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.

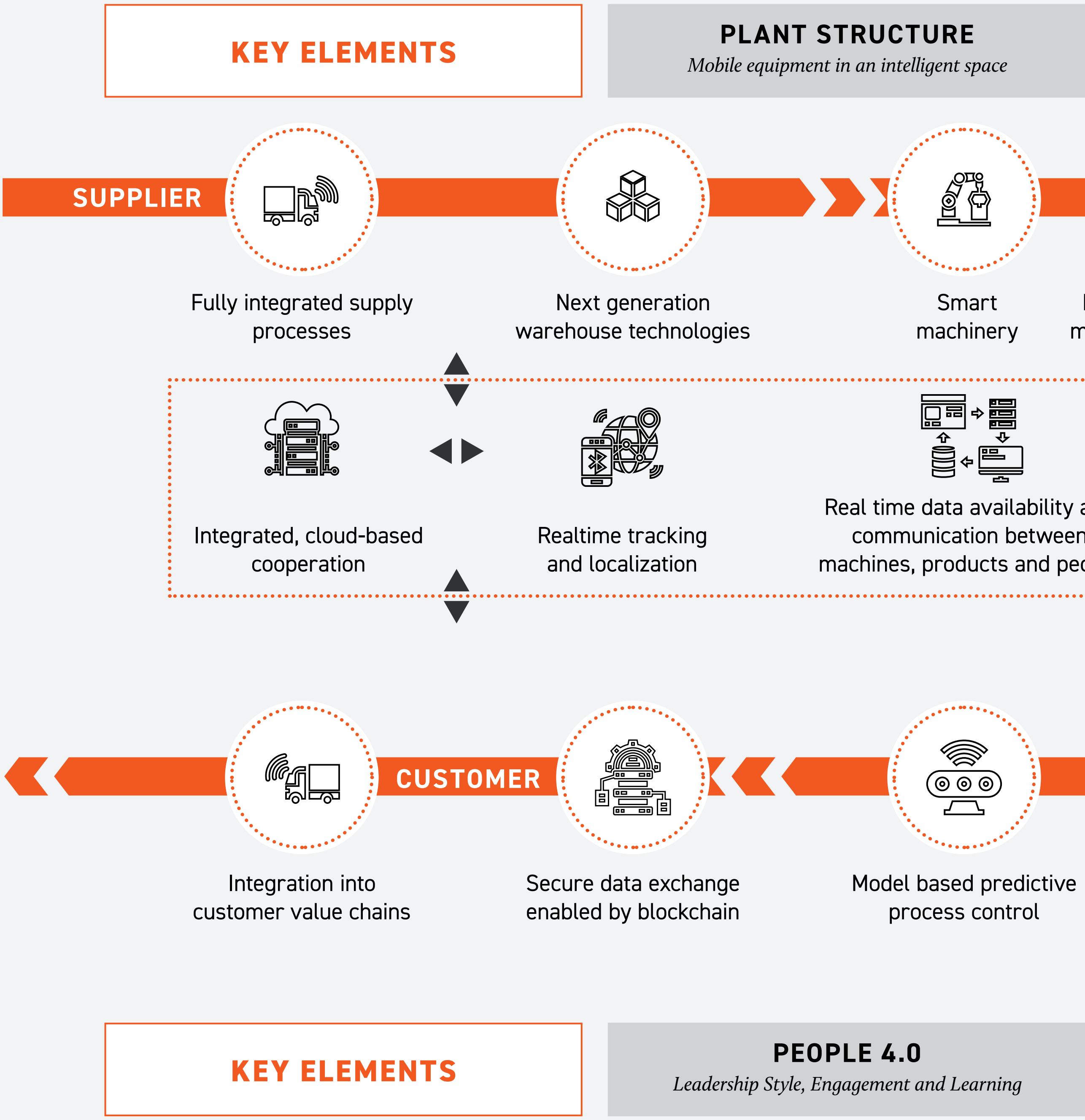
DIGITAL TWINS

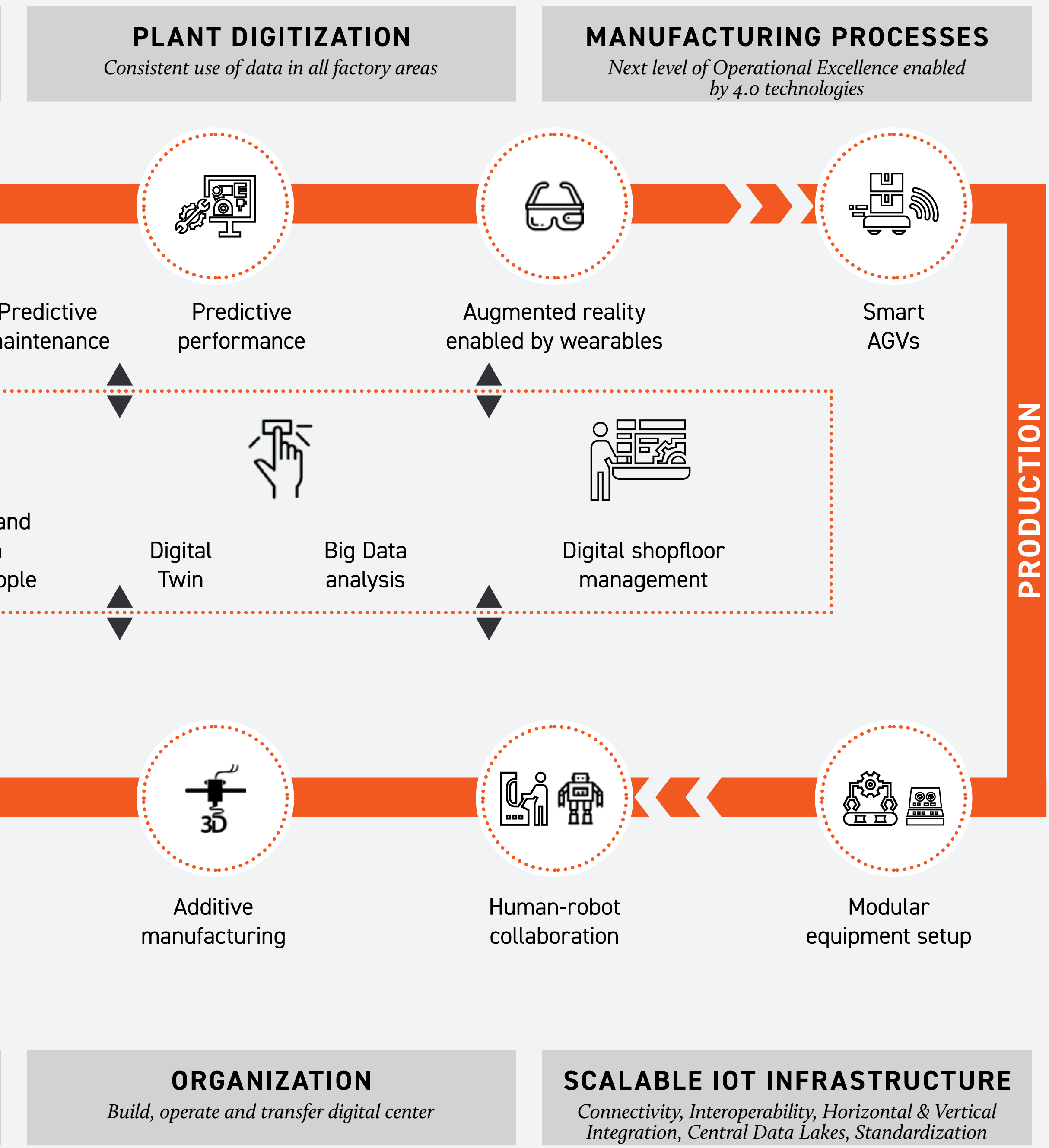
WELCOME TO CYBER-PHYSICAL SPACE

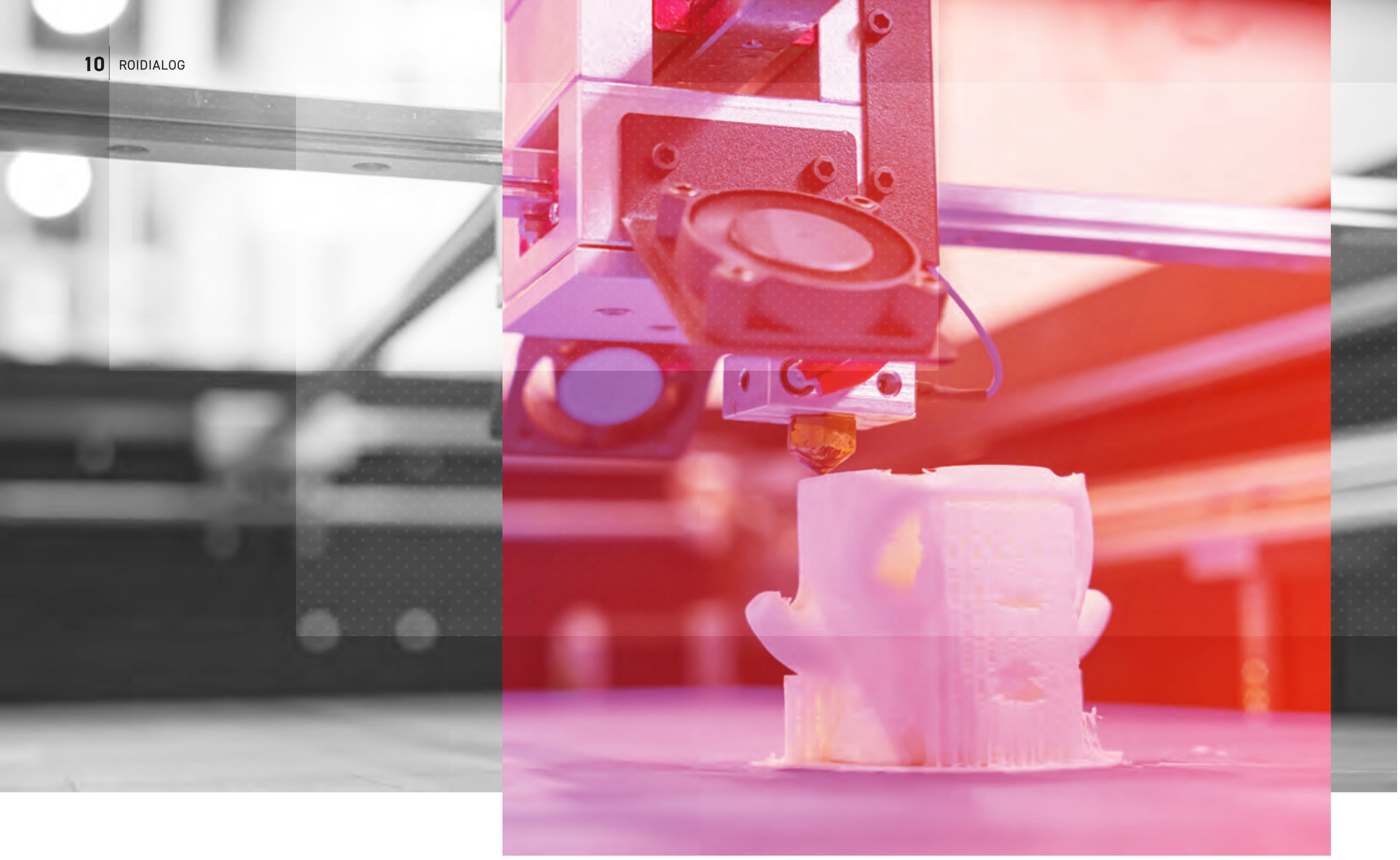
The Digital Twin approach is one of the digital technologies with a particularly large potential for change in terms of the Smart Factory. This "digital shadow" of products, plants or workflows opens up completely new possibilities for the planning and operation of industrial processes. The highly precise 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
aintenance
Predictive performance
Augmented reality enabled by wearables
Smart AGVs
and
ople
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

1 IGNITE

- *Quick Impact Tools*
- *KPI Visualization*
- *Digital Performance Management*
- *Connectivity Booster*
- *Initial trainings in ROI-EFESO Learning Factories*

AWARENESS

Identify opportunities for quick and self-funding solutions

2 DESIGN & PILOT

- *Holistic concept, prioritization & roadmap*
- *Develop scalable IoT-Landscape*
- *Implement state-of-the-art digital solutions*
- *Demonstrate impact on performance*
- *Develop Management System 4.0*

LIGHTHOUSES

Realize integrated solutions at selected sites and show measurable impact on P&L

3 SCALE

- *Build up required resources (data scientists, automation specialists,...)*
- *Launch group-wide recruiting & training program*
- *Prioritize, manage and monitor deployment roadmaps in each function / entity*
- *Leadership & Management System 4.0*

INDUSTRY 4.0 AT SCALE

Build up required infrastructure and capabilities across the whole company 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.