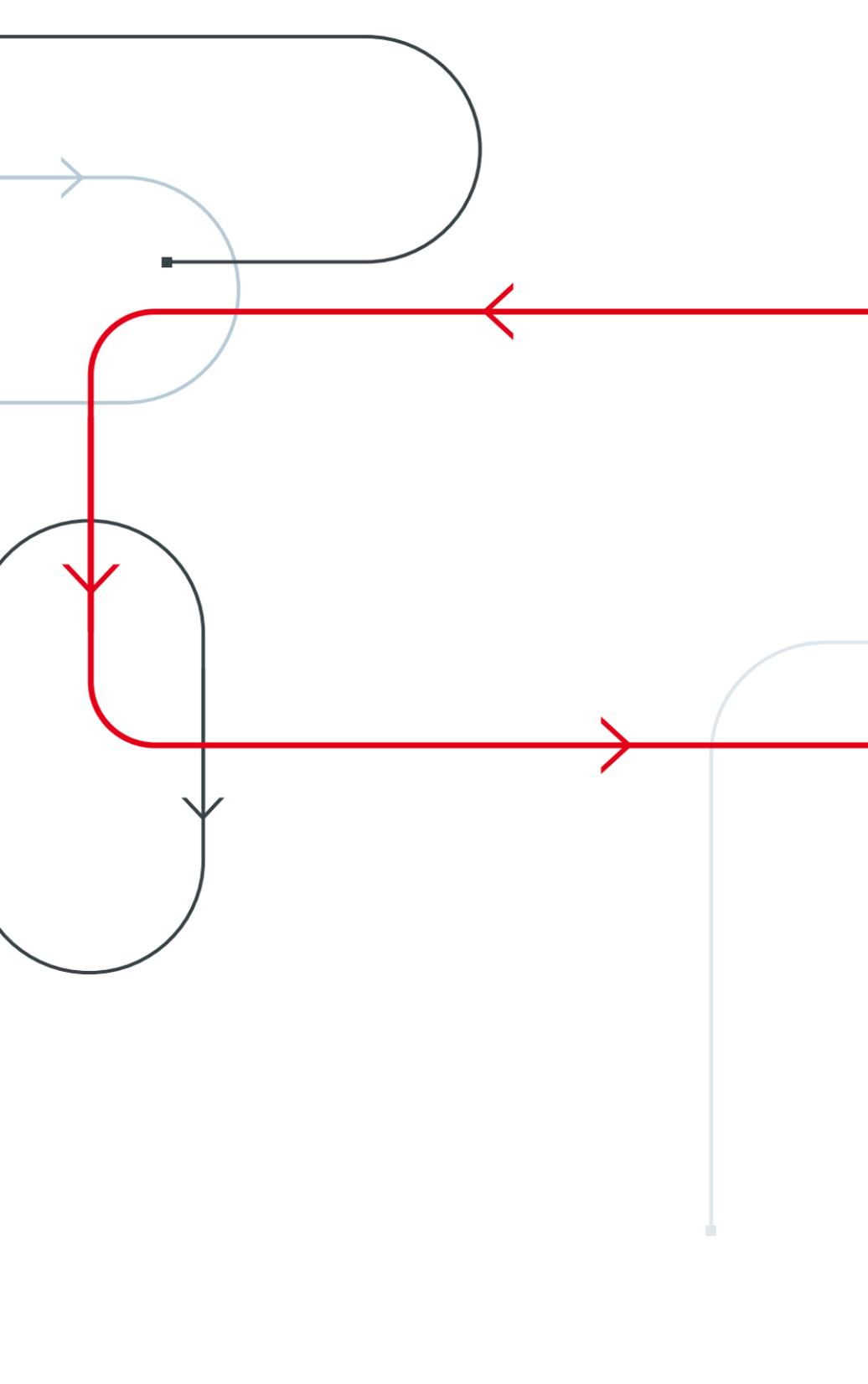
Value creation chains are becoming value creation networks. People, machinery, products and systems are sharing information – in real time and between different companies and countries. However, for communications to run smoothly in the digital world, everyone needs to speak the same language. Confusion in communication must be avoided at all cost.

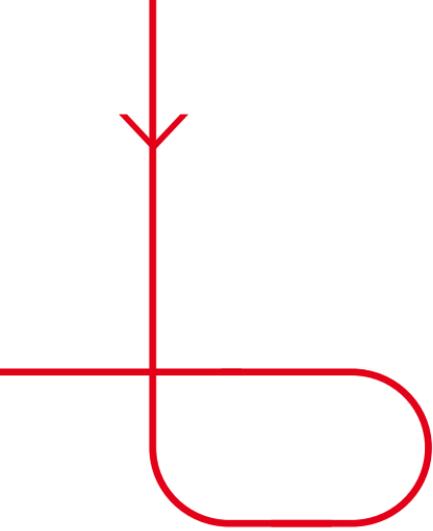
Companies communicate about their orders all the way to the manufacturer's production cell. Intelligent workpieces equipped with sensor technology maneuver themselves through the smart factory of the future. During the production process, customers can access information on the current status of their order at any time. Even last-minute changes can still be made before the customized product is released and dispatched to the customer. And this is by no means all when it comes to the opportunities offered by digital networking.

Yet the communication needed between IT systems, machines and workpieces is no small undertaking. Due to their history, customers, manufacturers, suppliers and logistics companies still use their own application systems and

**formats to share data. Even within individual companies, numerous ruptures in communication still exist that require vast amounts of manual data entry. Establishing global communication standards – for everything from sensors and machines to platforms for processing the data and information generated – is therefore one of the most pressing challenges for the research sector and industry today.**

**Both the German platform “Industry 4.0” and its U.S. counterpart the Industrial Internet Consortium (IIC) are working intensively on reference architectures for digital transformation. The two organizations are now collaborating and pooling their activities. If partners from China and Japan are also included, formal standardization – or, to put it more loosely, the global language of digitalized production – could be seen as being well on track. This is the only way to harness the efficiency benefits of networking and maintain competition between systems and companies.**





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## **Industry 4.0 –**

the employee's role



# Humans as architects of value creation

A great many things are being attributed to digitalization. In particular, negative predictions for people's work and personal development in factories are becoming ever more frequent. Will all employees in a digitalized Industry 4.0 factory really be running on autopilot in the near future? Will cognitive processes be increasingly automated? Will there still be any room at all for empathy for the work carried out in the smart factory? It's true that digitalization in Industry 4.0 covers all business processes. However, this will by no means eliminate human labor. Nonetheless, it will need to redefine itself. To implement real-time data sharing and networked production, teams combining the various disciplines will monitor processes and spearhead their value creation.

## From specialist to flexible operator between the digital interfaces

The status quo is being shaken up in the transformation process for Industry 4.0, and the reliability of all established processes is being placed under the spotlight. Those who view change processes as a challenge can only win, while those who look the other way will lose. The fact is that employees in a 4.0 factory need to find a new role. When smart machines are able to automate traditional processes,

the requirements of employees change and there is an increasing need for mentally creative rather than physically demanding activities. Flexibility, media skills, an interdisciplinary mindset and self-organization become more important.

Production employees, previously highly specialized machine operators, become flexible 4.0 operators between the digital interfaces. These new types of employees assemble, organize and communicate. For them, the machine is no longer merely a tool but an equal partner that networks processes, prepares various operations and issues instructions. Instead of being afraid of being squeezed out, people in the smart factory have the opportunity to harness its flexibility and thus benefit from the economies of scale in value creation.

### **The employee remains a decision maker, problem solver and innovator**

New cornerstones of value creation are created in the Industry 4.0 factory through digital process networking, combined with intelligent collaboration between humans and technology. While the digital native generation finds itself in a familiar environment, traditional, experienced specialists face new challenges. As might be expected from the advance of digitalization, an increasing proportion of value creation will take place in the virtual arena in the near future. A solid understanding of IT processes is thus vital for 4.0 employees.

Provided the necessary openness exists, exciting worlds will emerge that revolutionize workflows and define new areas of responsibility. SEW-EURODRIVE has installed six small factories at its plant in

Graben-Neudorf that comply with all the principles of Industry 4.0. Here, in a collaboration between employees and the cyberphysical systems used there, a new form of flexibility is being achieved. The interaction between humans and machines relieves employees' workload. Yet employees still remain decision makers, problem solvers and innovators. Their areas of responsibility are varied and are shaped by major challenges.

The capacity utilization of factories – and thus the tasks of employees – are no longer planned weeks in advance in the SEW-EURODRIVE model, but rather a maximum of three hours ahead. If a bottleneck starts to emerge in one of the six factories (assembly islands) in a shift, employees and cyberphysical systems can be deployed. Employees now need to respond flexibly and prove they can handle much more than just one skilled operation or the assembly of just one product.

## **At the heart of the digitalized factory – people**

**Managers of assembly units are becoming architects of value creation – a cognitively and socially demanding task.**

### **Tasks:**

- **Decentralized, results-oriented factory management**
- **Detailed planning of production sequences**
- **Ensuring flexible, results-oriented use of resources**
- **Production- and customer-oriented collaboration**
- **Transparency in performance and results in real time**
- **Entrepreneurial decision-making skills**
- **Predictive job simulation**
- **Being proactive, not reactive**

## Publishing details

The “Industry 4.0” white paper from SEW-EURODRIVE is the result of interdisciplinary exchanges between acclaimed specialists in production technology, automation, information technology, logistics, personnel development and marketing. Strategies and experience in designing the 4.0 factory – SEW-EURODRIVE’s showcase factory at the Graben-Neudorf plant – were taken into account in its development.

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