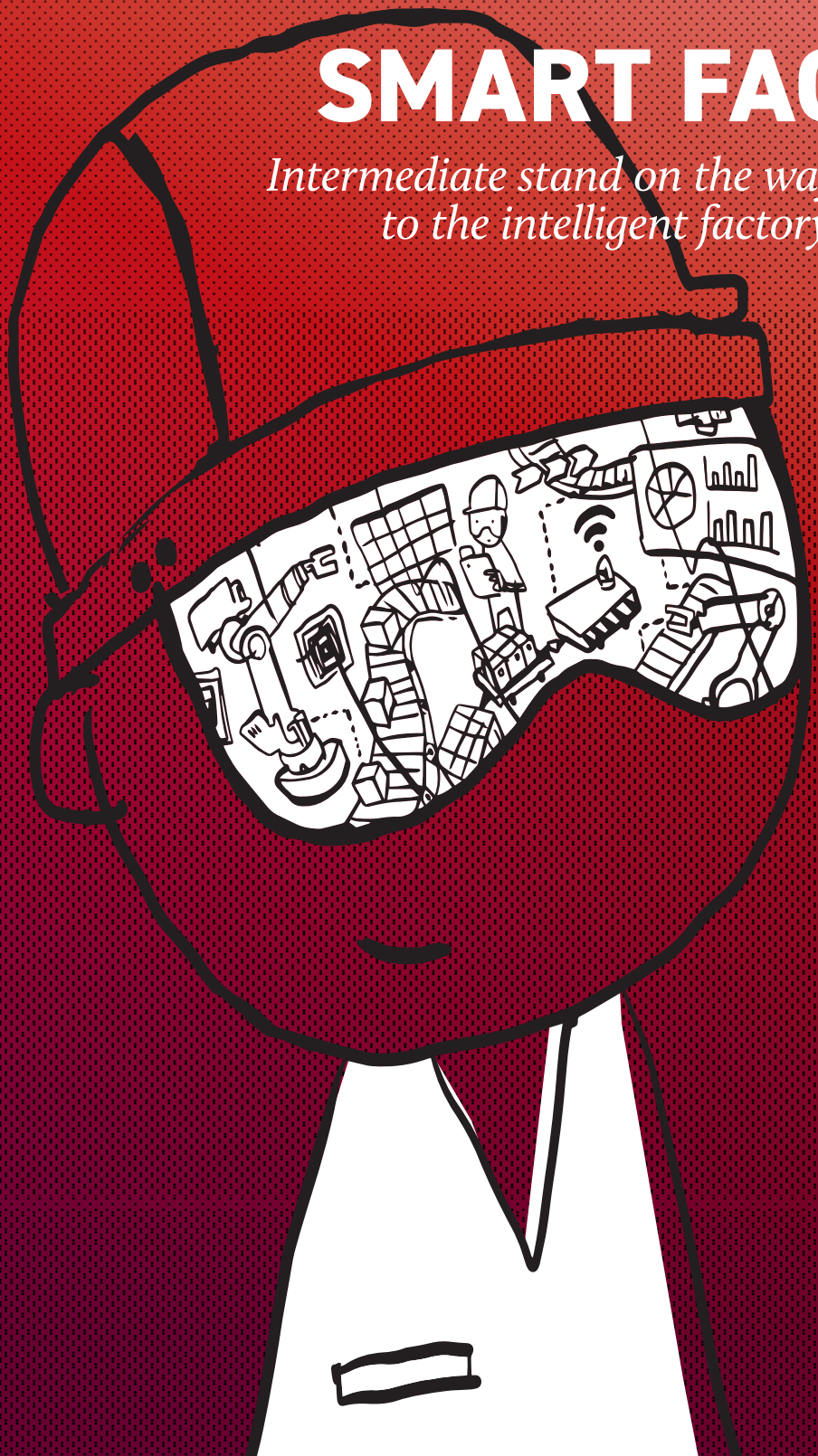
#62

ROIDIALOG

SMART FACTORY 2020

Intermediate stand on the way to the intelligent factory.



ROI-EFESO DIALOG ENGLISH EDITION 62_2020

ROI EFESO
MANAGEMENT CONSULTANTS

CONTENT
EDITION
#62

Hans-Georg Scheibe
Management Board,
ROI Management Consulting AG

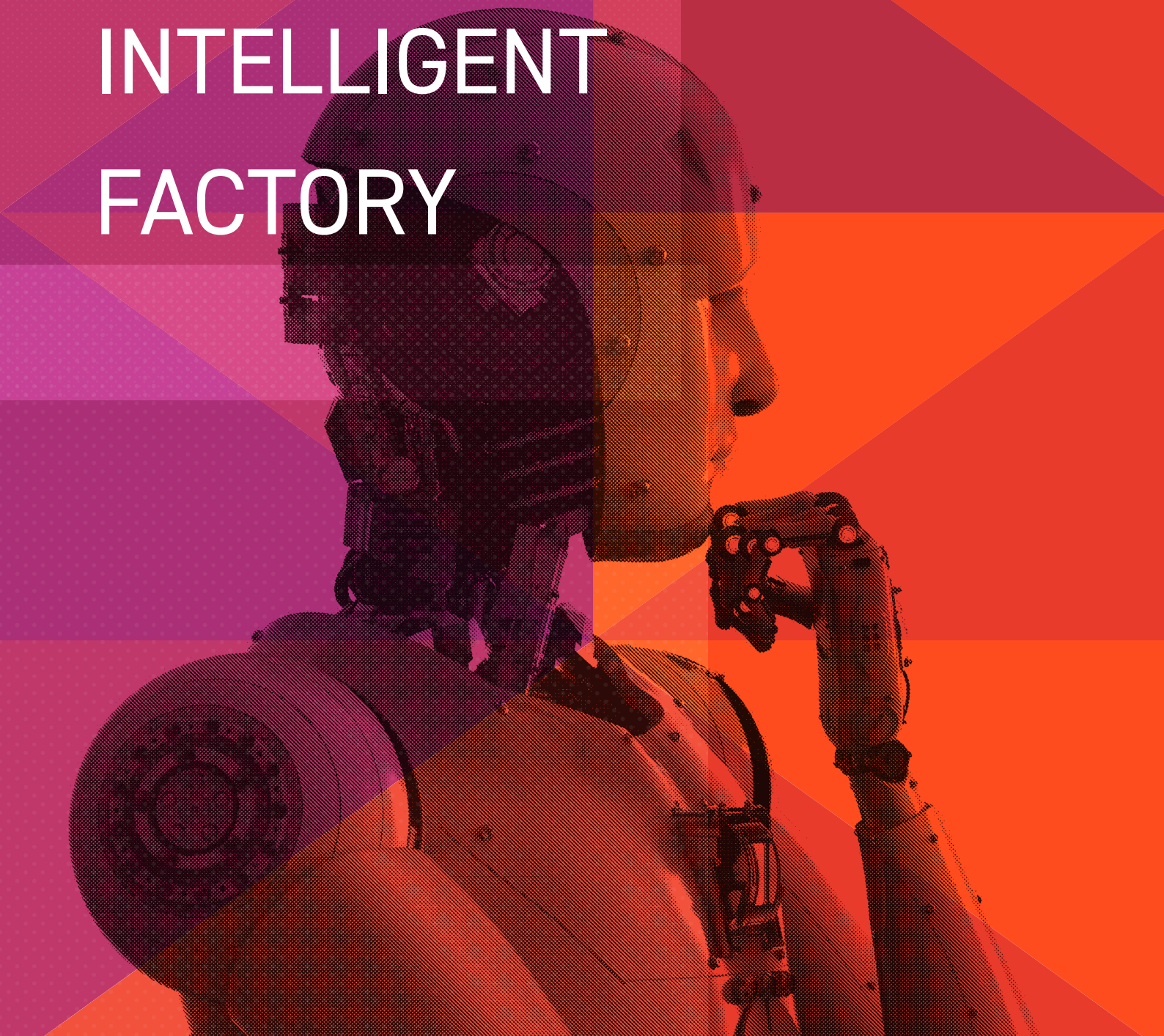
SMART FACTORY, HALFTIME.

IN 2013, WE PRESENTED THE INDUSTRY 4.0 AWARD FOR THE FIRST TIME, TOGETHER WITH THE TRADE JOURNAL PRODUKTION AND A RENOWNED JURY.
The relevance of the topic has changed diametrically since then. What began as a strongly scientific and conceptual vision has become the motor of a profound change in the industry.

Today, and this is perhaps the most important change, no one needs to be convinced of the strategic importance of industrial digitisation - the time of missionaries and evangelists is over. Gone are also the days of fundamental discussions, large-scale regional comparisons and generalist roadmaps. And last but not least: the time of exaggerated, not practically supported expectations is over. Intelligent factories have proven their worth in the exceptional situation of the Corona pandemic. They have made a significant contribution to maintaining operations and have ensured the adaptation and stability of processes. Beyond this, the results of properly implemented Industry 4.0 projects are also remarkable - as a look at the winners of the Industry 4.0 Awards in recent years shows. In the meantime, we have gained solid experience of what is of real benefit in the Smart Factory, the intelligent factory characterised by Industry 4.0 technologies. We have learned how to launch digital initiatives effectively and what framework conditions are necessary. We know the connections between the conception of new and extended business models with the technological framework. And we see that the successful establishment of the Smart Factory depends to a large extent not on technology, but on the process-related and organisational basis and, above all, on the people who create added value and develop creative solutions in this new environment. However, they will only do this if they are given the appropriate framework, motivation and freedom to do so. This too is an essential experience of recent years. With this issue of ROI DIALOG we therefore want to feel the pulse of the Smart Factory concept - and show which cultural, organisational and technological fields of action have emerged as important levers for success.

SMART FACTORY 2020

INTERIM STATUS ON THE WAY TO AN INTELLIGENT FACTORY



THE PATH FROM THE CLASSICAL FACTORY TO THE SMART FACTORY BEGAN SEVERAL DECADES AGO.

Robotics, process automation, sensor technology, ERP and MES systems have paved the way for what we now call the fourth industrial revolution. And yet it is only the digital and intelligent technologies that have been available to us for a few years that have dramatically accelerated this change. However, experience in recent years shows that technological leaps alone do not guarantee successful transformation. Only the interplay of technologies with processes and structures, and above all the reinterpretation and further development of roles, skills and culture can bring about lasting change. Which approaches, strategies and solutions have proven themselves in practice? Time for an intermediate status.

BEYOND THE LINEAR

REDESIGNING PRODUCTION PROCESSES

The potential of the Smart Factory is particularly evident in projects that consistently pursue the triad of technology, process and culture and implement holistic concepts. If one takes a look at the winners of the Industry 4.0 Awards in previous years, this holistic approach has proven to be the key lever for success. The impressive results are further fuelled by the increasing maturity level and the performance explosion in many technologies with rapidly decreasing costs. A current example of this is the Factory 56 from Mercedes. In its car factory of the future, the automobile company shows how the technologies will manifest themselves in concrete terms in production. For example, the car does not pass through various stations in a traditional serial arrangement - instead, the transport systems move between the various islands, creating completely newly designed production steps. The components of the transport systems can be tracked via RFID. All systems and machines are connected via a dedicated 5G network, enabling data to be linked and products to be located at all times on the

PROJECT RESULTS OF THE WINNERS OF THE INDUSTRY 4.0 AWARD

PRODUCTIVITY	OEE	+ 35%
	OUTPUT PER FTE	+ 70%
	SCRAP REDUCTION	- 55%
	ENERGY COST	- 7,5%
AGILITY	LEAD TIME	- 33%
	INVENTORY REDUCTION	- 48%
	TIME2MARKET REDUCTION	- 28%
	CHANGE OVER TIME	- 30%

respective assembly line. Smart AGVs, automatically controlled vehicles, transport material and tools independently and do not follow fixed routes: The networked and sensor-equipped vehicles, which interact with their environment - people, machines or intermediate storage facilities - are able to plan routes optimally within the transport network and to improve efficiency significantly.

AR WEARABLES
NETWORKED EYES

Another technology that has already proven itself many times in production environments is smart Augmented Reality (AR) glasses or comparable wearables. Relevant information on the production process, or on machine maintenance and changeover is shown on the display. At the same time, data is collected and distributed via built-in cameras - the employee's view of the production environment can be shared and made available to the entire network. In intralogistics in particular, the use of such devices leads to significant simplifications and efficiency gains. For example, the employee in the warehouse collects the required parts or tools in the sequence optimised for production and brings them to the place of use. This avoids unnecessary distances and time losses.

Particular in intralogistics, the use of AR wearables leads to significant efficiency gains.

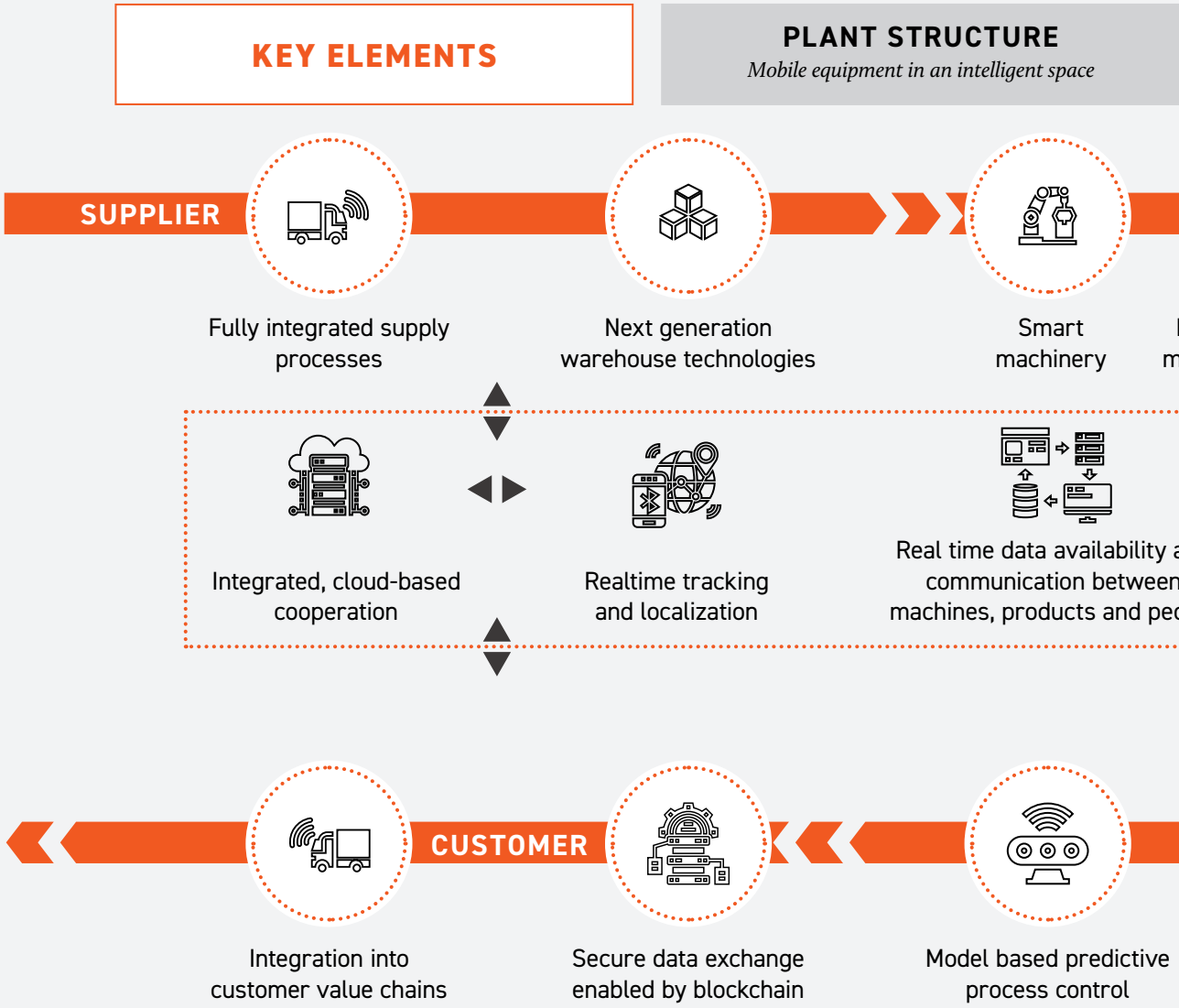
The prerequisites for this are created by machines and production islands that diagnose requirements early and precisely and transfer them to the Factory Cloud, as well as parts and tools whose location can be identified at any time. Further fields of application for the technology are, for example, in remote maintenance: the responsible expert can recognise critical situations on the basis of the data transmitted by the machines, through the glasses of the employee on site, and enable him to maintain the plant using digital instructions.

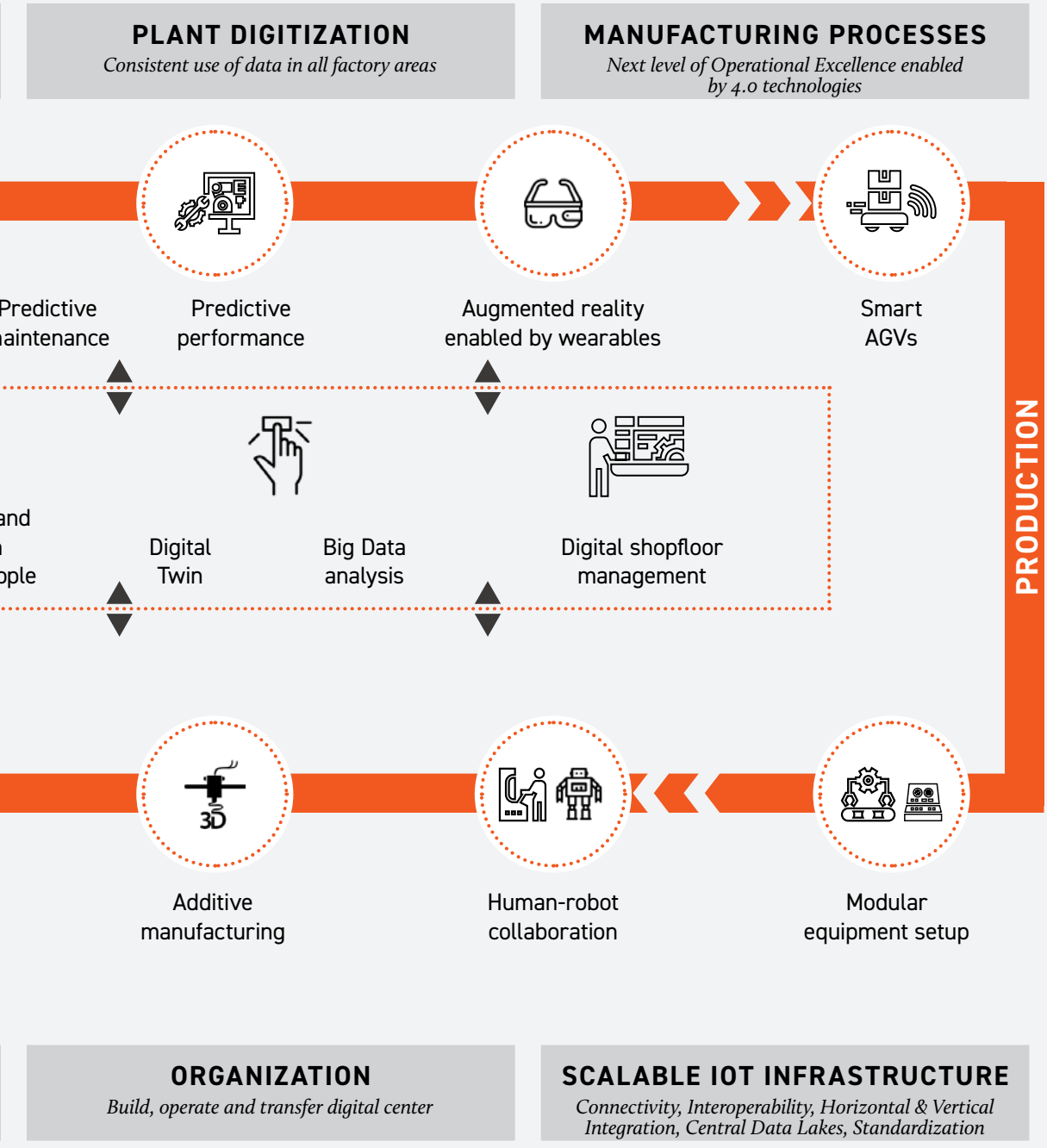
DIGITAL TWINS
WELCOME TO CYBER-PHYSICAL SPACE

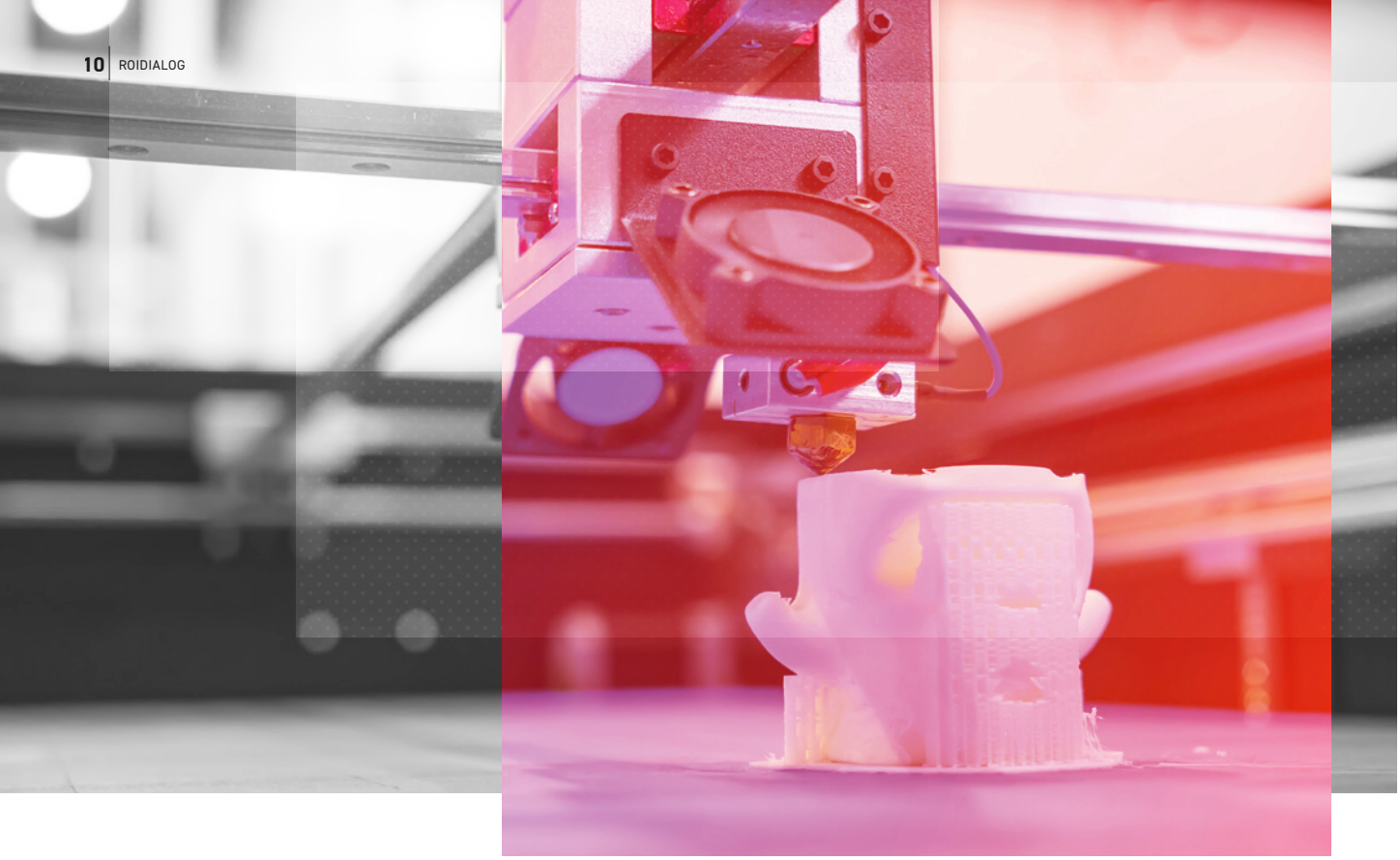
The Digital Twin approach is one of the digital technologies with a particularly large potential for change in terms of the Smart Factory. This "digital shadow" of products, plants or workflows opens up completely new possibilities for the planning and operation of industrial processes. The highly precise and dynamic digital representation of a physical model opens up exciting potential. These include, in particular, a significant reduction in time-to-market and development and industrialisation costs, increased performance throughout the entire supply chain and greater efficiency in maintenance and service processes. In addition, a digital twin also creates the conditions for the development of new service and business models, for example through pay-per-use approaches based on operating data. In practice, different types of digital twins have already established themselves along the product life cycle:

- Digital Product Twin: 3D product models used for simulation, validation and digital prototyping.
- Digital Factory Twin: 3D simulation of processes, material flows or plants that are part of integrated production planning.
- Digital Process Twin: Data models of processes used for real-time monitoring, process optimisation and prediction.
- Digital Service Twin: Data models of end products that form the basis for real-time monitoring, predictive maintenance and operational optimisation.

THE FACTORY OF THE FUTURE IS NETWORKED, ADAPTIVE, EFFICIENT AND SCALABLE




PLANT DIGITIZATION
Consistent use of data in all factory areas
MANUFACTURING PROCESSES
Next level of Operational Excellence enabled by 4.0 technologies
Predictive maintenance
Predictive performance
Augmented reality enabled by wearables
Smart AGVs
Digital Twin
Big Data analysis
Digital shopfloor management
PRODUCTION
Additive manufacturing
Human-robot collaboration
Modular equipment setup
ORGANIZATION
Build, operate and transfer digital center
SCALABLE IOT INFRASTRUCTURE
Connectivity, Interoperability, Horizontal & Vertical Integration, Central Data Lakes, Standardization



The concept of the digital twin in particular clearly shows that the use of the technology is tied to numerous prerequisites. On the one hand, these are of a technological nature. For example, the implementation of these complex digital models requires the targeted use of other technologies. These include, in particular, full PLM integration (3D CAD), simulation tools, industrial IoT and asset management platforms, as well as the use of sensor technology and connectivity to generate and make available the necessary data. On the other hand, the use of digital twins also changes established processes and creates new interfaces and competences. Only when this context is taken into account in a Digital Twin Initiative can the potentials described be realised.

COBOTS

THE FUTURE OF COLLABORATION

A direct change for the employees in the Smart Factory manifests itself in the concept of the collaborative robot. In contrast to industrial robots, cobots do not serve as a substitute for, but rather as a complement to, human labour. ABB, for example, uses this form of collaboration between humans and robotics in the Robot Factory in Shanghai. There, the robots move autonomously between the stations and enable greater customisation than in linear production systems. The 6-axis robots usually work without a safety fence. In order to ensure the safety of the employees, Cobots require highly developed safety functions: Thanks to built-in sensor technology, they can always scan their environment with the highest precision. The sensors are connected via a programmable logic controller (PLC). If a person or object is touched, the Cobot comes to a standstill. Programmable interfaces form the technological basis and ensure additional compatibility. The Cobot technology already shows a high degree of maturity. In the coming years, the main question will therefore be how established forms of organisation and direct cooperation on the shop floor can be further developed through the use of Cobots.

ADDITIVE MANUFACTURING

INDIVIDUALISATION 4.0

The concept of additive manufacturing is causing major changes in production methodology. In contrast to conventional processes such as casting, 3D printing applies filaments and powder of plastic, metal or ceramic in layers. A classic field of application of additive manufacturing is the production of prototypes. But even the production of small series and very specific, individual parts can be made profitable with the 3D printing process. In addition, the technology allows considerable time savings and enables designs that cannot be realised with conventional methods. The potential offered by the exponential progress in 3D printing is impressive and is becoming increasingly important in the manufacturing industry.

It is not only the new production technology possibilities that are interesting. New business models can also be developed, for example through new forms of contract manufacturing and individualisation. And last but not least, the technology also provides a buffer against bottlenecks in the supply chain. However, experience in recent years has shown that not only the mastery of 3D printing technology itself, but also comprehensive process and software know-how are necessary to leverage this potential.

BLOCKCHAIN

WHEN MACHINES MAKE CONTRACTS WITH EACH OTHER

Profound changes in the Smart Factory are also reflected in the communication between companies. The exchange of process-relevant information and documents via traditional EDI solutions is reaching its limits for various reasons. On the one hand, the integration of IT between the value-added partners causes high harmonisation efforts. On the other hand, with the current status quo of technologies, a full digital integration of the IT worlds is enormously

expensive. One way out is offered by block chain technology and its core application, Smart Contracts. These are programmable scripts that ensure an automated flow of business logic across company boundaries, control and forgery-proof documentation of partner interactions and manage data access rights. The use of quickly implementable and scalable Smart Contracts thus reduces the costs of data exchange and optimises tracking and data transfer, for example in order entry and creates the basis for new, token-based business models such as pay-per-use. The first resilient experiences gained with the use of block chain technology also show that Smart Contracts can create benefits not only between the individual partners in the supply chain. More and more companies are discovering valuable application possibilities also within their own production environment.

RTLS

SMART SPACES FOR THE SMART FACTORY

Real-time localisation is necessary to reliably locate goods movements in warehouses with short latency. This is guaranteed by real-time tracking and localisation systems (RTLS). The software, which is accessed via local ERP and MES systems, analyses and visualises dynamic data. This means that objects can be localised with centimetre accuracy at any time. Geofencing, which uses RFID or GPS to determine location, forms the technological basis for this. Fully automated bookings, complete transparency of assets and fewer line stops due to better material availability are just some of the advantages RTLS offers. This creates a new level of visibility and control, making RTLS an essential component of the Smart Factory.

PREDICTIVE MAINTENANCE

MAXIMISED OEE

Predictive maintenance has become a core component of Industry 4.0 with the aim of predicting faults and preventing them by taking appropriate measures. It has become one of the most prominent elements in the Smart Factory. However, building an effective Predictive Maintenance system requires the collection, consolidation and correlation of enormous amounts of data - especially condition and process data of machines and plants. This data gains value in the maintenance area when it is analysed with data analytics solutions such as RapidMiner and used to avoid critical conditions. In the ideal case, machine failures can thus be largely prevented, resulting in an extended service life of the plants, a massive improvement in OEE and greater stability and planning reliability in production.

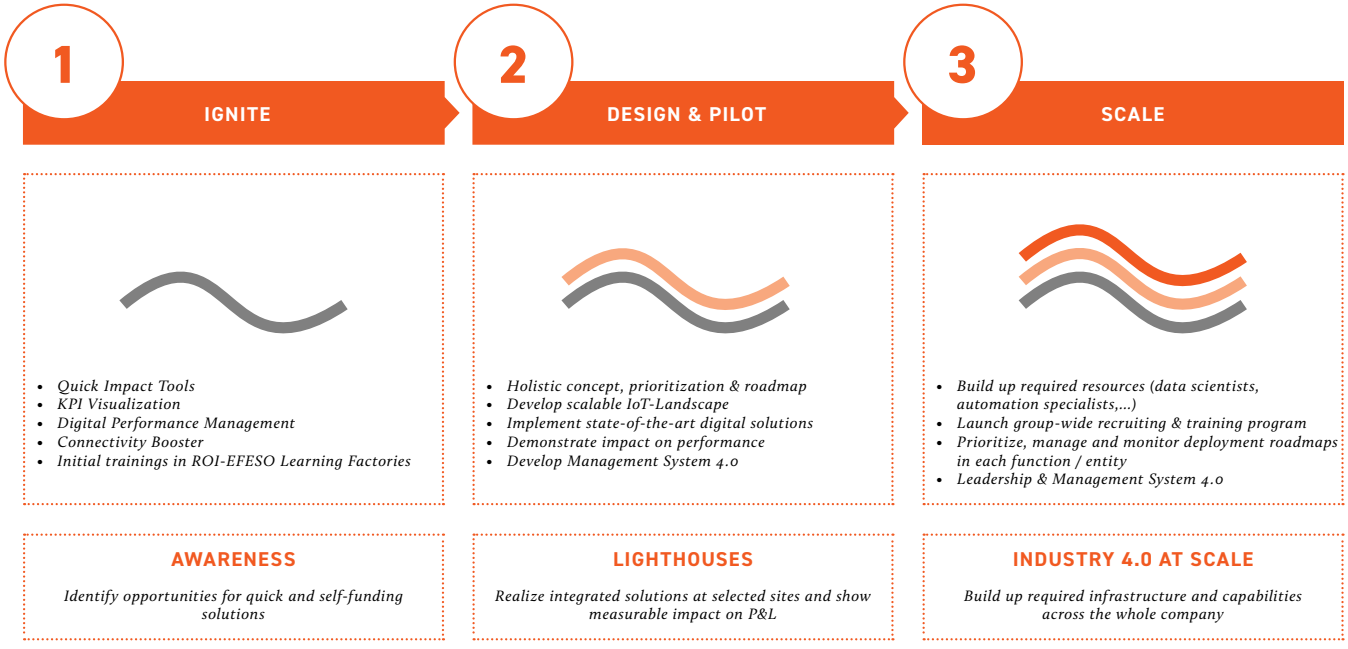
DIGITAL SHOPFLOOR MANAGEMENT

ENHANCED COMMUNICATION

However, the changes in the Smart Factory are not only characterised by new technologies. Rather, they are in a reciprocal relationship with structures and processes that must also change. Changed workflows and forms of organisation, such as the already mentioned departure from line production, are made possible by new technologies. Dürr provides a good example. The machinery and plant manufacturer has broken away from traditional line management and is dividing its automotive painting operations into boxes and short process sections. On the other hand, however, new technologies also require changed framework conditions in order to develop their potential.

For example, the digitalisation of shop floor management and a digital shift book are redesigning traditional communication processes. In this way, all relevant process and status information is collected directly at the sources - such as machines or production sections -, visualised and made available to all stakeholders. The information cascade that dominates in analogue shop floor management is shortened, information deficits and misunderstandings are reduced to a minimum. Employees are thus given more room for problem-solving processes and can

IN THREE STEPS TO A SMART FACTORY



also draw on powerful analysis tools and AI solutions. The advantages are obvious. But so are the risks. After all, the digitalisation of shop floor management also means a far-reaching intervention in the well-rehearsed processes stabilised by informal best practices and the mutual trust of team members. If this intervention takes place without intensive communicative support and does not achieve the commitment of the team, the project will fail. The technology is not self-sustaining - this is also an experience that has been gained in the Smart Factory in recent years.

THE DIGITAL GAP

MANAGEMENT CHALLENGES IN THE SMART FACTORY

The realisation of the Smart Factory, however, also brings profound cuts to established routines, but also to world and role models. The high degree of networking and interdependence - also across companies -, the permanent acceleration of processes and cycles and constant organisational and technological change characterise the Smart Factory. On the other hand, this dynamic also creates a break with the empirical knowledge, self-image and learning strategies of the employees.

This rupture becomes a fundamental challenge for management, which must be met on three levels. On the one hand, intelligent technologies and the abundance of available data and analysis methods also create new approaches to complexity. Deeper insights into production processes and an end-2-end transparency of the entire supply chain can reduce complexity and ambiguity. As a result, decisions can be made faster and more accurately. Knowledge is distributed in a structured and targeted manner, coordination is simplified and learning processes are supported. At the same time, the high speed and change dynamics also demand changed forms of organisation. Agile and decentralised structures and communication platforms create the framework for the optimal implementation of new planning and production approaches. Above all, however, an open communication and management culture is becoming a critical factor: explaining change, reducing fears and uncertainties, raising motivation potential and opening up scope for experimentation and improvisation is becoming a central management task in the smart factory.

THE WAY TO THE SMART FACTORY

KEEPING UP WITH THE MARKETS

The best practices show that a sustainable transformation towards a Smart Factory requires a clear and structured approach based on three pillars The first step is to create attention and overall commitment to change. Ideally, this is achieved through quick, visible and measurable initial successes and, on the other hand, by ensuring a common basic understanding of the issues and goals. In the second phase, lighthouse projects are implemented in individual plants to demonstrate a relevant impact on the profitability of the company and to gain experience. This creates the conditions for finally building up infrastructure and resources for a comprehensive roll-out and scaling up the successful business case throughout the production network. However, the journey is not over at this point, as the particularly successful initiatives of recent years clearly show - on the contrary.

The transformation towards a Smart Factory enables companies to “run with the markets”. Making constant adaptation as effective and friction-free as possible is becoming a core industrial task and a distinguishing feature in competition. It is therefore not surprising that it is precisely the industry 4.0 champions who are quickest to question their own best practices.

NEW WAY OF THINKING

DIGITISATION HELPS US TO TAP INTO THE CREATIVE POTENTIAL OF OUR EMPLOYEES

Jochen Kärcher, Senior Vice President at Bosch Blaichach, on the role of managers in digital shop floor management

Is the classic monitoring and control function of management losing importance and how does this manifest itself in shop floor management?

The leadership role is changing dramatically. We are currently seeing a transformation away from classic control to a coaching process. The manager proactively accompanies the improvement process. This is another reason why communication in shop floor management is becoming increasingly important. The manager no longer controls, but guides and supports the employees in the improvement process. Therefore, it is not only a change, but rather an improvement. Until now, the manager has spent far too much time gathering the data needed for the improvement process. For an initial analysis, digitisation makes the information more easily accessible and much faster available. The time saved can now be used for personal dialogue with employees and for accompanying them during the improvement process. Last but not least, this increases our competitiveness, as the main task of our managers is to tap into the creative potential of our employees. We can only achieve this by intensifying communication, and in no case by reducing it.

To what extent are the demands on shop floor management staff changing?

Employees are now more strongly encouraged to contribute themselves and their ideas. In this context, I am talking about a positive effect triggered by the qualification profiles of our employees, e.g. dual training. More interesting job profiles open up completely new opportunities for skilled workers, as proactive participation is expected. This increases the value of the employees, who are virtually our first line of defence at the plant.

In the Smart Factory, intensive networking across the various departmental boundaries is central. To what extent does this change the classic pyramidal organisation?

The classical work will continue to be in a hierarchical structure, because here it is a matter of linking business standards. When changing business standards and optimising business processes, however, we have to proceed differently. Up to now, departmental boundaries have sometimes hindered us in order to generate corresponding effects. Therefore, working models must change. We are working together more across functions in agile teams. The focus is less on control and more on the underlying improvement process. Especially if you want to change business processes, this can only be implemented with cross-functional cooperation.

Is the leadership role changing in the context of closer cooperation between OEMs and suppliers?

This is a good question. First of all, you have to ask yourself the question about the cooperation model of OEMs and suppliers: Is it more of a partnership model or is it based more on price? Some of our customers still focus strongly on the cost aspect, especially in commodity business. All in all, the cooperation of tier 2 and tier 3 suppliers as well as that of a tier 1 supplier with an OEM must change, because there is still great potential to be exploited. We are therefore intensively pursuing the goal of maintaining a partnership and trusting cooperation with all our partners in the value chain.

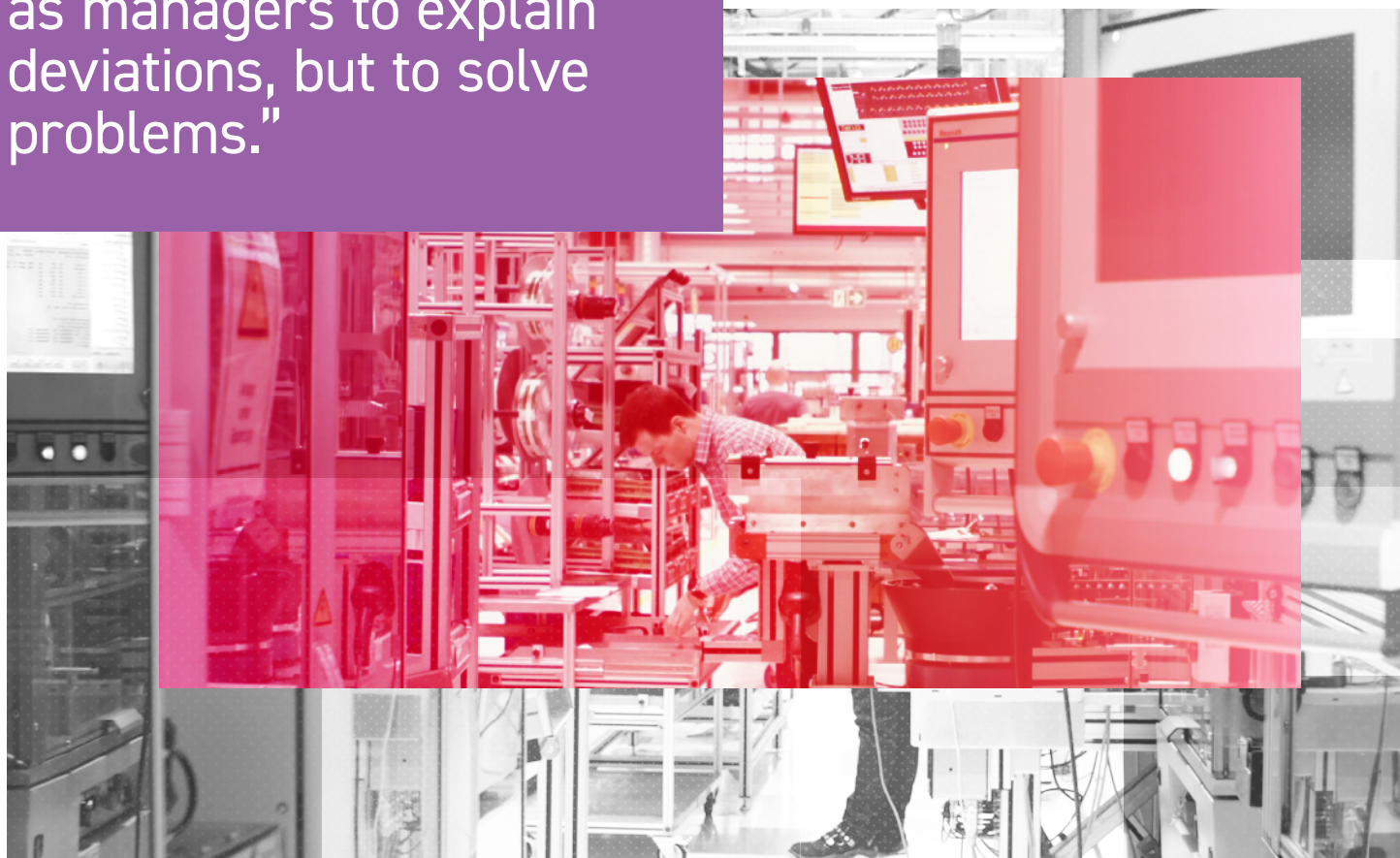
Is creating this basis of trust one of the key challenges for leadership?

Through digitisation, we can easily identify a variety of problems that would not arrive in the classic hierarchical reporting chain. The question is how to deal with them. Our view is that every problem is an opportunity for improvement. However, as problems increase, people sometimes tend to become overwhelmed. Here, the organisation must be trusted to solve most problems independently, i.e. without the hierarchical way. It is also important to prioritise tasks: one should not assume that every problem can be dealt with immediately in the form of deviation management. I believe it is important at this point to note which hierarchical level in the company or which management level is responsible for which problems. It is also important to focus employees more quickly on the issue of problem solving. We can only counter competitive changes by working on our competitiveness. Therefore, problems must also be solved.

Then you see the role of leadership in problem-solving processes rather than in monitoring and controlling tasks?

That is the bottom line. We as managers are not tasked with explaining deviations, but with solving problems. In doing so, we must take advantage of the benefits of digitisation and give employees more personal responsibility again. It must be clearly defined who is responsible for which type of key performance indicator in the company in order to achieve the goals.

> "It is not our task as managers to explain deviations, but to solve problems."



TECHNOLOGIES AND APPLICATION SCENARIOS THAT HAVE PROVEN THEMSELVES ON THE ROAD TO THE INTELLIGENT FACTORY.

BEST PRACTICES OF THE INDUSTRY 4.0

DIGITAL SHOP FLOOR MANAGEMENT

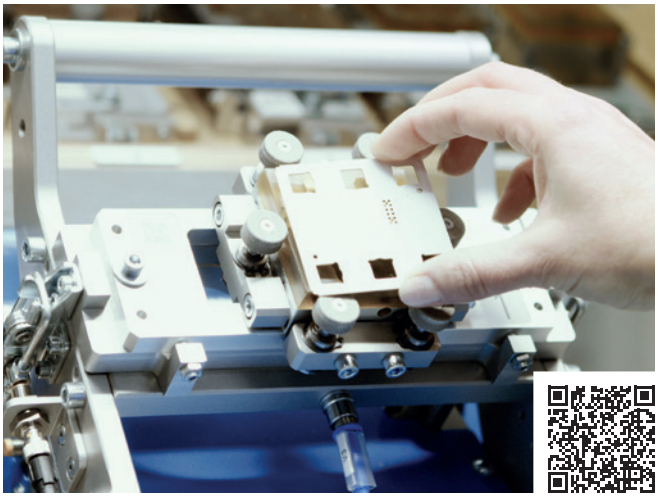
How can the performance of an automotive group be improved? First of all, the status quo with regard to workflows and processes must be determined. It quickly became apparent that there are some duplications in communication. In order to create a central collection point for the transfer of information, ROI-EFESO convinced the automotive group to set up an IoT platform. By means of a uniform reporting system their suitability for practical application was demonstrated promptly.

❮ QR-CODE TO THE CASE STUDY

SMART FACTORY PLANNING

What are the potentials of a pharmaceutical and life science company for digitisation? ROI-EFESO first established the status quo with its Smart Factory Scan by identifying the relevant factors for digitisation. Then ROI-EFESO developed development scenarios and location strategies, which were then analysed in more detail in a next step. Finally, the project team classified the main topics according to specific structuring criteria.

❮ QR-CODE TO THE CASE STUDY



FACTORY OF THE FUTURE

For the factory of the future, individual production means increased flexibility and short changeover times for different products. ROI-EFESO first took stock of the situation to see which elements should be prioritised. Three areas represent the foundation of the factory of the future: A machine park and a production layout should be checked for physical layout. The flow of information is to be checked to see which information is to be recorded at all. And finally, the question of the optimal production system of the future should be asked.

❮ QR-CODE TO THE CASE STUDY

TRANSFORMATION THROUGH SMART PRODUCTS DEVELOPMENT

How can a series developer reconcile his smart products with a disruption? ROI-EFESO took on this task and set up a core team, an Ideation Team and a few bridge builders in its change process. The clash of these working cultures meant a merging of competencies to create valid prototypes. Once these prototypes have been developed, the team is dissolved. This combination of teams not only adds value to product development, but also helps to break down silo mentalities.

❮ QR-CODE TO THE CASE STUDY

DIGITAL PROCESS TWIN

A digital twin can help for a better understanding of a production plant, for example. ROI-EFESO was given the task of reducing the reject rate of the high number of variants. It was therefore necessary to find out which process parameters could influence performance and the quality result. Based on a collected database, a model was developed in a cloud application. This “Digital Process Twin” monitored the physical process in real time and allowed early intervention based on critical process parameters.

❮ QR-CODE TO THE CASE STUDY

AGILE METHODS IN SOFTWARE DEVELOPMENT

Agile methods are also used by an energy supply company. The primary aim is to make the R&D team more agile. ROI-EFESO first analysed the status quo of its units and processes in the R&D area. Then the appropriate transformation methods were selected and implemented. From these steps, ROI-EFESO drew a best-practice process map for the R&D department.

❮ QR-CODE TO THE CASE STUDY

ELECTROMOBILITY: NEW MANUFACTURING PROCESSES

The automotive industry needs new approaches to autonomous driving. Because this brings with it completely new functionalities and communication channels. ROI-EFESO examined the processes and procedures by providing a new concept in terms of anticipatory production and quality. The use of a Digital Process Twin also made it possible to carry out the first successful verifications.

❮ QR-CODE TO THE CASE STUDY

END-TO-END DIGITISATION

When a company is very broadly based and each brand has its own sales channels, a uniform end-to-end process must be designed. ROI-EFESO relied on two teams - one was responsible for the back-end integration of the IT and ERP systems. The other was responsible for setting up a digital channel. Thanks to the company’s strong affinity with digital tools, ROI-EFESO was able to restructure processes across all sales channels and for all brands.

❮ QR-CODE TO THE CASE STUDY

VOICES AT HALF TIME SMART FACTORY

ROI-EFESO EXPERTS ON SUCCESS FACTORS AND CHALLENGES ON THE WAY TO THE SMART FACTORY

ARCHITECTURE DESIGN FOR THE DATA WORLD

> The greatest challenges in handling data are not of a technical nature."

Gernot Schäfer,
Partner, ROI Management Consulting AG

What has changed in recent years in the handling of data in the Smart Factory?

The focus is increasingly shifting away from individual pilot projects to holistic, integrated solutions. More and more companies are approaching the topic of analytics in a planned, strategic and conceptual manner - both in terms of the view of the entire production process and with regard to the holistic data model of a digital factory. This also applies to integration into the overall environment. Keyword Architecture Design: How do I introduce Analytics into existing legacy systems and as an integration scenario into the existing IT solution world?

Against this background, where do the greatest need for action and challenges currently exist?

The biggest challenges are not primarily of a technical nature, but lie in the approach. It is not enough to apply the roadmaps of individual providers of digital solutions - on the one hand, a broad, cross-technology and systematic approach is needed to identify potential. On the other hand, it is also necessary to take into account the specifics of your own organisation, which are not reflected in standard models and recommended procedures. Companies must ask themselves the following questions: How do I formulate requirements? How do I define my options in the development plan? The procedure is often such that one relies on the expertise of well-known providers and their procedural models. The starting point should always be your own roadmap and the individual situation, your own setup.

> "The starting point of data analytics projects should always be your own roadmap, individual situation and setup."

In production landscapes, old and new machines often coexist, producing different, sometimes incompatible data sets. How do you have to deal with this heterogeneity?

Everyone knows the situation of different data sets. Many of the companies we talk to as part of our projects or in the context of the Industry 4.0 Awards have a wide range of technologies. The companies typically see their specific problems here. But these are usually the same. The challenge is not primarily whether old machines are Industry 4.0-capable, although this aspect is often the focus of attention. Rather, the task is to use retrofit approaches to extract the relevant data from the process. This requires some manageable investments and clearly defined steps in the project.

Which data types are to be distinguished and how do they have to be generated?

What we need are the structured metadata from the production data model. This applies specifically to products, orders, variants, attributes, batches and production orders. This is the structured data world that we know from classic business applications such as ERP, BDE and MES. On the next level are the unstructured data. These are machine, status and process data as well as production process parameters. This is followed by data which we generally summarise under the term Condition Monitoring. These include measurements of temperature, humidity or vibrations. We initially record these in isolation from the structured, systematic production process. All these data together then form the basis, one could say the raw material, for the data model to be set up. With some machines it is more difficult to generate the data. In some cases further steps are necessary. Sometimes additional sensor technology is needed to measure and record the data.

Do the machines, some of which are decades old, represent an obstacle to factory-wide digitisation?

No, an older machine park is definitely not an obstacle to the successful implementation of Industry 4.0. Practice shows that the creation of an integrated data model, with which analytics and machine learning can be successfully operated, is possible in a few weeks. And this also applies when a factory has both new plants with programmable logic controllers (PLC) and old machines. In the meantime, there are already many proven and effective approaches to make older machines smart.

To what extent does the legal and regulatory framework, such as the Supply Chain Act, play a role in data management in the Smart Factory?

The keywords here are tracking and tracing and the mapping of all relevant and verifiable product and process data by the digital twin. The legal and regulatory requirements, which are reflected differently in each industry, play an important role, e.g. an ISO standard in medical technology or an FDA standard in the pharmaceutical industry. Companies are required to comply with certain regulations. But that is just one aspect of the topic. Because at the same time, the industry sees that traceability and process transparency for customers are also rapidly gaining in importance. And finally, it is also a question of their own performance: if errors and risks are detected early on, costs can be saved to a significant extent, process times shortened and bottlenecks avoided.

> "An older machine park is no obstacle to the successful implementation of Industry 4.0."

If, for example, a batch or series is already halfway through production when the error is detected, you have an immense disadvantage compared to a competitor who detected and eliminated the same error very early. And, of course, the end-to-end perspective, the integration of customers and suppliers in the supply chain, is also critical to success here. This is exactly what the cross-company data models and digital process chains are aimed at. In a nutshell: Regulation is an important driver for change. But it is by no means the only reason to ensure transparency and traceability in the supply chain.

What contribution does an effective use of data analytics make to increasing resilience and flexibility?

A very important one, if you can map the supply chain digitally and in real time. With the block chain approach, for example, a very decisive driver comes here. In Smart Contracts I can implement exactly that between the individual companies in the value-added network. A batch is mapped as a block chain object with all production data, material data, production process data, quality data and batch attributes. And that is exactly the necessary basis. Because I can only be resilient and flexible if I can recognise certain trends at an early stage, clearly assess their effects on various aspects of my production thanks to clean data, and thus take precise measures at an early stage.

Which mistakes and misunderstandings in dealing with data and data analytics do you observe particularly frequently?

I have already mentioned one major misunderstanding. You don't need ultra-modern production facilities and networking implemented at the highest industry 4.0 level to obtain data and use it productively. Another misunderstanding concerns the step-by-step approach that is necessary to model data and work with it in a meaningful way. This is often underestimated. It is not as if a KI solution could push all structured and unstructured data into the data cloud at the push of a button and process them there. Data modelling requires theses and correlation assumptions and a logic that fits the production process. Only then can added value be created. And this is a learning process that requires several iterations.

Every day a thousand things happen in the factory that cannot be standardised."

SUCCESS KILLERS OF CHANGE

Prof. Dr. Werner Bick,
Senior Partner, ROI Management Consulting AG

Professor Bick, looking back on the last five years: What has changed in the field of smart factories, which factors have proven to be critical for success?

I think we are at a different stage today than five years ago. At that time, companies wanted to find out above all how relevant Industry 4.0 was for them. Does anything need to be done at all? And if so, what are the areas that offer potential? Today, the strategic relevance of the Smart Factory has reached industry across the board. The focus is on the challenge of prioritising the individual topics in view of limited resources and generating results quickly. Ironically, this is also where the danger lies: because the best recipe for ensuring that nothing happens at all is to take on too much. A project typically starts with an assessment, from which potential initiatives with regard to the Smart Factory are derived and placed in a portfolio. Such a portfolio will contain perhaps 40 to 50 potential initiatives. And the worst thing you can do is to start with 30 of the 50 in the first step. Because then nothing will happen at all. We advise our clients to start with maybe two or three initiatives. But these must then be brought to life consistently - and only when these initial projects are largely completed do we consider what comes next.

What is the reason why people then so often act differently, get bogged down and fail to get things done?

It is not unusual for top management to be impatient and put pressure on the team. They want to start quickly, see results quickly - and as many of them as possible. At this point, the corporate culture proves to be a decisive factor. In companies where it is not common practice to constructively contradict the management, an action plan is then drawn up. In fact, many people already know that this is too ambitious and cannot work. But nobody has the courage to say, let's concentrate on one or two things.

And it would also be absurd to demand this courage from the employees. And so projects are created that are "set up to fail". That is why this problem is far less pronounced in companies that work together on a cooperative basis, where discourse is part of the corporate culture.

So are too high expectations, pressure and fear the main reasons for failed projects?

That is at least one very important aspect. Another pillar of failure is to approach the issue at too high an altitude. The realisation of Industry 4.0 has a lot to do with experimentation and fault tolerance. You have to be prepared to get carried away if you enter uncharted territory. One or two things just won't work. But at least then you know that it won't work. As a company, you have to give people a certain amount of freedom to try things out and gain experience as a team. Of course, in the end, the whole thing has to work from a business perspective. But you must not see the way there as a straight track.

Now, "Trial & Error" has been preached for years, without the feeling that there is a lot going on in practice. How great is the actual willingness to act on this principle?

There are certainly companies that take this very seriously. A very good example is the BMW plant in Regensburg, which received the Industry 4.0 Award in the special category "People & Communication" in 2018. There they have managed to involve their employees. A lab has been set up in which people are given room to manoeuvre, and not only on Industry 4.0 topics. Nothing is created in an ivory tower, but always very close to the practical requirements of the factory. And this combination works. The people are very committed, there are over 100 decentralised initiatives. A steering committee makes joint decisions and sets priorities. This in turn takes the pressure off the individual employees and something really happens afterwards.

Assuming that the framework conditions are right, but are people really willing to get fully involved, is this where the real "Google spirit" emerges, so to speak?

Yes, absolutely! It is not that we do not have people in the manufacturing industries, but rather that we do not demand and promote them accordingly. We must create the opportunities for people to develop. And that requires - as I said earlier - a culture that supports the whole issue. That is a question of mindset. If I have a large number of highly qualified and, above all, very creative employees, then that falls on fertile ground. What do many of them do away from the workplace? They pursue their own projects. There are gifted software developers and craftsmen who do all kinds of things in their spare time. So why not create the framework for this creativity in the company as well?

These spaces for creativity, but also many core processes in the factory, rely on strong informal communication networks. Will they remain useful and necessary in the Smart Factory?

Yes, 100 percent! Of course, stable and standardised processes are essential. But there are also a lot of things that happen every day in a company that cannot be standardised. The question when you talk about the Smart Factory is not whether you continue to communicate with each other, but how you can intelligently support communication. An example of this is the shift book, which used to be kept physically and is far from being thorough all the time and everywhere. This then led to information going badly between shifts - until it was not clear which job had which status. Or a machine was constantly malfunctioning. The solution was found, but not communicated to the next shift. Today, there are digital shift books that can be set up so well that the maintenance effort is low and the information flows directly from the machines and workstations into a cloud and is immediately accessible, perhaps even via a smartphone app. When the shift is handed over, everyone will then have the same level of information. I still have an intensive communication process, but it is simply much smarter and better supported.

In addition to informal communication, implicit expert knowledge is something that persistently eludes standardisation. Does the Smart Factory offer new solutions for this?

If people regard their experience and expert knowledge as dominating knowledge and are not willing to pass on this knowledge, you fail, no matter what tool you use. This was also one of the most important reasons why the ex-

pert systems of earlier years did not work. The question is why this willingness is missing. If a culture is characterised by fear, then it is not surprising that knowledge becomes a defensive weapon for the employee, and they do not want to share it. This is dramatic, because today we finally have the technical means to make this knowledge globally usable. Because we have the communication platforms to do so, which did not exist before. But you have to generate trust and identification so that people are prepared to make the implicit knowledge available to the company in a structured and documented way. In some companies it is a matter of course for employees to share knowledge. Today there are very good examples of such expert teams working on problems on a global basis in a global network, using knowledge tools. But even if all this works, it will always need experienced people, because some things simply cannot be formalised. And this appreciation of experience must also be anchored in the culture.

Doesn't rapid technological and social change lead to a generation gap between management and young employees? Do we still speak a common language?

Apart from the symbolism, management teams are still quite homogeneous. It is usually not quite so young people who have come to these management positions through a long classic career path. There are very open-minded, very agile people. But still it is not always easy to place some topics. So you need a mediating level. People, perhaps department heads, who are both able to package messages in such a way that they reach a political level and to communicate with the young team in an Innovation Lab. Because I doubt whether these two very different worlds can always be let loose directly on each other. And that need not be the case if there are levels at which such activities are consolidated.

So the function of the interface manager, who is culturally and procedurally at home in both worlds, becomes more important in the Smart Factory?

This is a real criterion for success. You need experienced mediators between these systems and cultures, social translators who moderate and give impulses. They help to pick up ideas from the private lives of employees with a digital affinity and bring them into the company, and also help to build bridges within cross-sectoral ecosystems. This mediating role is relatively new. But I believe it will develop into a very important function within the company.

"If people regard their empirical and expert knowledge as dominating knowledge and are not willing to pass on this knowledge, you fail, no matter which tool you use."

OPEN THE BLACKBOX

> Digitisation creates room for manoeuvre and strengthens competitiveness."

Jonas van Thiel,
Principal, ROI Management Consulting AG

Let us look at the topic of Smart Factory and Industry 4.0 in the context of process industries. Where do you see a need for action here? And what promises can the Smart Factory make in the process industry?

In the process industry we find different conditions than in discrete manufacturing. Connectivity and process monitoring are standard. The processes in the process industry can certainly be compared to the implementation of a cooking recipe. Different raw materials and pre-products are either added successively or mixed together in one set. This process is continuously monitored by SCADA systems. The great challenge in the process industry is not to introduce and operate such systems, but to integrate them with the planning processes, production sequences, approvals and controls. Connectivity is usually provided. However, it is not consistently used to optimise and simplify the control process. Often the link between the subsequent processes and to the planning areas is missing.

Against this background, what steps must be taken to make production really smart?

Traceability is a crucial aspect - regardless of whether chocolate, whisky, cosmetics or medicines are produced. Today, one often has the situation that traceability and control cannot be produced automatically and without media

breaks. Data is still often transferred manually from screens to slips of paper and then transferred to another system.

The more dynamic and critical a process is, the greater the associated risks and inefficiencies. The SCADA system actually contains all relevant information. But the interfaces in processes with many finishing stages and several systems involved destroy efficiency. Breaks between system worlds can unfortunately be observed in many plants.

Why are there no solutions, even after decades, to comprehensively and sustainably integrate production and make it transparent?

There are certainly solutions, such as the interaction of SCADA and ERP systems. But they do not always cover the reality in the factory. An example: The employee can automatically call up centrally stored recipes at the plant and knows which materials are used. If he proceeds exactly according to plan, that is sufficient. But if this employee has extensive experience, which is often the case when producing fine whisky or rum, for example, he may be able to modify the recipe slightly on his own.

He may then write down the material numbers he has added. But not the modified ratio. Someone else will then enter it into the system at some point - and will not have all the information. Traceability is not guaranteed. In general, the fact that manual processes are complex and sometimes error-prone, but well-rehearsed, also plays a role. "Never change a running system" plays a certain role. But this is changing more and more, the advantages of integrated, automated approaches are becoming increasingly clear.

What potential does digitisation in the process industry offer beyond the individual plant, i.e. with regard to the supply chain?

The opportunities are generally always at the interfaces in the value chain. Where my processes and the supplier's processes have to mesh. At these points, a smooth and automated transfer of data is also immensely important. Especially if certain parameters such as temperature and humidity have to be monitored continuously and in real time, but also if traceability really has to be seamless. This is where the harmonisation of data sets and the automatic management of interfaces can unlock great potential - in terms of efficiency, quality and compliance.

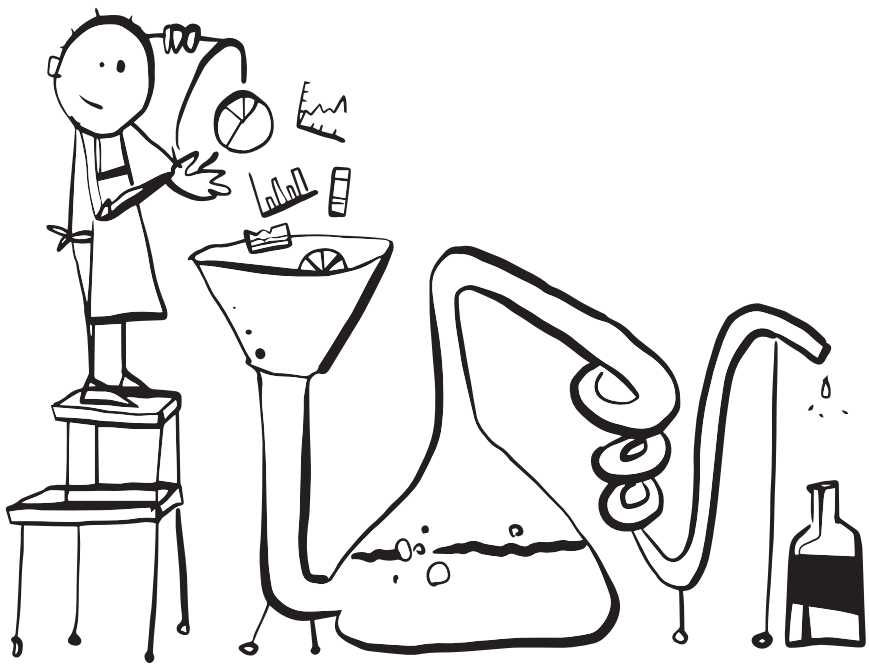
Let us take up your example of the production of high-quality spirits again. The transparency that results from a complete digital recording of processes also makes implicit empirical knowledge explicit. This weakens the position of an experienced master distiller. Does this development hold conflict potential and the danger of knowledge loss?

It depends on how one deals with this development. A master distiller has a high level of expertise. However, he may not understand why process parameters should now suddenly be monitored and evaluated by systems with regard to product quality. Because that is exactly his job - even his art! He uses his senses to test the product. At this point it is important to show that one does not want to replace, but to help. After all, what are the goals of digitalisation in production? To stabilise the process, to predict poor quality, to be able to plan comprehensively.

To use the data to understand when deviations occur. Not only solve problems, but massively accelerate the solution processes and gain resilient, available knowledge from each such process to become better and faster and thus more competitive. You have to make sure that employees can rely on the system to use their time, experience and talent for high-quality activities. Digitalisation does not disenfranchise, but creates creative freedom and makes companies more robust. The challenge is to communicate this clearly and credibly and to demonstrate the benefits to every employee. This is already associated with a profound change in the mindset. And it requires a great deal of trust and appreciation from everyone involved.

What is the impact of these changes, of digitisation, in the process industry on innovation and for example on the individualisation of products?

Individualisation does not play as big a role in the process industry as it does in discrete manufacturing and is more of a marketing issue. But one has other possibilities. You can make the whole process of distillation transparent for the customer, I can clearly show which ingredients were used and create a "product journey" for the customer. One can use the time of the top experts to continuously improve quality and develop new recipes in creative but data-supported processes. Our project experiences show that people go along with this path. We experience that for real experts who are passionate about their profession, it is not the knowledge of domination that is in the foreground, but the desire to create outstanding products of which they can be proud.



> In the future, managers must define themselves as enablers of their teams and draw motivation and recognition from this."

THE ART OF INITIAL IGNITION

Sebastian Diers,
Vice President, EFESO Consulting GmbH

CO-EVOLUTION OF CULTURE, ORGANISATION AND TECHNOLOGY

Mr Diers, there have always been changes, even profound ones. What is different today, or why do we talk so much about transformation?

> "A natural growth of corporate culture and technology is no longer possible. The dynamics of transformation must be actively managed."

Of course there have always been phases of dramatic change. But nevertheless, what we are experiencing today is different. Firstly, we have extreme networking at all levels. This produces a complexity that makes decisions and forecasts extremely difficult, sometimes impossible. The speed at which information circulates globally and events have a global impact is very high. That is the second aspect. The third is massively shortening cycles. Technologies, business models, product life cycles - this leads to a massive increase in the pressure on companies to adapt. Change is no longer linked to individual disruptive events and individual technological or social trends, but has become a constant in our lives. It is no longer possible for corporate culture and technology to adapt and grow "naturally" with the company. The dynamics of transformation must be actively managed.

How can organisations deal with this dynamic, which is also evident in a Smart Factory?

The essential question in a transformation is the roles and behaviour of people in the organisation. In the Smart Factory, not only individual activities change, but many processes and structures - and that very profoundly. Virtual and real processes merge, new production logics emerge, customer wishes have to be fulfilled in a highly individualised manner and sometimes in real time. Business models are also changing - for example, as new services and billing methods are developed. Completely new roles and activities also emerge, or existing roles must be reinterpreted. For example, there are technologies, such as data-based problem

> "What is required is a big picture of the transformation that is not one-dimensional, but all relevant Success factors are linked and guided by a clear vision. "

solving for maintenance and planning, which are strongly integrated into and change daily processes. To meet this pressure for change, cooperation must become more agile, flexible and effective, problem solving must be accelerated and new tools and methods must be used effectively. This also applies to the management system - intensive communication, target planning and control mechanisms across all levels of the organisational structure, iterative improvement processes, the possibilities for self-organisation and autonomy of individual teams and much more. Otherwise the innovations cannot develop their potential and instead cause negative effects.

What negative effects do you mean and what is necessary to avoid them?

Massive changes always create uncertainty for us at first. With regard to our own role and position, with regard to the overall objectives, the value of our experience. There is a very great need for interpretation and also an unrest in the organisation. The management must take action here - it must provide a clear picture of objectives and a vision, open up individual perspectives, actively empower employees to fulfil their changed roles and establish sustainable processes and structures. And it must communicate and explain a great deal and intensively. The introduction of new technologies is not enough for a real transformation. It requires a co-evolution of behaviour, processes and structures - the creation of contexts in which the new solutions can really add value.

> "Real transformation requires not only new technologies, but the co-evolution of behaviour, processes and structures."

This also includes a critical assessment of the corporate culture. If you have a culture that is characterised by rigid processes and hierarchies, low fault tolerance and a lack of freedom, it will hardly be possible to motivate the people in the organisation and take them on the journey. A destructive tension and discrepancy arises, which means that leadership and management cannot be fruitful. What is needed, therefore, is a big picture of transformation that is not one-dimensional, but links all relevant success factors and is guided by a clear vision. In addition to the corporate goals, the question of how change can be organised in such a way that fears of change are counteracted and employees have a sense of achievement must be discussed. At the same time, successful change requires a high level of involvement and commitment from the management. It is not a topic that can be delegated entirely to experts and project teams, nor is it a topic that can be managed timidly and at half speed.

How do you raise the sensitivity of management teams to these requirements and what approach is generally appropriate to tackle the transformation correctly?

We always start with a comprehensive assessment and show the management team what is required in their company to create that very big picture. The prerequisite for a target-oriented concretisation of the work steps is a systematic cascading of this strategic target picture across all levels and functions. In the next step, we concretise the requirements and define the work steps, also on the basis of successful use cases. In doing so, we also evaluate the options that arise from new technologies for optimising this process. Basically, three thematic complexes must be considered. The real art lies in the initial spark, in creating the momentum for the transformation process: communicating the vision clearly and simply, conveying urgency and creating the greatest possible unity within the organisation. On the one hand, this requires a broad leadership coalition.
On the other hand, you need torchbearers and supporters at all levels of the organisation. A good communication concept is absolutely essential to establish an intensive, target group-oriented dialogue. And you have to make sure that the blockers are put out of action and do not torpedo the process. A second aspect is team dynamics. I have to consciously put together the people who work together in the new work situation and bring the right characters together. In order to have a powerful team, it is not enough to have only skystormers and daredevils. A team also needs people with a guardian function who work with different perspectives on situations and different approaches to situations. You have to convey that nobody is perfect - but a team can be. This is a great motivating force. After all, the focus should be on the managers. For many managers, dealing with an increasingly autonomous and effective organisation is not easy.

Leaders need recognition to be able to fulfil their role. If employees are less concerned with routine tasks and more with independent problem solving, there is a lack of "recognition resources". To counteract this, the leadership role must also change from professional leadership to leadership of people. In the future, managers must define themselves less as "protective" problem solvers and more as enablers of their teams and draw motivation and recognition from this. A mix of intrinsic and extrinsic motivation is required. In this way, the company can promote this process by setting goals, targets or role expectations and also establish a feedback culture, which in turn has a confirming effect and, all in all, leads to a cultural change in the organisation.

A core element in the conception of the Smart Factory, and of a smart organisation in general, is the greatest possible transparency - a development against which there are certainly reservations.

If companies only increase transparency and raise requirements, conflicts are inevitable. Transparency must not be an end in itself, must not be reduced to data obsession and must not lead to employees feeling at the mercy of others. They must therefore be given the tools to deal with the increase in transparency. This is about empowerment, but also very much about a management philosophy that lives a culture of error across all levels. Successful change depends on innovation, improvisation and creativity. And thus on a differentiated approach to mistakes. If it is possible to establish such a culture, transparency becomes a good experience that leads to more openness, progress and resilience throughout the entire organisation.

"If we as a corporate culture can succeed in learning from our mistakes then this newly created transparency actually becomes a positive experience."

BOOTCAMP FOR THE SMART FACTORY

Tayfun Kaymakci,
Head of Learning Campus, ROI Management Consulting AG

Fit for Industry 4.0 - practice-proven qualification at the Learning Campus of ROI-EFESO.

The majority of participants in your training courses are managers. How much does the classic manager need to know about Industry 4.0 and Smart Factory?

This depends very much on the participant's area of responsibility and also on the strategic orientation of the company with regard to Industry 4.0. The more specific the participant's field of activity is, the deeper the need for qualification in a particular topic. For example in the collection, analysis and use of data. In the case of production management or plant management, this does not necessarily mean that they must have full knowledge of every technology or data use model. It is more important to know the overall context and overall benefits of a smart factory and to be able to define the way there for the company. This is the strength of our seminars: On the one hand, to provide a sound overview of Industry 4.0 to a certain depth, and on the other hand to show how the individual elements of Industry 4.0, such as the use of digital technologies, lead to process improvements and efficiency gains in the factory. Therefore, many of our seminars also include case-related simulations as well as practice-proven application examples from industry. Here you can see very clearly the added value that the technologies bring to the factory, both for the employees and for the entire company. This helps managers to get a feel for what the right technologies and the right Industry 4.0 approach can be for the company.

ROI-EFESO has already been conducting training courses around Industry 4.0 for several years. How have the participants' previous knowledge, initial situations and questions changed?

It can be observed across the board that the need for training is still very great. One must not forget how new the topic is for companies, even though Industry 4.0 is increasingly coming into focus. There is still no comprehensive prior knowledge and not much concrete experience. The initial situation is also similar in principle. The participants have often gathered a certain amount of know-how about individual technologies, also from working on concrete problems in their companies. Sensor technology and

smart robotics are very good examples of this. What is usually missing, however, is an overarching view of the topic of Industry 4.0, an overall vision of how Industry 4.0 can change and advance the company or its own area of responsibility. Developing such a vision is challenging, it requires a broad and networked knowledge.

What is necessary to make the implementation of Industry 4.0 strategies successful?

Let us take the situation of a plant management as an example. She knows what initiatives should be taken in the factory. But when a new cloud provider comes into play, for example, this causes uncertainty and the need to adapt the roadmap. It can happen within any level of the organisation that a new tool, a new system is introduced and previously planned digitisation initiatives can no longer be implemented as planned. It is therefore essential that in Industry 4.0 projects several disciplines and departments cooperate and agree on planned activities on a regular and above all short-cycle basis. After all, such projects are always about investment and staff capacity. A tried and tested approach is to determine the actual fields of action of Industry 4.0 for your own company. To what extent do you want to expand digitisation within the factory? Which target image is derived from digital networking with customers and suppliers? And what does this mean for the downstream architecture? So this is a process that helps to promote the topic of Industry 4.0 step-by-step within the company and thus also gives managers and all employees acting on the shop floor the necessary security to implement the task packages in the right order in a targeted manner.

Isn't digital shop floor management counterproductive for this exchange in particular? Doesn't automation cause a certain loss of communication between employees and line managers?

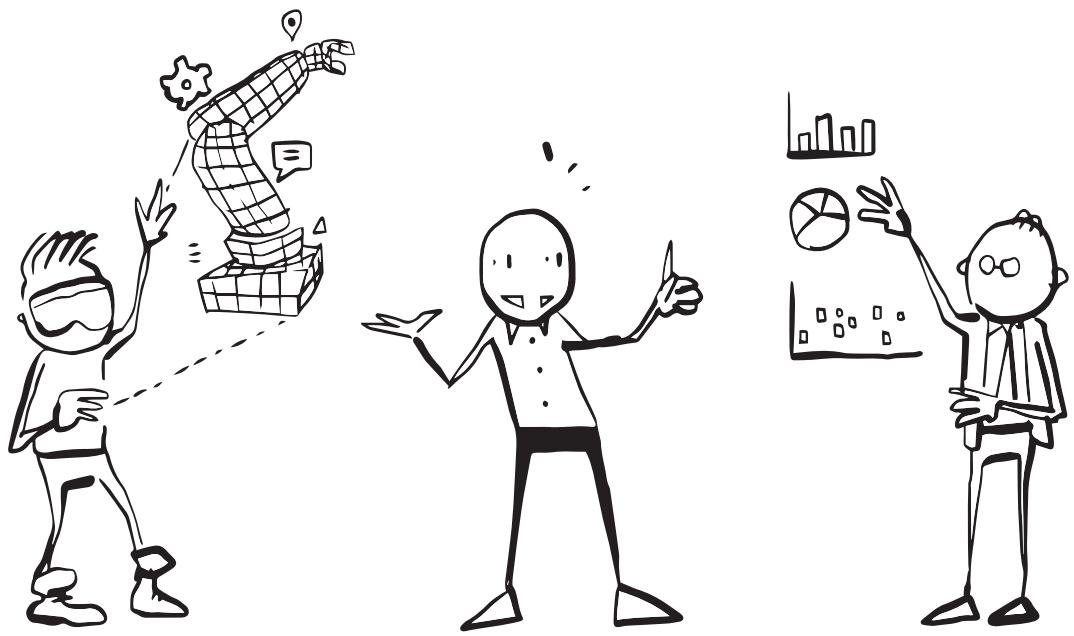
On the contrary. In the Lean philosophy, shop floor management is a management and communication tool and is intended above all to increase the problem-solving competence of employees. Communication in this context means that people meet regularly and exchange information in a targeted manner. And in my opinion, this should not be replaced by any technology in the world in this form.

Digital shop floor management is a valuable supporting component of regular team meetings on the shop floor to discuss problems and exchange information on the causes of problems and approaches to solutions in the sense of a PDCA cycle. Digitalisation can provide support in identifying and solving the causes of problems, for example in the event of a machine failure. Nevertheless, it must then be discussed why this happened. This has the great advantage that experience values are shared and thus a common learning process takes place. Collected data about the machine and its history, which are recorded within the framework of digital shop floor management, can in turn support the employees in finding and eliminating faults. If a problem history is stored, it can be used in the future for similar problems elsewhere in the factory. Another advantage is the time saved. This in turn creates room for more productivity. Thus the possibilities of digitalisation can make shop floor management even more powerful, provided it is used correctly.

How justified do you see the often predicted disappearance of certain roles and functions in the factory as a result of digitalisation?

In everyday factory life there are very different and complex processes and tasks. It is therefore more correct to talk about replacing certain activities and assisting in other activities rather than about the disappearance of entire roles or job descriptions. The technologies that are predominantly used in the factory today in the context of Industry 4.0 support people in the work process, for example in the form of digital assistance systems. However, wherever more complex tasks have to be mastered, people are needed. If, for example, there is a sudden system failure or faulty products are produced, it is the task of the responsible persons to carry out the fault rectification and cause analysis.

In such critical, dynamic and complex situations, data can help to gain a clear picture - but not replace human judgement. Thus, the task of ensuring error-free and robust processes in the factory still lies with the people. However, the increasing digitalisation in the factory makes it necessary to acquire new skills and become more involved with technology as it changes work processes and the form of cooperation. Moreover, it is becoming apparent that new roles and job profiles are emerging in companies as a result of digitisation, and we also raise awareness of this among participants in our seminars.



building industrial future

As an expert for research and development, production and industry 4.0, ROI-EFESO supports industrial companies in optimising their products, technologies and production networks and in using the potential of digitisation for more efficient processes and intelligent products. Operational excellence and quantitative, sustainably effective results are the goals against which ROI-EFESO can be measured. ROI-EFESO has received several important awards for its strongly implementation-oriented projects, such as the "Best Consultants" seal of approval from "brand eins" and "Best of Consulting" from "WirtschaftsWoche" and occupies top positions in the WGMB study "Hidden Champions of the Consulting Market".

In order to make the topic complex Industry 4.0 tangible and effectively usable in business practice, ROI-EFESO operates an Industry 4.0 Learning Factory, in which technological fundamentals and principles of digitalisation are combined with the lean production approach and taught in a practical way. With the "Industry 4.0 Award" ROI-EFESO also honours groundbreaking projects from industry 4.0 practice. The prize has been awarded in Germany since 2013 and in China since 2017. Founded in 1999, ROI-EFESO employs around 500 people at 30 locations worldwide. The spectrum of customers ranges from renowned medium-sized companies to DAX-listed corporations.

IMPRINT
Person responsible for content under German press legislation: Hans-Georg Scheibe
ROI Management Consulting AG | Infanteriestraße 11 | D-80797 Munich | Germany
Tel. +49 (0)89 121590-0 | E-Mail: kontakt@roi.de | Directors: Michael Jung, Hans-Georg Scheibe

www.roi.de **www.efeso.com**