



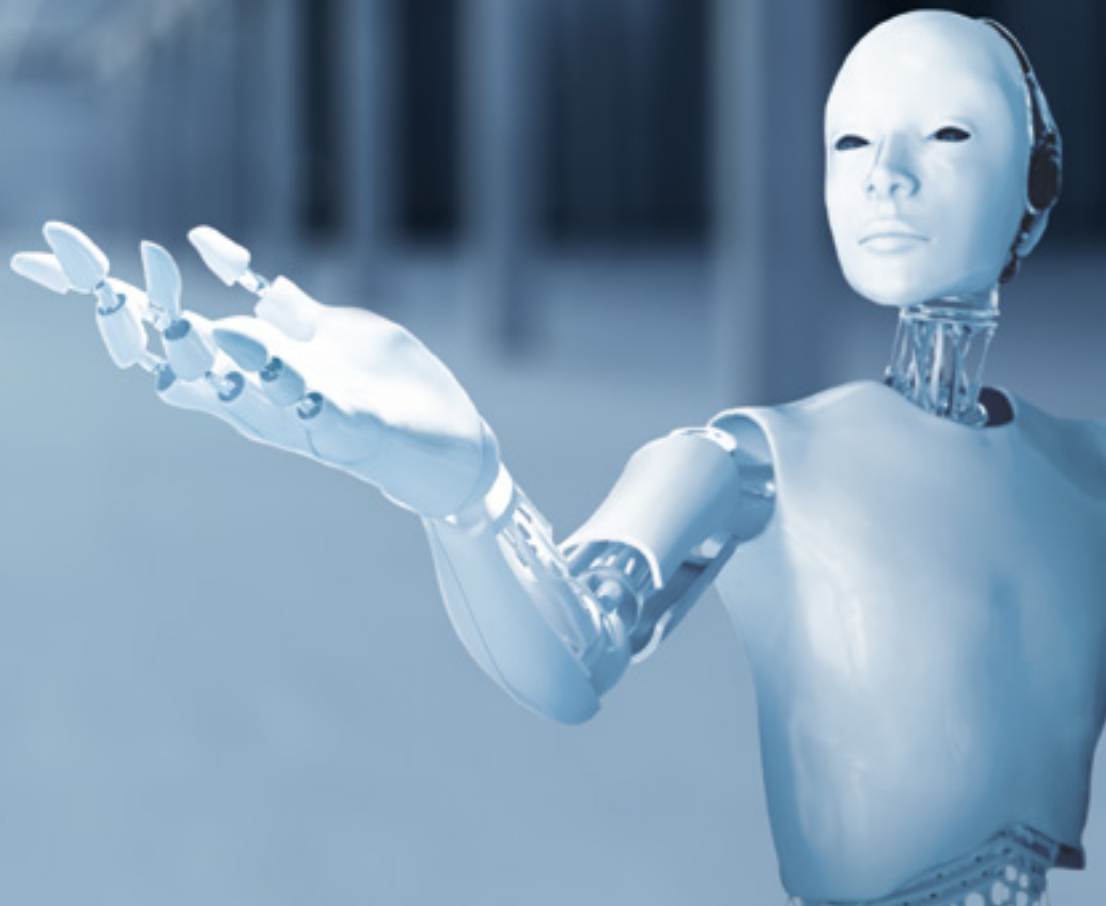
The Factory of the Future

**Industry 4.0 –
The challenges of tomorrow**

2017

KPMG guide
Part 1

kpmg.com



Introduction

What do you need to do to be sustainable in volatile, fast-moving and customer-driven markets? To keep pace with ever quicker product lifecycles, shorter order leadtimes and growing product variants? More flexibility, shorter response times, greater resource efficiency and higher production quality alone are no longer sufficient.

The key term is Industry 4.0. It was coined by the German federal government in the context of its high-tech strategy in 2011. It describes the integration of all value-adding business divisions and of the entire value added chain with the aid of digitalisation. In the “factory of the future”, information and communication technology (ICT) and automation technology are fully integrated. All subsystems – including non-producing ones such as R&D as well as sales partners, suppliers, original equipment manufacturers (OEMs) and customers – are networked and consolidated into one system. This makes it possible to simulate the results in full by changing the parameters. In other words: all relevant requirements concerning manufacturing and production capacity are already confirmed during product development. The entire process can be considered and managed in real time holistically from the very first step – including seamless quality assurance in production.

In manufacturing, networking and transparency provide for a paradigm shift from “centralised” to “local” production. Today, manufacturing already works with “embedded systems”, which collect and pass on specific data. In the “factory of the future”, a central computer organises the intelligent networking of these subsystems into cyber-physical systems (CPS). The systems are able to work with increasing independence. Through human-machine interfaces, the physical and the virtual worlds nevertheless work closely together: The human defines the requirements, while the process management takes place autonomously.

The path to the “factory of the future” is an evolutionary process. Although it is proceeding at varying speeds in different companies and branches of industry, all companies are faced with a challenge: How can value added that is free of media and process disruptions be achieved? And how can the product planning and product development processes as well as the production and logistics workflows be efficiently integrated here?

This two-part guide sets out to give you information and concrete support in order to successfully meet the challenge of Industry 4.0: In the first part we analyse the relevant trends, drivers and effects of the transition to Industry 4.0. Furthermore, we introduce to you the KPMG customer-customer process as a cross-functional, multi-disciplinary model for companies in the production industry that feature a high proportion of industrial value added, but that do not yet fully exploit the potential for integrating their subsystems: Starting out from a customer-customer process, the actors along the internal and external value chain dovetail their systems in our approach and merge together into value added networks. Departmental and company boundaries disappear, suppliers become strategic partners. Order-based and customer-specific models emerge under the “regency of the customer’s wishes”. In the second part, we highlight what your role is and how we can support you as you develop an implementation roadmap, a future-proof operational and organisational structure and an appropriate business model. The conclusion contains recommendations for action and task assignments at the C level.

We provide you with support for this with our interdisciplinary teams comprised of IT architects, IT test managers and IT process designers as well as engineers, accounting and controlling specialists, transaction managers, logistics specialists, tax experts and lawyers. No matter whether it involves the specific challenges faced by your company, concrete proposals for solutions or the assignment of the tasks for top management, we support you in every phase of the transformation process. Let us work together to raise your company to the 4.0 standard.

Sincerely



Harald v. Heynitz
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Part 1 – Industry 4.0: The challenges of tomorrow

Is Industry 4.0 one of those buzzwords that the world of finance media is obsessed with for a short period of time, or is there more to it? A brief look at the background and current economic developments is enough to recognise that Industry 4.0 is nothing less than the next industrial revolution. This chapter describes what Industry 4.0 stands for, what the driving forces behind the transition are and what skills and abilities are required in order to cope successfully with the transition from Industry 3.0 to Industry 4.0.



Cyber-physical systems (CPS)

The term cyber-physical systems (CPS) describes the networking of individual embedded software systems that collect and pass on specific data. A paradigm shift from “centralised” to “local” production thus takes place: A central computer provides for the intelligent networking while taking into consideration physical factors – such as inputting requirements through human-machine interfaces – and allows independent process management. The close interaction between the physical and virtual worlds here represents a fundamentally new aspect of the production process. When this is related to production, we talk of cyber-physical production systems (CPPS).

The new pacesetter of the industrial cycle

Evolution and convergence as key concepts

Evolution and convergence are the key technological concepts for the production processes of the future. **Evolution** is constantly receiving new impetus from pioneering technological innovations. The pulley, the steam engine or plastic, for example, paved the way for the next industrial revolution that followed their invention.

Convergence describes the merger of previously separate industrial structures, technologies, media and solutions. The fusion can access common resources, which creates synergies and thus leads to more efficiency and additional added value. Example: Smartphone Convergence is also associated with a dramatic expansion of the functions of machinery, services and infrastructure. Like the innovations mentioned above, convergences – with the exception of the first industrial revolution – have also laid the foundation for the next industrial revolution. Both phenomena characterise the industrial lifecycle.

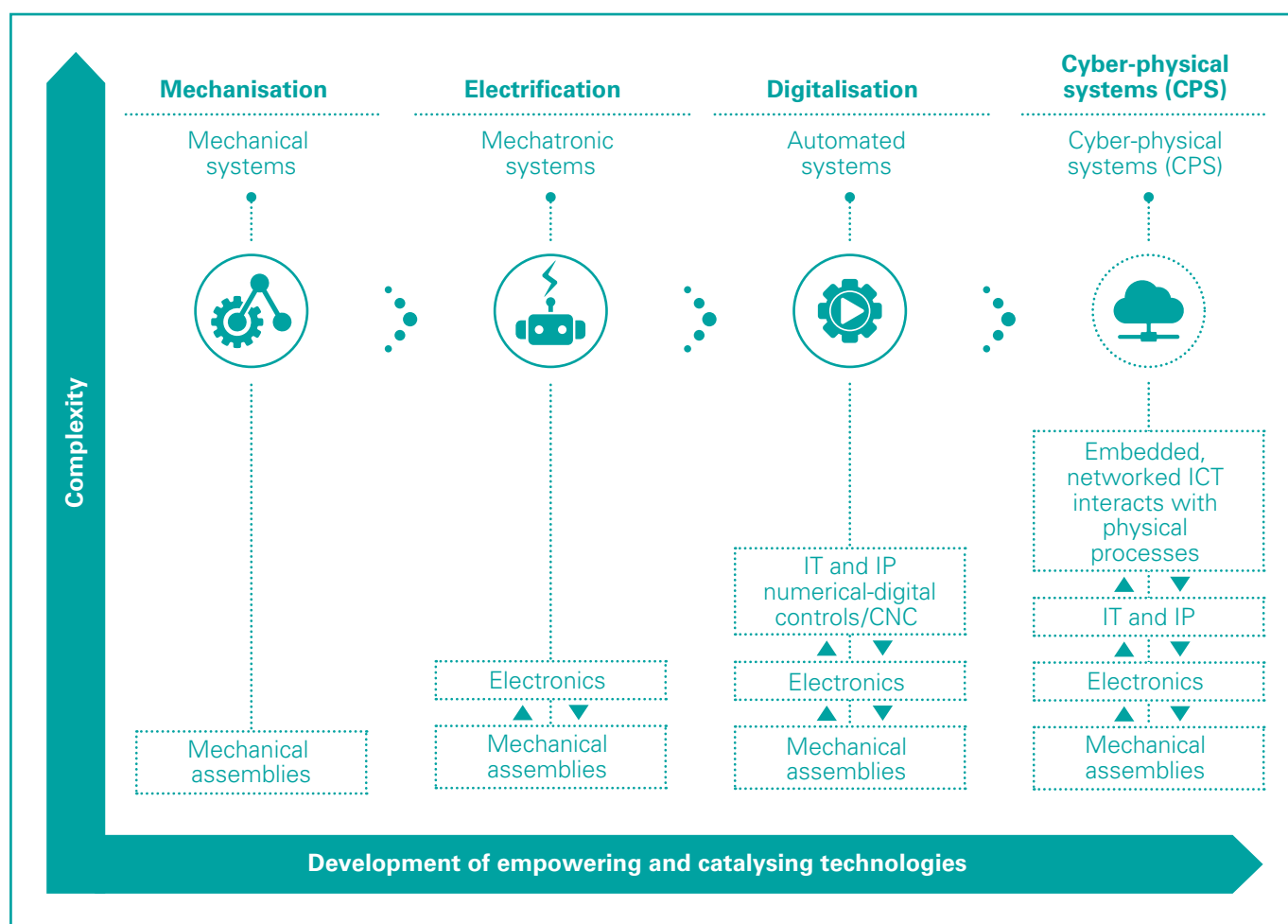
Merger of the physical and virtual worlds

The driving force behind the “third industrial revolution” was information technology. With the integration of software and hardware in the entire production workflow, industrial companies are now beginning to digitalise production. The physical and the virtual worlds in industrial production are merging and laying the foundation for the “fourth industrial revolution” (smart manufacturing, Industry 4.0): Companies are consolidating their product development, production, logistics and business systems so that they can always produce and deliver on a decentralised basis, in a self-directed way and in real time.

Industry 4.0 is driven and enabled by networking and the Internet. Previous individual solutions and embedded systems on a software basis – for example sensor systems in individual machines – form a network of reciprocally communicating elements, where the physical input is made by humans and the actual product is a physical output. The data for the entire production process chain, including product, customer and order data, is networked in these cyber-physical systems (CPS) – from capacity planning and production logistics, through production, all the way to quality control.

Local intelligence follows central management

Holistically interconnected software manages the local operating parts of the company. CPPS consists of intelligent machines, storage systems and production plans, which exchange data autonomously, manage processes and monitor each other on a reciprocal basis – including safety and energy efficiency. This means a transition from rigid, central production management systems to local intelligence.



Source: KPMG 2016

Fig. 1: The lifecycle of the industry

More permeable boundaries between sectors, technologies and companies

To the extent that the boundaries between industrial sectors and different technologies are disappearing, the boundaries between companies are also becoming more permeable. Former competitors are working together, and the number of cross-sector alliances is increasing. Features of the industrial production of the future will be: strong individualisation of the products within extremely flexible (series) production, comprehensive involvement of customers and business partners in the company and value added processes as well as the integration of production and high-quality services. Hybrid products will thus be created from purely industrial products.

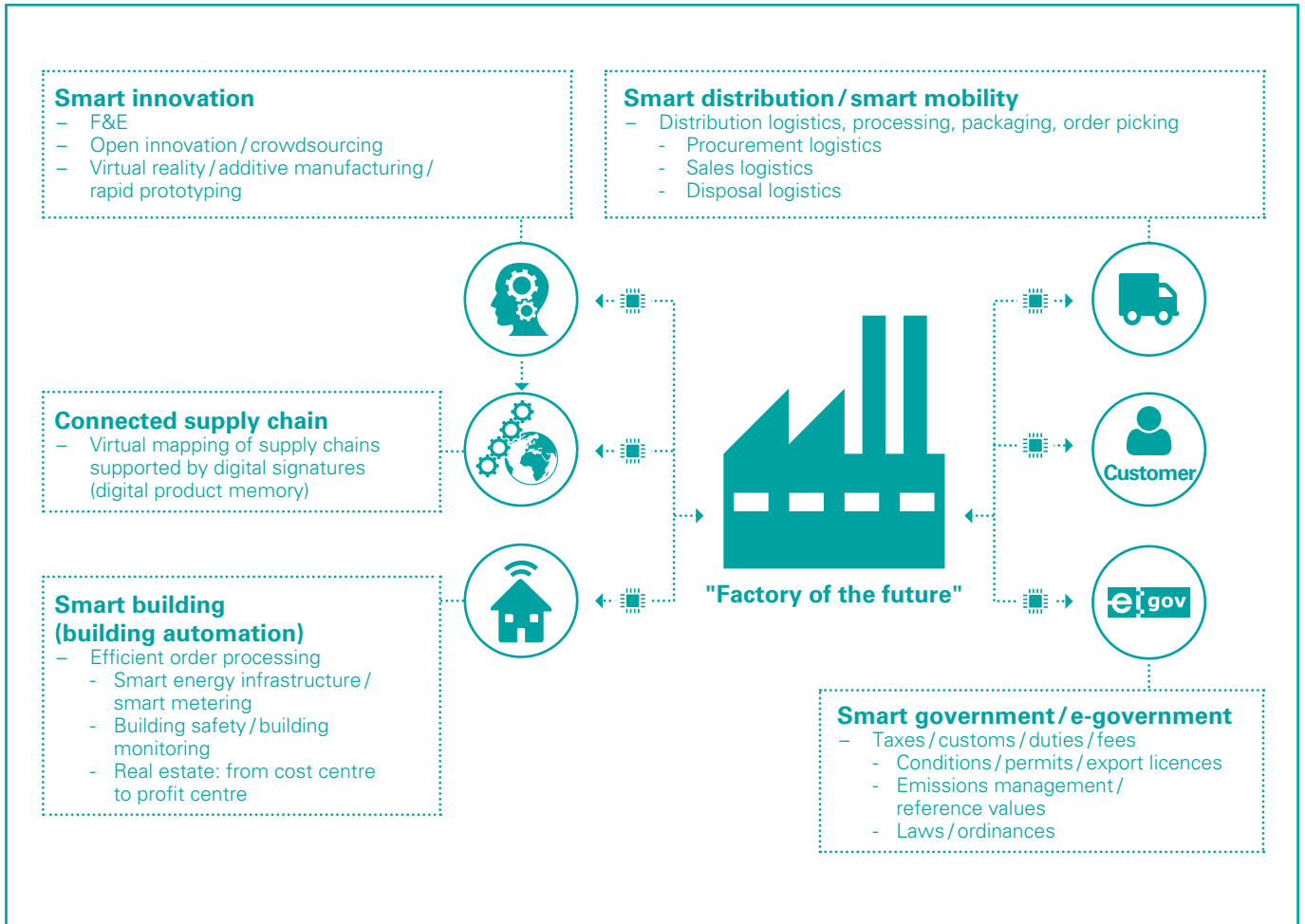
Using real-time data for better decisions

In the vision of Industry 4.0, the digitalisation, automation and networking of processes encompasses all functions, areas and segments of the manufacturing industry – including economic (and macrosocial) action. All the relevant parameters are thus available in real time, which means maximum transparency and an improved decision-making basis.

Companies must still create the general conditions for this to begin with. However, they must invest in the infrastructure (hardware and software) for data connections and processing and in the digitalisation of their processes. In addition, they have to identify existing or potential points of contact between their value chain and that of others and develop these into efficient, standardised interfaces.

The automotive industry leads the way

How quickly the networking proceeds depends primarily on the technological innovation cycles (e.g. Moore's Law, Gilder's Law), the acceptance of technology and the willingness to invest. Various speeds can already be distinguished today in the implementation of Industry 4.0 applications: Taking the lead in this area are sectors with short investment cycles, high plant investments and distinct batch sizes, like the automotive industry. If OEMs become "Industry 4.0 companies", suppliers will have to follow. Suppliers and service providers will have to offer solutions that can be integrated with systems. Full traceability of all parts, modules and components is already today a prerequisite for a supplier to continue to be listed with an OEM. In manufacturing, Industry 4.0 is therefore already essential from the start for those sectors that work under a great pressure for innovations, have distinct core skills and are dependent on the automotive industry. The end product is a comprehensive system that fully integrates man, machine and the whole of the related environment – what we call a "connected ecosystem".



Source: KPMG 2016

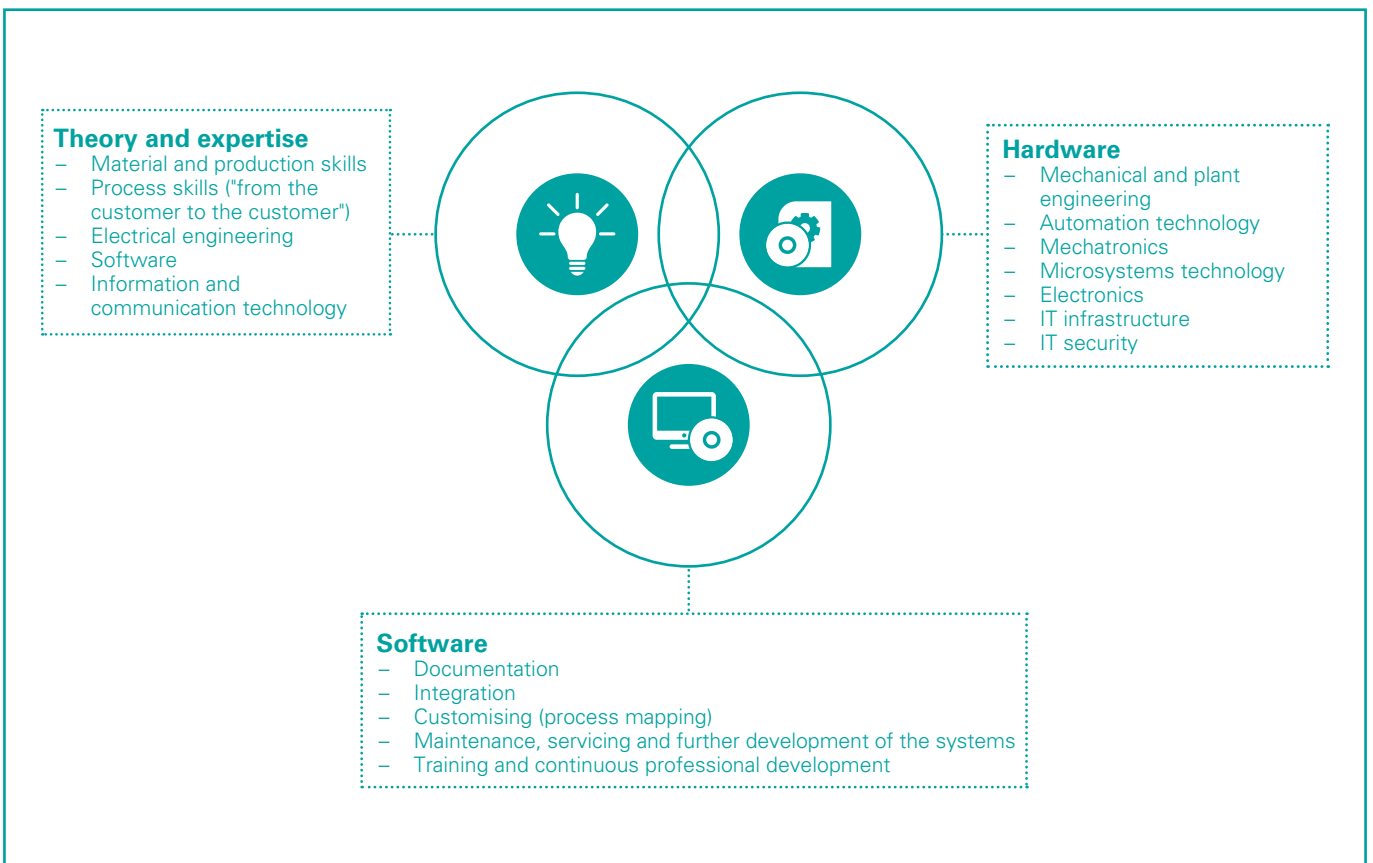
Fig. 2: The "factory of the future" in a "connected ecosystem"

1 THE RIGHT SKILLS PROFILE

All disciplines are required

The merger of previously unconnected technologies and applications in the course of the convergence of the online and offline worlds makes Industry 4.0 an all-encompassing and interdisciplinary field. The requirements for skills and expertise, for technologies and services is correspondingly broad.

Upon closer examination, the term Industry 4.0 results from a rapid sequence of convergences: To begin with, information technology (IT) and telecommunication technology are merged into ICT. This is followed by the merger of ICT with the microsystems technology, i.e. the networking of sensors, actuators and data processing. With the convergence of industry-specific expertise and contents with technology (hardware) and product-related IT services (software), the various production islands are turned into an integrated manufacturing system and, in the end, a customer-oriented unit.



Source: KPMG 2016

Fig. 3: Industry 4.0 skills profile

Many challenges, first solutions

The necessary skills profile for Industry 4.0 is essentially composed of production technology and logistics: What is needed are overarching specialised, methodological and system skills as well as technology and market-related **expertise and theoretical knowledge**.

A further building block of the skills profile is **hardware skills** from the product portfolio of the production system providers and technology companies: practical and application-oriented knowledge of techniques, technology and the peripheral physical systems.

The third building block is provided by software and algorithm skills – such as the knowledge of methods for analysing, evaluating, designing and managing complex systems, structures and processes. The **software** is used to manage data and information as well as to prepare and present information. It is only on this basis that the hardware relevant for the vision of Industry 4.0 can be used.

Many of the building blocks necessary for Industry 4.0 are already available – such as digital and networkable sensors and control elements (actuators), cloud computing, tablets as human-machine interfaces, integrated software solutions and (industrial) communication networks. A major deficit, however, is the widespread lack of standards.

Ensure access to required disciplines and abilities

Despite all the requirements of Industry 4.0 placed on system providers and system users, not everyone needs all the disciplines or has to master all the abilities. Instead, the task is to identify and develop or acquire the disciplines and missing abilities that are actually required. As a CPS user, companies therefore have to upgrade their business model for Industry 3.0 to an Industry 4.0 business model.

But how can a company's own organisation and the related processes be mapped in order to subsequently digitalise and automate them for Industry 4.0? And in a way that makes them comparable with other companies? Cross-system consistency and thus global applicability

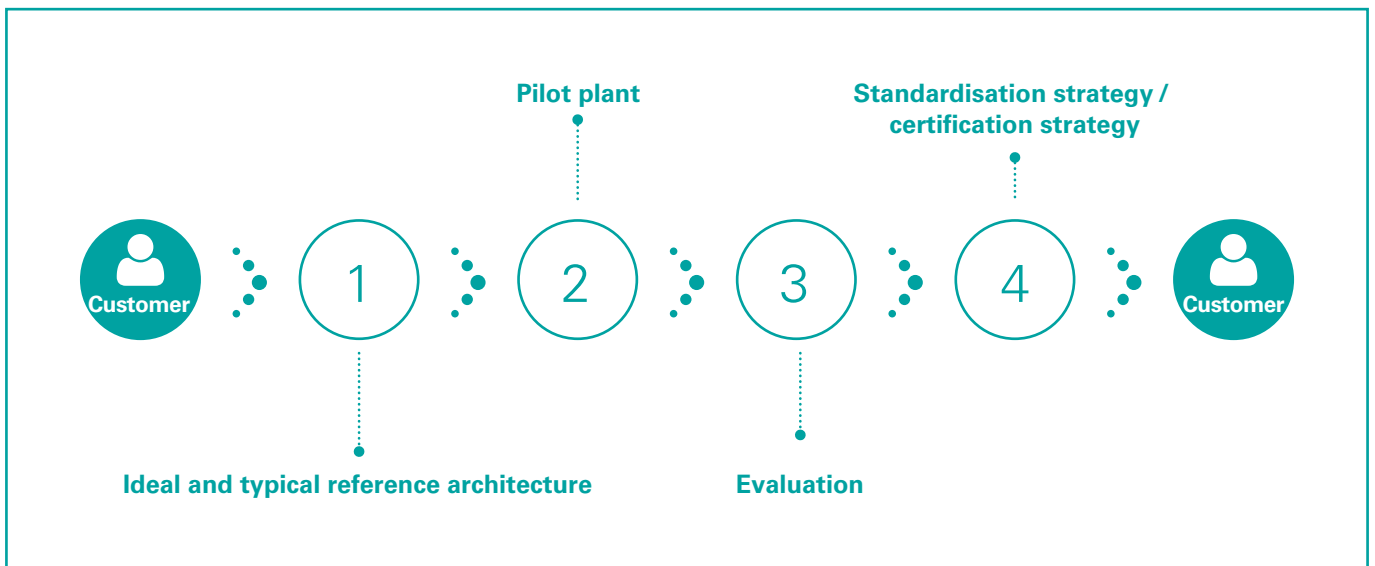
require uniform general conditions for technologies, systems and processes based on international norms and standards. Anything else would not be accepted by the market and thus would not be sustainable. A reference architecture is thus demanded.

From a reference architecture to a standardised system

The requirements for an ideal and typical reference architecture are high. To enable the actual integration of technical and business processes, it must overcome the boundaries between objects and services, actors and machines, different manufacturers and users as well as the real and the virtual world. Additionally, it must be able to fall back on consistent process standards, rules and concepts for the research and development work – especially against the background of regulatory requirements. On top of that, finally, are basic structuring principles, interfaces and data

formats. Only then will all market participants deliver integrable and cross-system results (“plug and work”).

The reference architecture developed by the Industry 4.0 Working Group (see text box on page 13) can be used to develop pilot plants (in joint ventures). Based on the documentation of use cases and the evaluation of individual implementation aspects with a view to the capability for integration, findings can then be obtained for generally valid systems – including important pointers for standardisation and standardisation strategies as well as quality control and certification.



Source: KPMG 2016

Fig. 4: The data trail in the customer-customer process



Location advantage through technology clusters

Germany has renowned technology clusters where market leaders in mechanical engineering and the electrical, electronic and automotive supply industry as well as internationally famous research institutions pool their strengths. These clusters have contributed to Germany's high international standing with well networked science, research, application and institutional infrastructure. In addition, the German manufacturing industry is known for developing solutions for virtually every challenge. Practical, mass market applications and functional systems emerge in a short time as a result of the high density of participants either providing or demanding solutions. In the future, cluster structures of this kind will also expand to include important areas such as training, R&D and services.

Profiling of the relevant market participants

Not all companies by far have yet embarked the road to Industry 4.0. However, four groups of actors can be distinguished.

1. Multinational technology corporations: Companies such as Siemens, General Electric and Mitsubishi already possess a broad portfolio of production and automation solutions. They will perfect, supplement or upgrade their portfolios in order to create complete solutions for intelligent production.
2. Multinational IT giants: Corporations such as Cisco, IBM and SAP are expanding out of the ICT sector and penetrating the market for intelligent production.
3. Tightly focused market participants: These include organically developed specialists, niche companies and suppliers of special solutions as well as joint ventures, mergers of business units and other forms of co-operation between machinery manufacturers, suppliers of automation solutions, hardware and software developers, telecommunications providers and system integrators. They include companies such as DMG Mori, Wittenstein, Bosch, Rockwell, Omron, Schneider, Stäubli, Yaskawa, Krones, PSI and Software AG.

Cluster

A cluster describes the regional conglomeration of companies that are active along a common value chain, including the manufacturers, service providers, suppliers, primary customers, research institutes, universities and other institutions such as trade associations and chambers of commerce and other involved institutions such as trade associations and chambers of commerce. These clusters within a region or a centre have often been formed to benefit from factors such as networking, close proximity, key skills, qualified workforces and specialists, the scientific and industrial environment, a specialised (physical and knowledge) infrastructure and production processes. On this basis, clusters generally accelerate technical innovations, improve the business environment and the cost situation, bring producers and customers closer together, encourage start-ups and ensure new investment. Once critical mass is reached, a cluster attracts more companies, investors, service providers and suppliers as well as staff and expertise. Clusters are therefore regarded as key components in reinforcing the manufacturing industry, especially as companies are moving away from vertical integration and increasingly outsourcing business units and production stages.

Examples of outstanding clusters include the "it's OWL" technologies network, the "micro-TEC Südwest" technology cluster for intelligent and energy efficient microsystems, the leading-edge "Cool Silicon" cluster for developing energy efficient information and communication technologies (ICT) and the "Software Cluster" for developing business software for the management of business processes.

4. Plant designers and general contractors: Initially, we expect the emergence of Industry 4.0 clusters in selected areas. The manufacturing industry and vehicle production are examples of sectors in which demand is already increasing. Actors here include Ferchau, EDAG, Altran Group/IndustrieHansa.

Note: The actors presented here represent a list of examples that does not claim to be exhaustive.

Major growth potential for the sectors involved

Industry 4.0 is a vision of the future for an integrated value chain of companies involved in industrial production: Various digital technologies are used here in order to record, store and distribute data on the one hand and, on the other, to exchange data between research and development and the production site and between sales partners, suppliers, OEMs and customers.

Industry 4.0 is currently more of a concept than a reality – it is in any case not a product that you can buy. That might have something to do with the imprecise delineation of the term “Industry 4.0” or with the exaggerated expectations of customers. What is certain, however, is that Industry 4.0 requires products: industry and management software (e.g. CAD, virtual simulation tools, ERP, MES, PLM), processors (e.g. SCADA, DCS, PLC) and devices (e.g. Ethernet, robotics, RFID, motors and drives, relays, switches, sensors). These devices require specialist expertise in information and communication technology (ICT) and automation technology. In addition, there are many examples of processes and services along the entire value chain that depend on basic digital technologies – from planning to simulation of the entire production process. And finally, it should not be forgotten that there must be a market for network-compatible production plants (Industry 4.0-ready).

2 DRIVERS OF THE CHANGE AND REACTIONS OF THE COMPANIES

Transformation of the core business and a new understanding of a solution-oriented approach

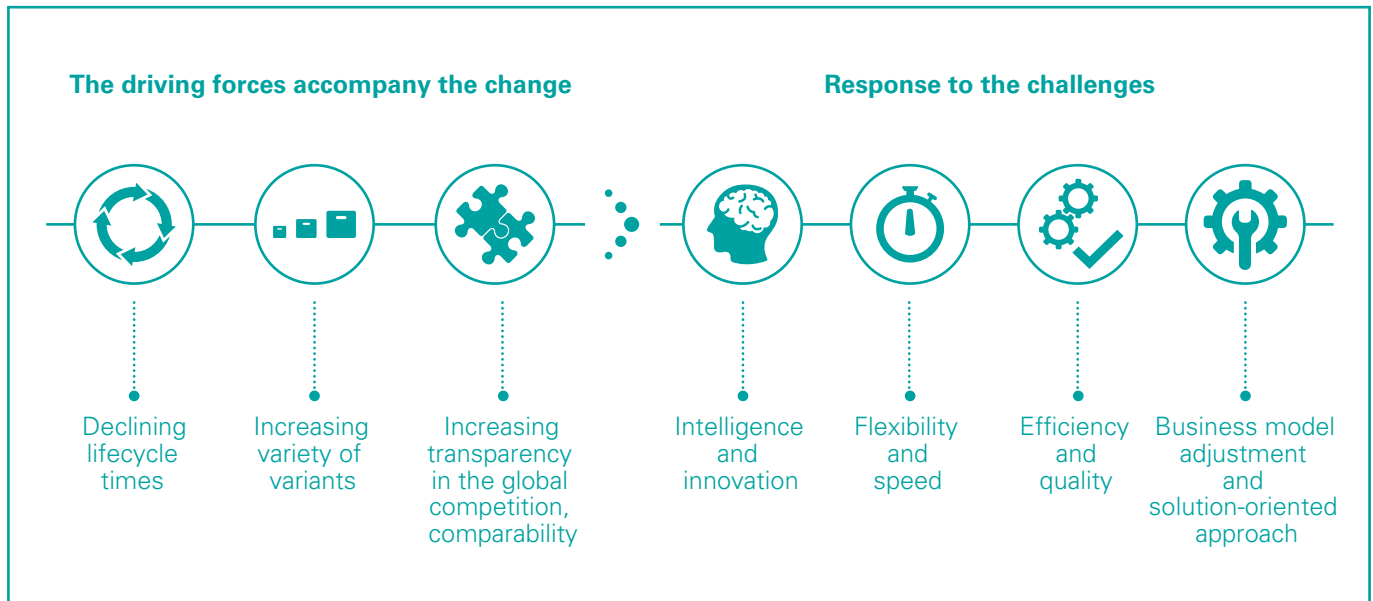
The “factory of the future” produces in an intelligent, fully integrated, flexibly and efficient way. The continuing evolution of previously separate and autonomous applications into integrated network solutions enables self-organising and flexible decisions on production processes in real time. However, this vision cannot be realised by itself. Rather, increasing digitalisation may even lead to a transformation of the core business and to a new understanding of a solution-oriented approach. This transformation will be driven primarily by growing customer requirements – and the necessity on the part of the production companies to fulfill more dynamic and sharply individualised customer requests ever more quickly.

Intelligence as standard

Technologisation, automation and digitalisation each exert an individual influence on all production processes in the manufacturing industry. Networking in the context of Industry 4.0 then leads to the “factory of the future” with data-based production, autonomous cyber-physical production systems – and integrated intelligence.

Modifications and readjustments, at whatever stage of the value and supply chain, are then possible in real time. Companies have quicker access to comprehensive data sets from connected or integrated data sources, such as sensors and control units. Even the processing of these larger volumes of data does not represent a problem, for analysis tools are also becoming more powerful. Better decisions can thus be made within a shorter timeframe.

Parallel to this, new, database-supported design tools are improving the processes of innovation, as production and process knowledge is reused and shared. Production also benefits from integrated intelligence:



Source: KPMG 2016

Fig. 5: The driving forces accompany the change

Additive manufacturing processes make complex forms possible that with traditional production processes cannot be manufactured to the required quality or at justifiable costs, if they can even be manufactured at all.

With flexibility and speed toward a new customer orientation

The value added processes in the “factory of the future” are transparent and flexible. That also means that the production workflows, including preparation and set-up times, can be calculated with pinpoint precision so that free capacity can be identified, accurately measured and consistently used.

However, a new generation of machines is required to benefit from these new opportunities: The production plant of the future will house multifunctional machinery as well as adjustable and intelligent production facilities. It will fulfill all the requirements of vertical integration, ensure the optimal depth of production and independently select the materials and components in accordance with the defined production and process techniques. The advantage: rapid response to higher variation, shorter innovation cycles for extremely complex products and the

manufacturing of different series or individual products in the same plant. In other words, a manufacturer can fulfill the requirements of its customers on an individual basis and bring innovations to market more quickly.

Efficiency and quality to the benefit of customers and employees

CPP systems optimise the production workflow through the improved use of resources and a decline in downtime. With CPPS it will also be possible to manufacture products that are individualised and tailored to the customer as well as small and mini series. Newly recorded process information provides a substantially more accurate overview of the production and business workflows and creates focused attention on the potential for optimisation.

The basis for optimal material and resource efficiency is already laid in the early phase of development: A single, fully digitalised and integrated software system is responsible for all processes, from concept and design right up to the numerical control of the CPPS. The system links functions such as computer-aided design (CAD), production planning and production organisation, and generates a comprehensive data set for the product, the necessary

material flow and the relevant production process. This “simultaneous engineering” leads not only to quicker workflows in product design and production planning, but also to greater precision, higher reliability and quicker marketability.

Total quality management becomes a reality: 24-hour production is monitored without interruption, along with quality, and efficiency is constantly being optimised.

As a result, the target of a zero error rate is now within reach. Machine failures also become a thing of the past, for the data that is available allows a preventive maintenance strategy and planning that avoids unplanned and unpredictable downtimes. Production can be run around the clock at maximum capacity. The “factory of the future” secures a competitive advantage for itself as a result of quicker production cycles, higher throughput with a reduced inventory and lower costs.

CPP systems also bring advantages on the employee side: The machinery and equipment ultimately work closely not only with each other, but also with the technical specialists: Displays, user interfaces and visualisation tools ensure that operators have constant and easy access to the relevant data. In addition, the equipment relieves people of more and more physically difficult or dangerous work and autonomously prevents tampering. This means more efficiency and safety for production and people.

Making use of the full potential through adaptation of the business model and a solution-oriented approach

In order to make full use of the potential of Industry 4.0, companies have to be versatile. A company that recognises at an early stage what regulatory, market, technological and even competitive factors are driving the change in its own industrial environment can adapt its business model earlier and accordingly secure sustainable growth potential for itself. In this context, it is important for a company to fulfill two requirements in the context of Industry 4.0:

Firstly, the realignment of the business model must be carried out across all functions. Secondly, the company

has to define its factors for success (Where is value created? Where are best cost positions? Are there alternative revenue models or new sales structures?), align itself on its core processes and skills and transfer these to new application areas and revenue models. The company’s own location also has to be defined as a further success factor: Should the company move closer to its customers (service providers) or instead act as a middleman or intermediate service provider?

The financing requirement can also be derived from the complete simulation of the new business model. Furthermore, missing or underdeveloped capabilities become apparent as the result of a data analysis – the first step towards identifying suitable co-operation partners or take-over targets. However, a solution can also involve radically revising the company’s own product and services portfolio and – where this makes sense – developing and picking up new products and services. This is where a structured innovation management process pays off: It ensures that the development work is already geared towards commercial success. Finally, the legal and regulatory dimension of the fourth industrial revolution may not be forgotten. The tax and legal departments of the companies should therefore be involved in order to avoid foreseeable risks and utilise the potential for tax breaks.

For companies in the manufacturing sector, the transition from Industry 3.0 to Industry 4.0 represents a change of more than one digit. It is a paradigm shift that means comprehensive change. KPMG has developed the KPMG customer-customer process for the “factory of the future”.

It describes a seamless and fully integrated value chain – with new technologies, new production processes and new operating and organisational structures. All areas of the company have to align themselves even more strongly to customer requirements and to their products, processes and markets. This chapter describes the individual links in the value chain of the future and the related requirements placed on companies.

The KPMG customer-customer process as an approach to solving problems

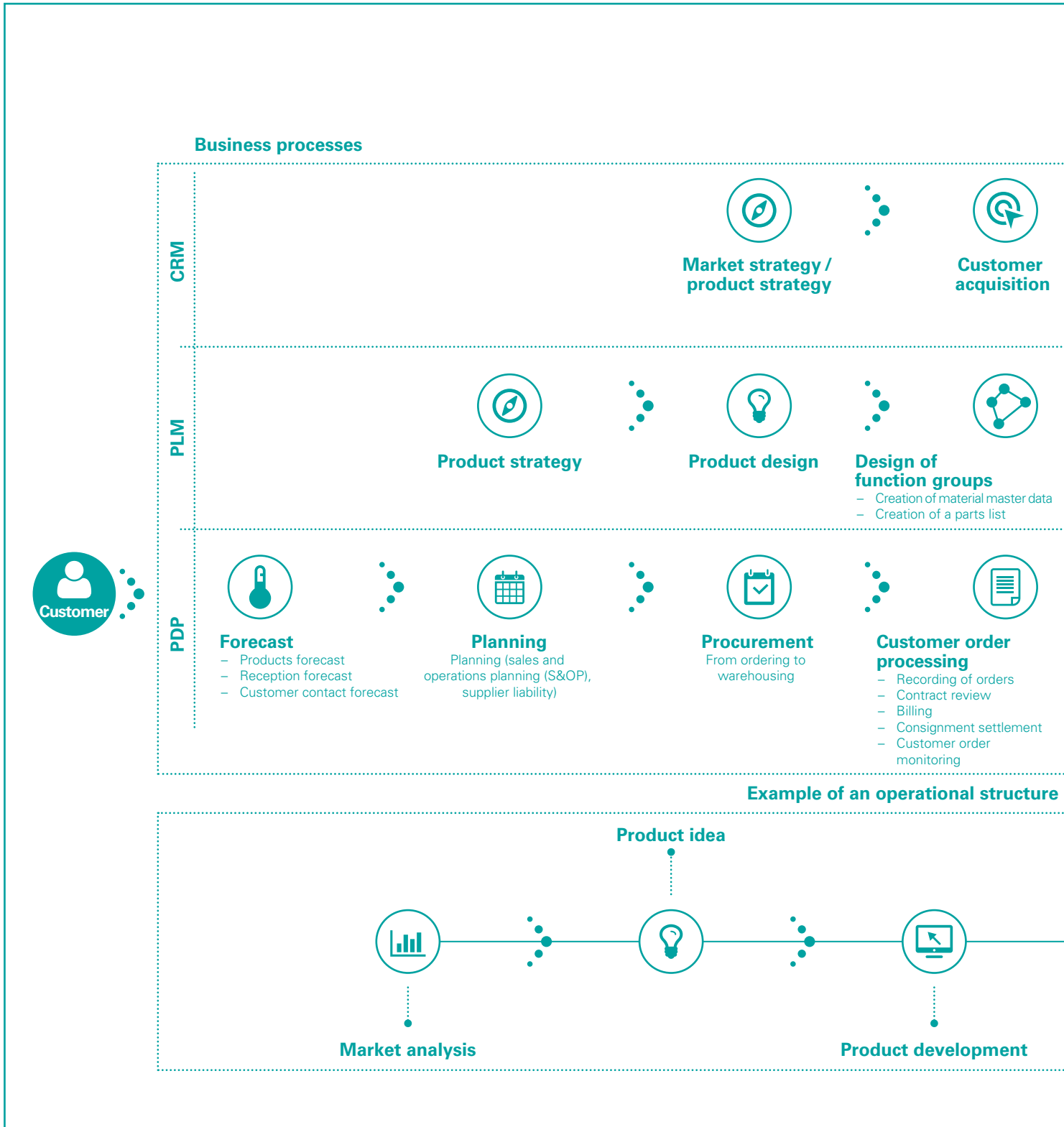
A company that wants to change track to Industry 4.0 has to be well prepared in order to achieve the highest possible efficiency and to rule out from the very beginning any errors that may subsequently prove expensive. In the context of this **preparatory process**, first of all it is important to understand and to anticipate the customers' wishes and to link the company's own core skills as well as the skills of suppliers and development partners, etc. which are available through the network. Once the skills network is in place, the consistency of the IT structures of all the companies involved must be created.

It is important to embed the core and network skills completely in the corporate strategy and thus to define a strategic, conceptual and organisational framework for the design of the IT landscape as well as to formulate standardised requirements for processes, employee skills and the actual IT support. Only then can we think about the actual upgrade to Industry 4.0.

1 THE KPMG CUSTOMER-CUSTOMER PROCESS AT A GLANCE

A concept becomes reality

As a result of the complete integration of all process stages and their consolidation into a software-supported end-to-end process, the organisational structure of the company must be aligned more strongly on the workflows (processes) – from the requirements profiles of the employees all the way up to the organisation of work itself. Everything is geared towards satisfying the customers' wishes. The organisational resources and works processes must be designed from the perspective of the client – from the latent customer requirement, through the provision of the product, to the satisfied customer requirement. The KPMG customer-customer process sketches the dovetailed sub-processes in the operational structure as well as the interfaces for the integration of the system environments.



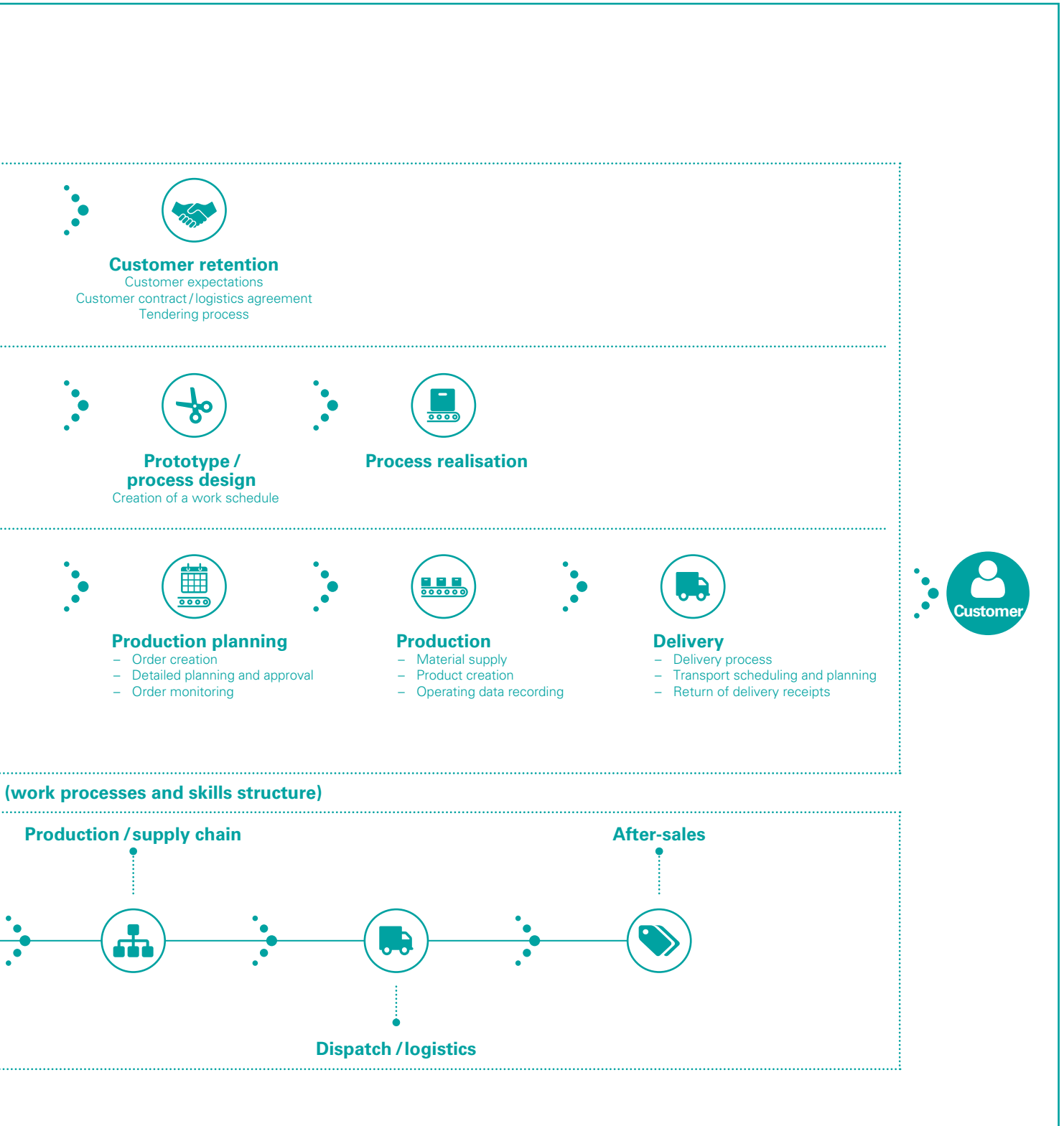
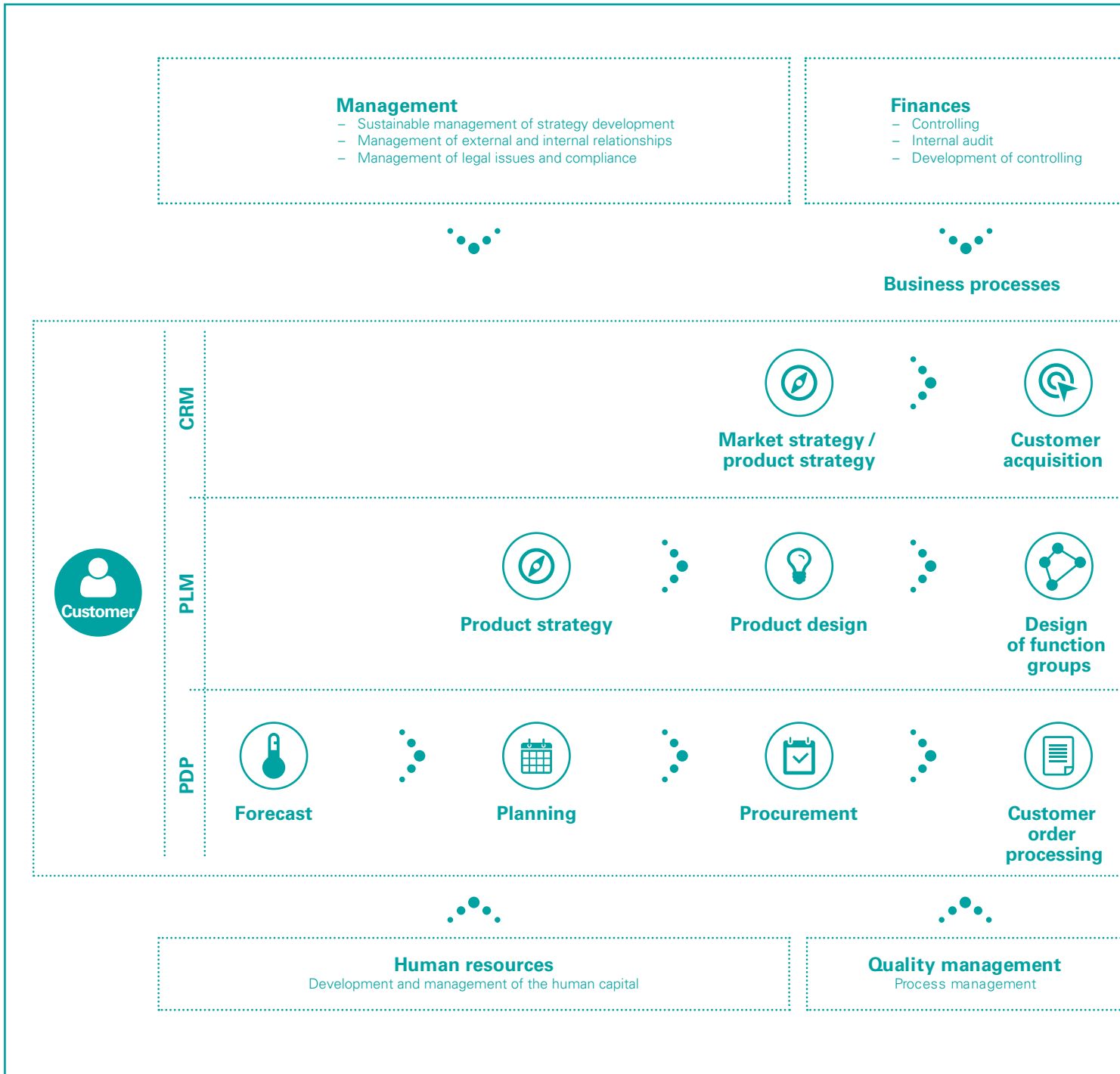


Fig. 6: The KPMG customer-customer process



Source: KPMG 2016 (Michael Bremicker)

2 PROCESS ORGANISATION

Modular structure along the product lifecycle

In our model of the “factory of the future”, we have divided the organisational resources of the operational structure into modules. These modules are based on the business processes along the physical and digital customer-customer process.

The three business processes are:

- CRM – Customer Relationship Management (marketing and sales process)
- PLM – Product Lifecycle Management (product creation process)
- PDP – Product Delivery Process (product provision process)

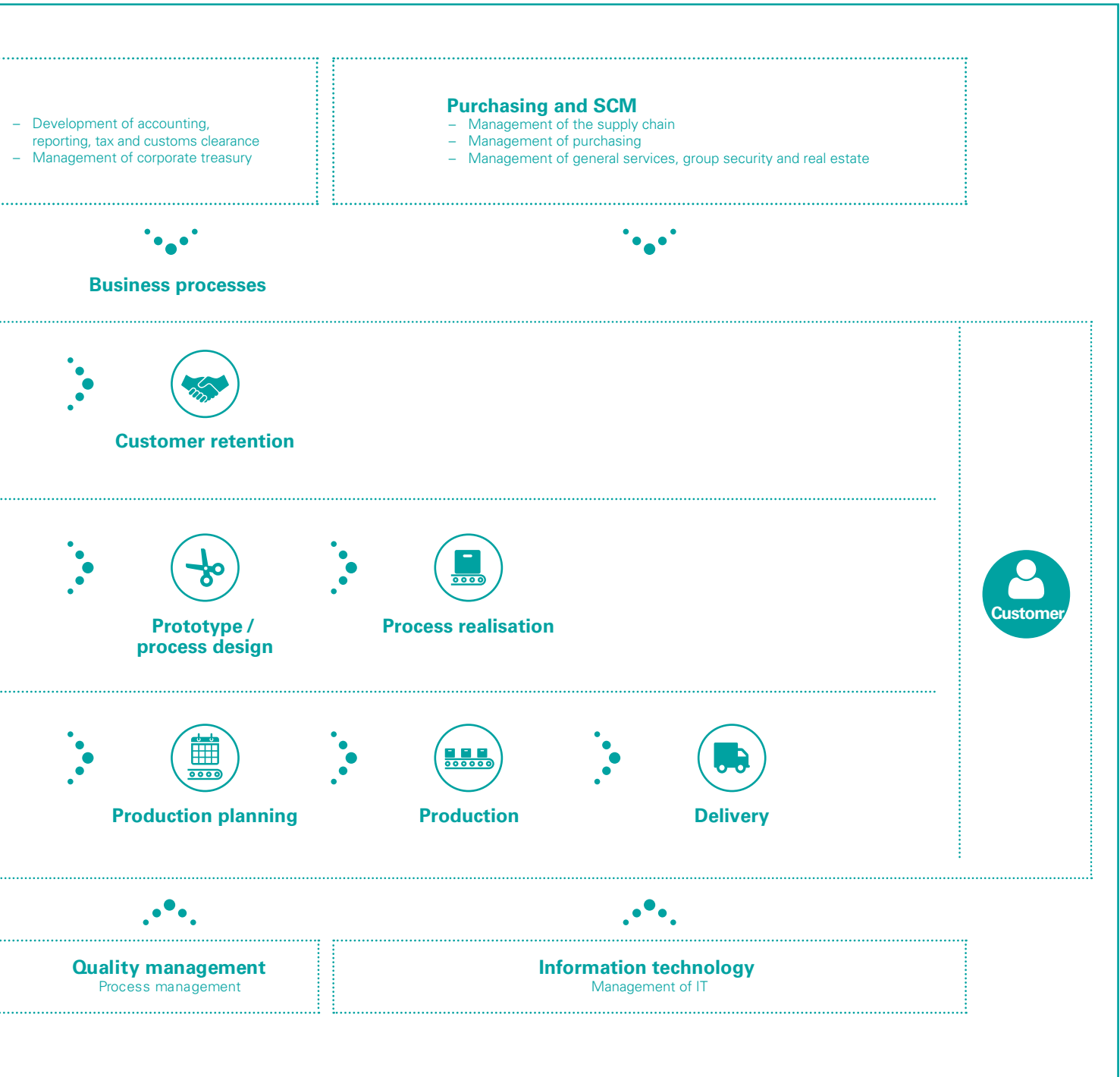
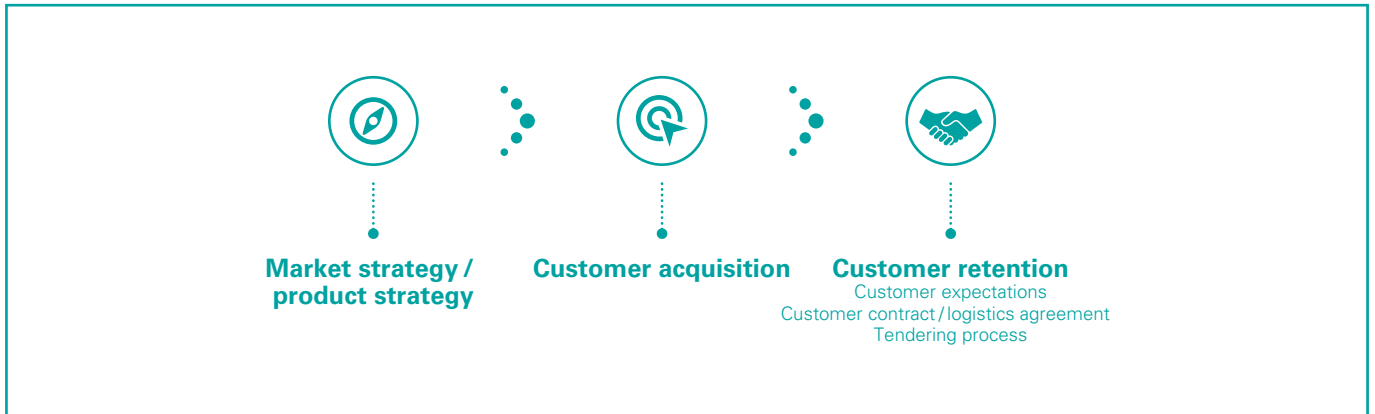


Fig. 7: Process map

The business processes are supported by central support processes:

- Management
- Finance & controlling
- Strategic purchasing
- Human resources (HR)
- Quality management
- Information technology (IT)
- Miscellaneous

In order to design robust products and processes, modular structures are required on the one hand and a consistent flow of information on the other. The further integration of the business processes enables the modules from management to IT to continue to merge until a differentiation is no longer possible.



Source: KPMG 2016

Fig. 8: CRM – Customer Relation Management (marketing and sales process)

Change in customer relations as a result of marketing and sales process

Industry 4.0 makes it technologically possible to realise a “batch size 1” and thus to satisfy customer requirements in full. In the future it will become even more important to understand the business model of the customer, to identify and scale the relevant market and customer requirements in full and to evaluate latent customer wishes. A successful marketing and sales process requires the increasing complexity of the products and services and the need to explain them in order to be mastered.

The **market strategy** defines the fundamental service areas of the company. The parameters of the purchase decision and also the existing resources for the economic implementation of the customer benefit have to be taken into consideration here.

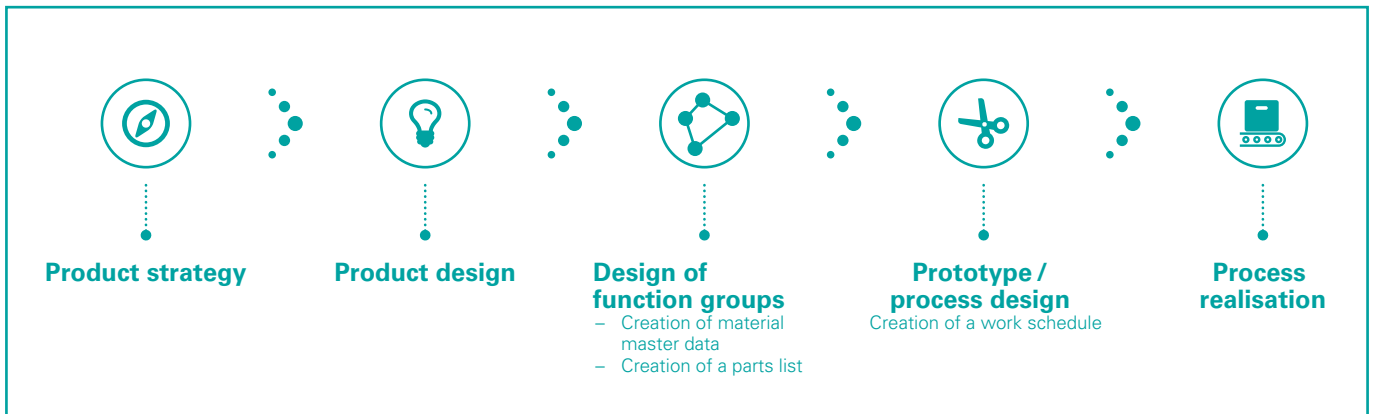
The **product strategy** bundles the customer requirements and expectations as a guide for the company’s own core skills. The product designs and variations are defined in both technological and organisational terms and consolidated on uniform, cross-facility, product-centric platforms that can also be accessed by all functions. All the internally and externally accessible knowledge, from customer acquisition to after-sales activities, is thus bundled together.

On the basis of completely available data from the digital “customer-customer process” and possible access to all the application knowledge, companies can restructure their customer relations and further consolidate their **customer retention**. Fully automated product offers for highly standardised products may also become possible. However, in exactly the same way a company can make an individual offer to a customer for a product that requires intensive consultancy – or the sales employee can retrieve a graphical, three-dimensional product representation together with the features required by the customer.

Product creation process extends all the way to manufacturing

The product creation process encompasses the strategic product planning, product development and process development. It is derived from the company’s **product strategy**. In addition to the statements relating to marketing and sales on the design of the product programme and on the portfolio management over the product lifecycle, the necessary technologies and materials are also described here.

The more precisely a company can translate market and customer requirements into specific product requirements and gear its product portfolio accordingly, the more the existing resources for the development of products in line with the market can be deployed in a targeted way. This will become increasingly important, as, in the light of



Source: KPMG 2016

Fig. 9: PLM – Product Lifecycle Management (product creation process)

reduced product lifecycles, the manufacturing processes already have to be developed parallel to the product planning and development (if possible).

Product design consolidates the individual internal and/or external drafts into a total solution on the basis of computer models (virtual product or virtual prototyping). Product design thus forms the crucial interface between strategic product planning and product development. This means that the product planning must be carried out in interplay with product design, because, for example, the manufacturing costs can be determined with sufficient reliability only on the basis of the product design.

The digital material master data is created in the **design of function groups** using parts lists. Here, suppliers must be involved here in the digitalisation of the separate material flows without any system discontinuity. All products that are procured, manufactured, stored or sold therefore have to become data storage media. As a result, data for order processing, recording of material stocks, invoice verification and production planning and management can be provided in real time or through autonomously initiated actions.

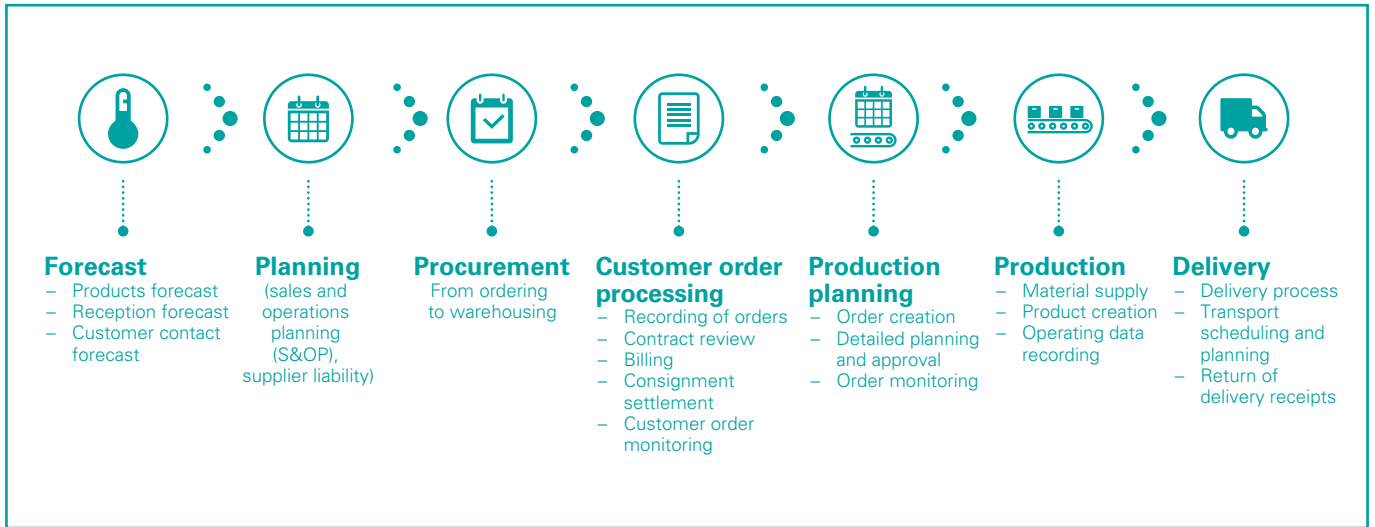
Prototype and process design involves the planning and virtual simulation of the manufacturing process (virtual prototyping and simulation) from drafting to production and work scheduling and the launch of series production.

All one-off measures to be taken are designed in an interdisciplinary and cross-facility way in terms of the design of the production system and the related work processes. Digitalisation then allows all development processes to be analysed on an ongoing and synchronous basis while feedback can be incorporated in real time and immediately verified. The process is thus digitalised from end to end: Workplaces and work equipment can now be ideally matched to the workflows and optimised in relation to individual parameters such as working hours or labour costs.

In the launch of series production (**process realisation**), the product and the production system are constantly optimised on the basis of all evaluated data, where subsequent adjustments are associated with occasionally significant follow-up costs.

Product provision process (PPP)

In the “factory of the future”, the co-operation and its organisation within the production company and beyond the company’s boundaries will look different from the way they do today: The provision of data in real time facilitates the co-ordination of customer requirements and available production capacity.



Source: KPMG 2016

Fig. 10: PDP – Product Delivery Process (product provision process)

In order to meet ever short order times, it is necessary to work with forecasts for the management of materials and capacity. The **forecast** allows the prompt provision of resources (people, materials, equipment). The key information has previously been supplied by the sales department responsible for the relevant customer. This process has not always provided enough accurate data. Industry 4.0 involves a paradigm shift: The weekly rolling, corporate planning driven by sales and marketing (sales and operations planning) with a horizon of 6, 12 or 24 months replaces the budget-oriented planning. Instead of statistical historical values, current corporate data is now used for planning. And thanks to the transparent data, this can be broken down all the way to parts lists.

On the basis of the consistent digitalisation, automation and networking and the intelligent evaluation of data, it becomes possible to set up rolling **planning** over several months or years and monitoring of critical innovations, trends and features as well as of movements in the market and competitive environment. With the help of operational corporate planning, companies can respond to developments within a product platform or model version.

Software solutions should accompany and co-ordinate the cross-generational evolution of the products, services and technologies throughout the entire product lifecycle.

Against the background of the digital consistency, all the steps of the production provision process (PPP) following the forecast are subordinate to the sales and marketing-driven production planning. The reorganisation of the company based on the PPP parameters means, for example, that the detailing planning of production and the detailed plans for preparing the work build on and are fully integrated into the sales forecast. At the same time, the internal and external sourcing structures change.

Scheduling and **procurement** then draw on the forecast-based planning. Conversely, when, at which location a particular component has to be processed and what ordering process has to be initiated for a vendor part can also be precisely calculated using the digital product DNA. The (intra) logistics processes for the provision of material that are necessary for that purpose are also represented in order to be able to ensure that the customer is supplied on schedule.

The actual **processing of the customer order** begins with recording the order. As all the relevant production process data is available in digital form, a configurable, digital end product signature (digital product DNA) can already be created at this time. A requirements and availability diagram can thus be generated in virtual form – which also includes all upstream order, logistics and processing steps. As a result, the manufacturing process can already be mapped in a completely configurable way at this early stage. Using a product configurator, complete articles with all master and transaction data can thus be generated. These are based on clearly defined standard modules, selectable features and the corresponding algorithms. In the case of production components from the company's own production, individual parts lists with the related work and assembly schedules can additionally be generated.

The rolling product sales planning directly controls the **production planning** in the future. The following steps can also be automated: Customer data is combined with the product data generated in the product configurator and allows automated production management; this is known as digital production design. This also produces the basis for billing and for monitoring the customer order.

When and at which location a predefined component has to be processed or which ordering process has to be initiated for a vendor part can also be precisely calculated using the digital product DNA. The related (intra) logistics processes for the provision of material can also be precisely mapped – a precondition for punctual delivery to the customer.

If the product goes into **production**, the product DNA also remains visible here: The customer data in combination with the product data generated in the product configurator allows digital production management (digital production design).

The final **delivery** completes the system. The unambiguous product DNA extends as far as the packaging logistics, the self-organising delivery to the



Product DNA

In Industry 4.0, there are no longer any “naked” products. Instead, all parameters, norms and standards are already clearly and automatically documented as part of the virtual product development. The workpieces thus possess a “memory” that is understood by the machinery and in which the blueprint as well as information on the customer order, production and assembly, are filed. Furnished with a product DNA, the workpieces can move semi-autonomously through a production environment. Additionally, the data stored in the DNA of various products can be aggregated and evaluated over the economic life – as a basis for the continual optimisation of the product development. Increasing computing power, high-resolution visualisations and the virtually exponentially increasing availability of data will make the issue of product DNA ever more important.

Rolling planning versus budget-oriented planning

In rolling planning, weekly projections are drawn up for the following 26 to 52 weeks for example. The planning is thus adjusted over and over again using regularly updated figures; in the final analysis, this is more precise than any planning based from the outset on a defined budget.

customer and the related customer communication: Customers are informed in real time, for example, of delivery delays, the expected delivery time and the geographical co-ordinates of the delivery. Finally, digital proof of delivery is returned to the supplying company.

Significant cost reductions possible

Access to real-time data also provides remedies for a whole host of problems: For example, order backlogs and machinery capacity utilisation can be compared in real time. Even the stock of materials can be continually checked – and the system can automatically trigger an order for materials if need be. The automatic processing of the product sales planning all the way up to production management and purchasing forms the precondition for decisions along the entire supply chain. The benefits for

the manufacturing industry are significant: lower material inventory, logistics and handling costs, shorter leadtimes, fewer shortages in distribution.

Of course, the restructuring of the planning processes in the “factory of the future” is successful only if the relevant process owner supports the changes. To this end, an overall target concept should be compared with a well-founded actual analysis of the operating workflows, the organisation and the planning and management processes. The planning areas, the planning process, the structural organisation and the project plans – in addition to data integration, training and “commissioning” – can be defined on this basis.

Conclusion – the challenges of Industry 4.0

The critical parameters in the introduction of Industry 4.0 are the design of the process landscape and the identification of the employee qualification profiles that will be required in the future. This is preceded by the development of a comprehensive Industry 4.0 strategy and an investment plan. Many aspects of the technology that is used in Industry 4.0 are already in place, but some areas still require internationally binding standards. The complexity and the expense of networking the subsystems are also

frequently underestimated. The most important point on the road to the “factory of the future” will be the commitment that the entrepreneurs, the management and the workforce invest in co-operation and acceptance of the new subject. For it will require decision-makers who want this change, who take the lead in introducing new methods and processes step by step and who gradually adjust the entire structural organisation.



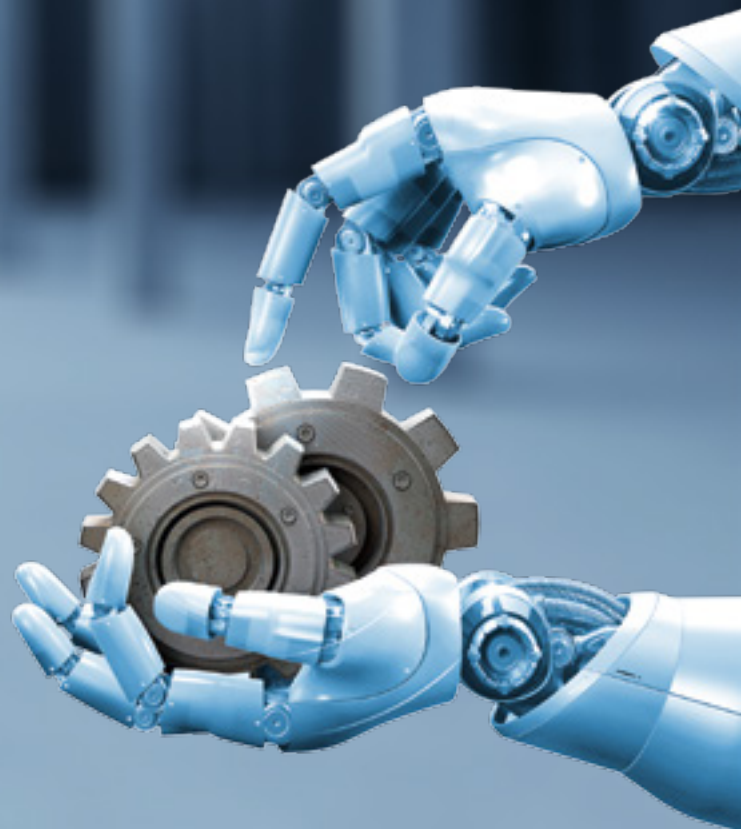
The Factory of the Future

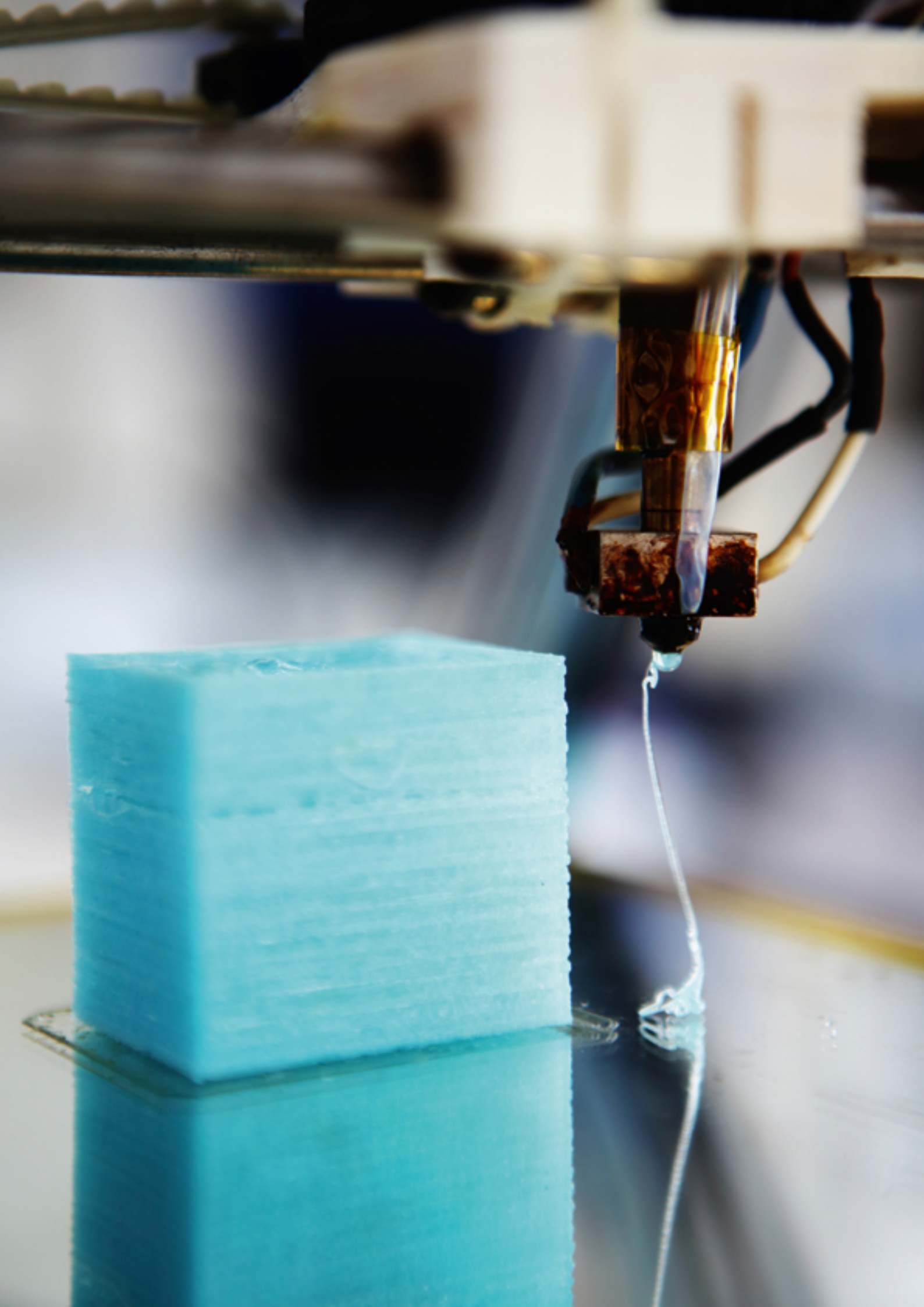
**Industry 4.0 –
The solutions for tomorrow**

2017

KPMG guide
Part 2

kpmg.com





Part 2 – Industry 4.0: The solutions for tomorrow

KPMG CONSULTING APPROACHES – WE PROVIDE YOU WITH INTEGRATED SUPPORT

The shift to Industry 4.0 will not happen suddenly and will not necessarily stick to ideal and typical change management models. Accordingly, in practice it will initially be important to individually identify and tackle the most important challenges facing the company in question. In this section, we describe the fields of action that are central in our experience. We will also show you how we can support you in successfully mastering the challenges – with the result that customer requirements as well as shareholder demands are both satisfied. For decisions have to be taken with immediate effect with regard to when which features should reach the level of the new generation of production technology in the individual company. Clear task assignments at the C level are needed for this, which we provide for you at the end of our publication.

Contents Part 2

Industry 4.0: The solutions for tomorrow

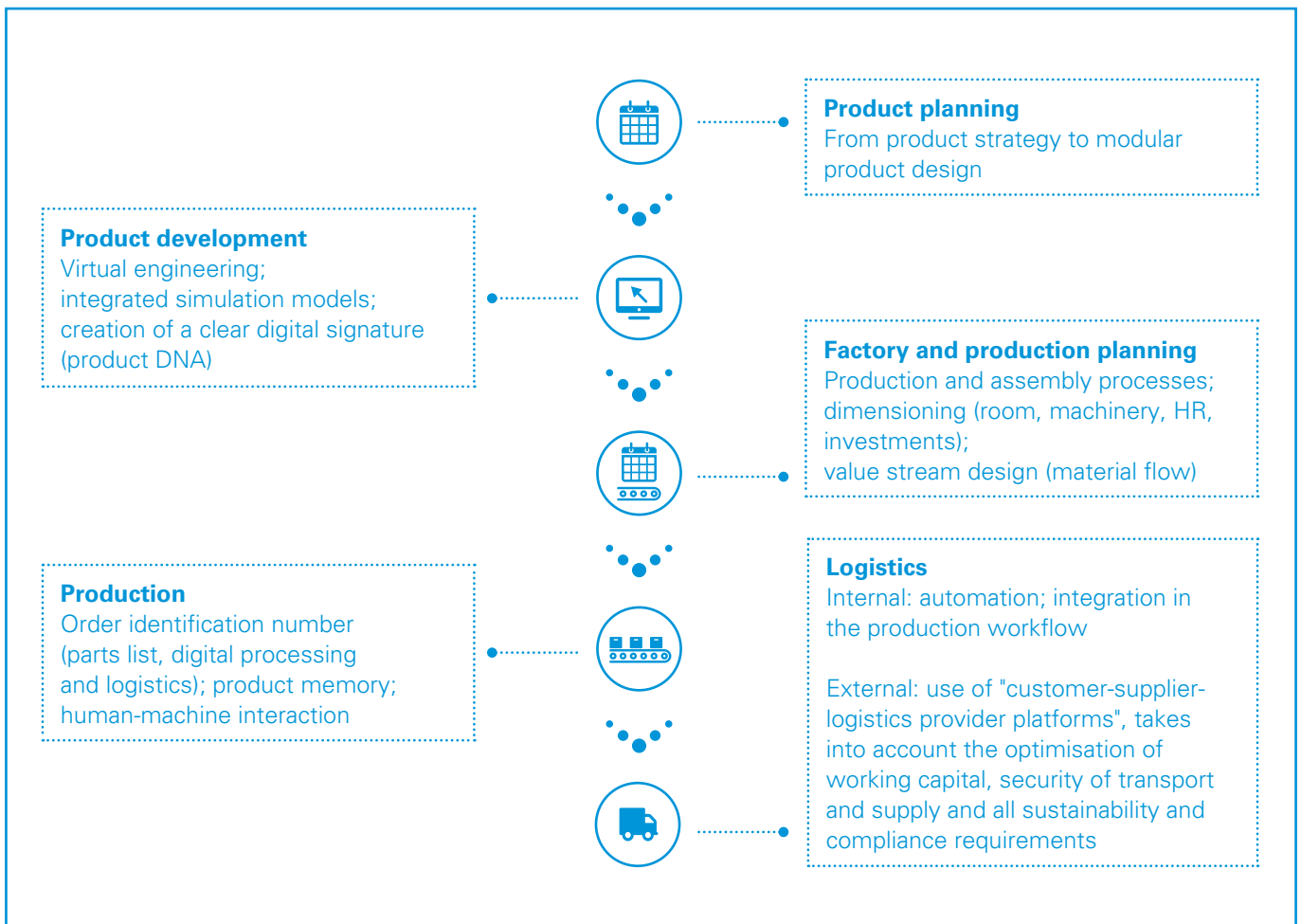
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1 Complete digitalisation

SYSTEM DISCONTINUITIES PUT PRODUCT DNA AT RISK

As described in the preparatory work for the KPMG customer-customer process (pp. 20-21), the consistent and seamless digitalisation of all processes forms the

basis for automated production. Naturally, this also requires appropriate technologies, production processes and operational and organisational structures.



Source: KPMG 2016

Fig. 11: Focal points of digitalisation

Paradigm shift in hardware and software environments

In addition to cross-company networking and integration across value added networks, universal standards are also necessary for the technical description and implementation of Industry 4.0. In the “factory of the future”, the boundaries between business management software and production management IT will become increasingly blurred. This will allow a decentralised organisation that has the option of implementing flexible and favourable adjustments and expansions.

Internal data long unused

The focus in the first “big data” applications concentrated on external consumer data from the Internet and social media. Their evaluation held the promise of knowledge and competitive advantages for companies. In-house data remained unused. Since then, many industrial companies have made massive investments in their IT systems, with the result that optimised calculation processes are also possible in real time. The necessary software already exists. Time and cost savings as well as a lower business risk

strongly suggest introducing such software. The intention is to derive knowledge for obtaining business advantages from the data that is won. A data-driven organisation can also limit its risks in marketing, the supply chain and finance and sell the right products and services to the right customer.

Employee skills as a safety factor

Similar to existing IT networks, intelligent production systems are vulnerable to hacker attacks, system errors and other risks. In all probability, further risks will arise in the course of Industry 4.0. Plants and products – and especially the data they contain – will have to be secured against misuse and unauthorised access. The most important protective measure is the further training of IT personnel and the workforce, following by investments in up-to-date security software.

OUR CONSULTING APPROACH

KPMG helps you develop smart solutions for a changing, faster and more open world of information, and to implement them in such a way that the changed realities are appropriately reflected. The focus of our consultancy offer is directed at optimising your business processes and at the efficient use of IT in your company and according to your needs:

- Enhanced performance and strategic alignment of information technology
- Optimisation of the contribution IT makes to business success while taking regulatory IT requirements and security into account
- Development, implementation and monitoring of security models for the IT lifecycle
- Drafting, implementation and certification of control and security measures for IT systems and new IT operating concepts
- Support in the design of the strategic target architecture, in the definition of a roadmap and in the development of a central meta data model

The KPMG View

“The digital transformation is changing customer behaviour, products and services and thus business and operating models in virtually every sector. This transformation is being driven by new technologies and their networking. Even classic industrial branches have to face this change. Industry 4.0 has to be understood not only as a challenge, but also as an opportunity for new business possibilities and optimised customer relations. German companies can hold their own against global competition if they learn how to exploit the potential of digital and networked manufacturing at an early stage and in a comprehensive way. But time is short. The technological structural change is proceeding at a rapid pace – and the international competition is not asleep at the wheel.”

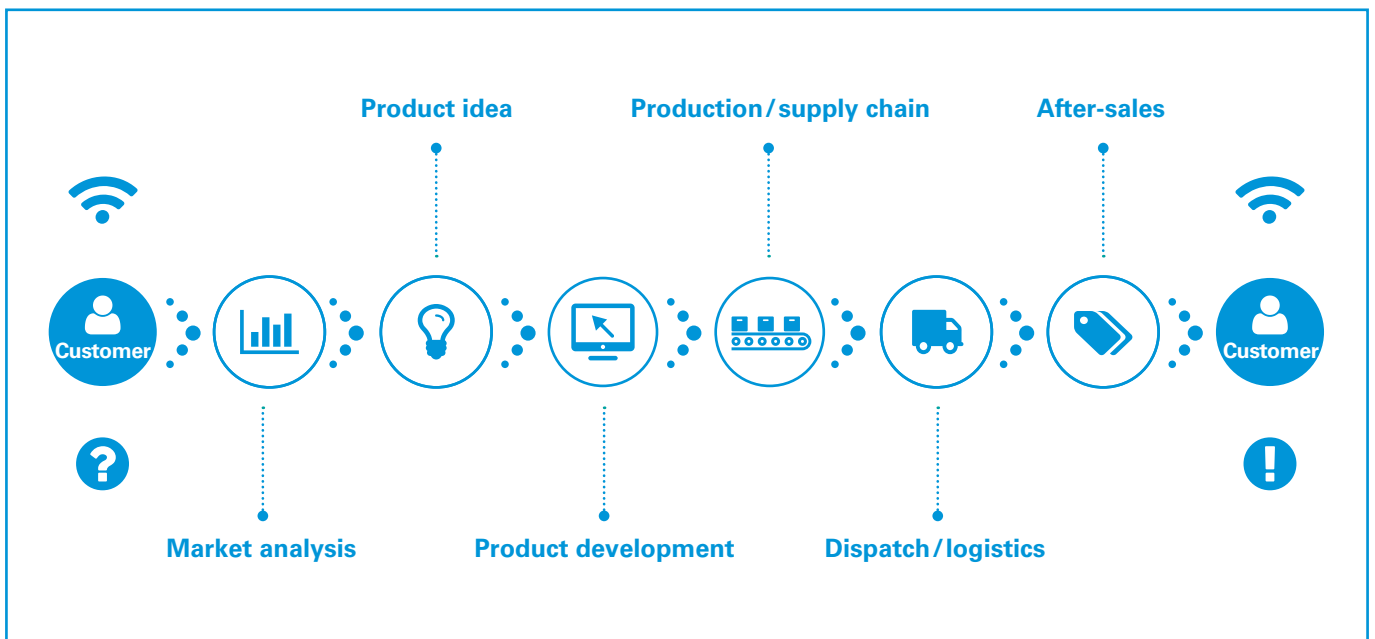
“Powerful network infrastructures and the resulting connectivity are a precondition for and catalysts of the digital transformation. Companies have to question their business models and adapt their processes to the digital change. The in-house analysis of digital performance allows the targeted development of growth opportunities and process adjustments. A digital ecosystem is emerging around modern manufacturing processes, in which market participants are coming together with different skills. Telecommunications companies are an integral part of this system. Cross-sector competition will become ever more intense as digitalisation progresses. Only companies that correctly evaluate their own digital maturity – also in context – can adjust their business model in a targeted way. In this context, a “digital readiness check” helps companies to experience for themselves how they appear to the outside. By surveying employees and benchmarking using individual, digital maturity dimensions, the correct implementation measures can be selected. In any case, new configurations combining technology, telecommunications and classic industry are emerging.”

2 Redesign of organisational and operational structures

CREATION OF A CUSTOMER-CUSTOMER PROCESS

The integration of ICT and automation technologies in all operating processes requires a re-evaluation of the need for co-ordination and of the operating functions and business processes in the company. To this end, the current status and the need for action in terms of digitalisation,

automation and networking have to be identified. The realignment of the organisational resources should be based on the defined process. The processes are supported by integrated ERP systems.



Source: KPMG 2016

Fig. 12: Representation of the flow of information and material in the KPMG customer-customer process

The functional alignment of the company should be transformed at all levels into a process-oriented structural organisation. Tasks, skills and responsibilities are adjusted to the holistic fulfillment of the customers' demands. This requires resources to be pooled under the primacy of the customers' demands. The product and process design will be viable only if a consistent flow of information on the basis of the product DNA is guaranteed. To do this the relevant process owners have to accept and promote the change. The comparison of an overall target concept with a well-founded actual analysis of the operating workflows, as well as with the organisation and the planning and management processes reveals the need for change. Data integration, training and "commissioning" must take place in parallel with this.

Automation requires organisation

The implementation of Industry 4.0 technologies is often complex, particularly in structures and processes that have grown over time: The specifications required for this often lack the necessary level of detail with relevant effects on the organisational processes that are derived. In addition, the value chains and networks are often not organised beyond the boundaries of the company. But process flows can be visualised as part of an organisational analysis by linking structural knowledge and process expertise.

OUR CONSULTING APPROACH

The KPMG approach to restructuring a business organisation encompasses all areas of the value chain – from sales, purchasing, logistics, production and R&D, through strategic qualification, all the way to the development of individual organisation models and solutions for compliance, risk management and tax optimisation.

In order to optimise your organisational and operational structure in a company-wide and sustainable manner, we provide you with support in the development of an integrated value chain that fits the requirements of increasingly volatile markets, decreasing batch sizes and global cost competition. Based on a broad portfolio of methods, we assist in optimising your leadtimes and your throughput and in reducing your inventories across the entire supply chain and support you in the introduction of a continuous improvement process. Even in make-or-buy decision-making processes and efficiency improvements within the entire production network, KPMG will help you plan and manage complex product ramp-ups and production processes efficiently and effectively. We support you in turning your production into a differentiating factor in the global competition.

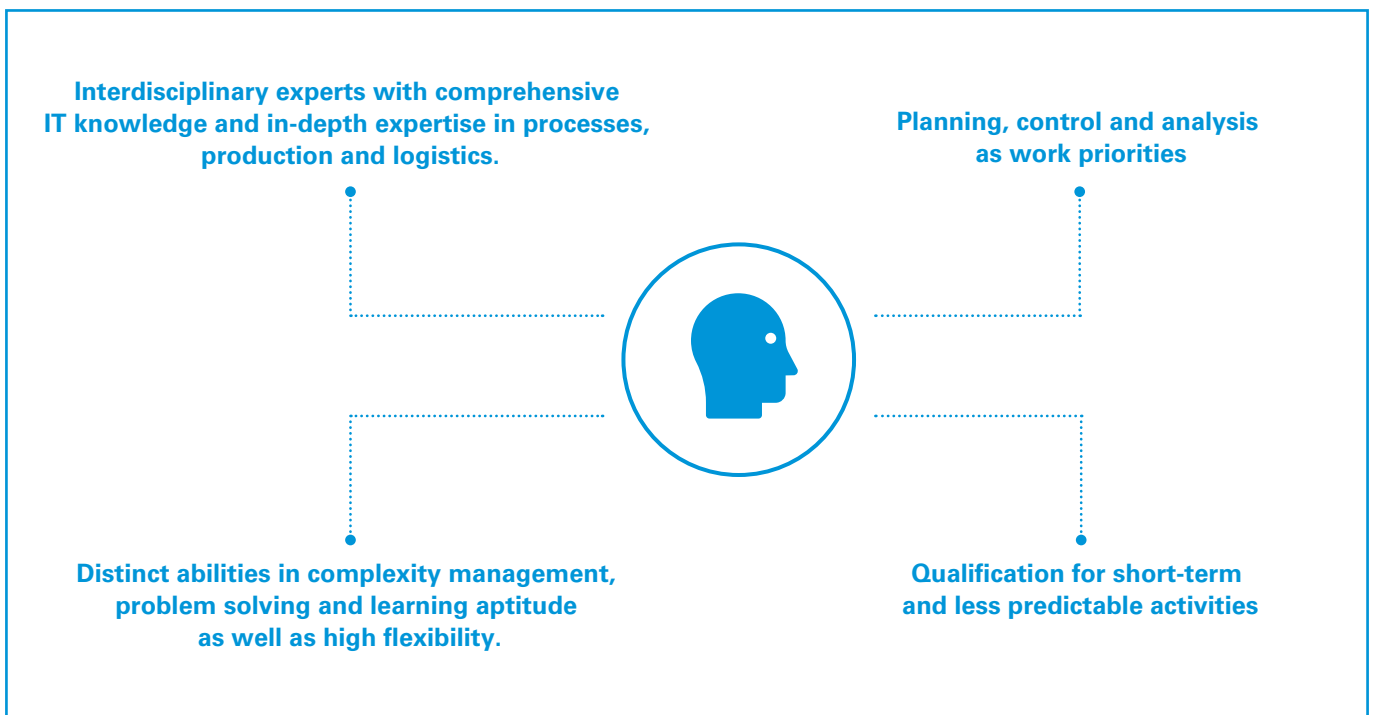
With the help of a structured and tried and trusted procedure, we offer you support in identifying inefficiencies in your processes, accompanying you as you expand your processes or helping you when you require assistance in developing and implementing new processes, so that you can integrate innovative services, products and business models in your company.

3 Human resources: qualified employees in demand

INTELLIGENT PRODUCTION SYSTEMS REQUIRE INTERDISCIPLINARY SPECIALISTS

The goal of higher productivity with lower costs must overcome the challenges posed by the rising demand for individualisation and consequently a higher number of product variants as well as the constantly increasing complexity of

the products. This makes the production processes more complex and even more dependent on fundamental knowledge and expertise of the workforce with regard to the structure and interaction of the systems used.



Source: KPMG 2016

Fig. 13: The employee of the future

Shortage of STEM specialists

Currently, the majority of companies rely on external specialist knowledge when it comes to introducing an intelligent production system. All the more important for the “factory of the future” are employees who bring with them the necessary knowledge of processes, organisation, production and IT. The lack of specialists from the STEM subjects (science, technology, engineering and maths) in many industrial companies already poses a challenge today. In the future, industrial enterprises will need professional staff who have both extensive IT knowledge as well as an in-depth understanding of processes, production and logistics. They will require specialists who can plan and implement production-related processes within a data-based and data-driven network. Experts in industrial production with interdisciplinary knowledge and talent of this kind are rare. And specialists of this kind are already urgently needed today in the preparatory phase of the “factory of the future”.

In the future, although there will be a number of production processes that will run extensively without human intervention, this vision will affect only narrowly circumscribed areas with highly standardised production. The past teaches us that automation technology not only replaces manpower, but also creates new roles and functions. In the “factory of the future”, employees will not disappear, but will encounter different challenges – in all areas, irrespective of the level of work, from production all the way to R&D. The foreseeable changes will make some work functions obsolete, but will at the same time require new skills. The digitalisation of the production plant in conjunction with the introduction of CPPS has parallels to past waves of technical change and will have a similar impact on the qualification profiles in the areas of planning, management as well as plant servicing and maintenance.

More intelligent interaction between man and machine

Two trends are driving these changes:

- The technical principle of local and intelligent self-organisation of intelligent production and self-organising production units.
- The intensified use of intelligent assistance systems, especially in production. Man and technology/machines will continue to interact, but this will be done more intelligently than today, thanks to the use of sensors, RFID chips, actuators and mobile devices.

Outside of the factory, many new jobs will emerge – for IT experts, designers, engineers, logistics experts, marketing professionals, etc. Educational and training systems as well as the labour market will have to adapt to these requirements. The change in tasks will also result in a change and a general increase in qualification requirements. Primarily affected by this will be middle management and the technical specialists. The challenge here lies in finding the right human resources strategy and in clearly defining the requirements profile that is based on a skills model that answers to HR-related questions, such as: How many specialists do we need? And what precise qualifications are necessary for our concept of intelligent production?

Once the requirements are clearly outlined, the appropriate qualification programmes can be developed. The goal is on the one hand to develop employees with as broad an interdisciplinary background as possible and, on the other, to provide an in-depth understanding of modern operating and production processes.

OUR CONSULTING APPROACH

Industry 4.0 in the “factory of the future” can be successful only if you include your employees in the (r) evolutionary process. Take on board the objections, worries and fears of your permanent workforce and initiate discussions on the basis of a human resources strategy adapted to Industry 4.0.

Even today, changes to the working environment often arise in the course of innovations; this is especially true for technology leaders. However, the automation of processes, the interaction with intelligent machines and the use of assistance systems as part of Industry 4.0 will fundamentally change the workplaces of the majority of employees and entail new requirements for qualifications, occupational safety and data protection as well as flexible working time regulations. These changes cannot all be decreed, but frequently require a basic willingness to change on the part of the employees. On the one hand, therefore, the process of change must be accompanied by information, education and training and continuous professional development programmes (change management). On the other, the general legal conditions must be adhered to and adjusted to future developments in negotiations with the social partners (employment law).

In the “factory of the future”, the production systems will take over many, but not all the tasks. While the proportion of manual activities will decline, co-ordination and management duties will increase. Against this background, new requirements and requirements profiles will emerge. Many can already be seen now. Others will need additional skills. As part of the strategic HR management, a roadmap will have to be drawn up to show how the necessary knowledge transfer will take place and how the missing expertise can be developed through training courses as well as training and continuous professional development plans.

The Chief Human Resources Officer-related Services (CHRO Services) of KPMG combine in the area of human resources the consultancy services of KPMG AG Wirtschaftsprüfungsgesellschaft (HR Consulting, Tax People Services, Compensation & Benefits, International Executive Services, Sustainability) with those of KPMG Rechtsanwaltsgesellschaft mbH (Practice Group Employment Law & Mediation). »

The CHRO Services thus offer you strategic and integrative HR consultancy. Our goal: to ensure the optimal workforce in line with the future requirements. We will also help you to define the strategic requirements for qualification measures and training and to develop a global pool of talent and experts.

The consideration of the HR function always takes place as “business in the business” and is conducted using innovative and tried and tested methods such as the KPMG 5+1 model, an HR assessment for reviewing the efficiency and effectiveness of the HR department.

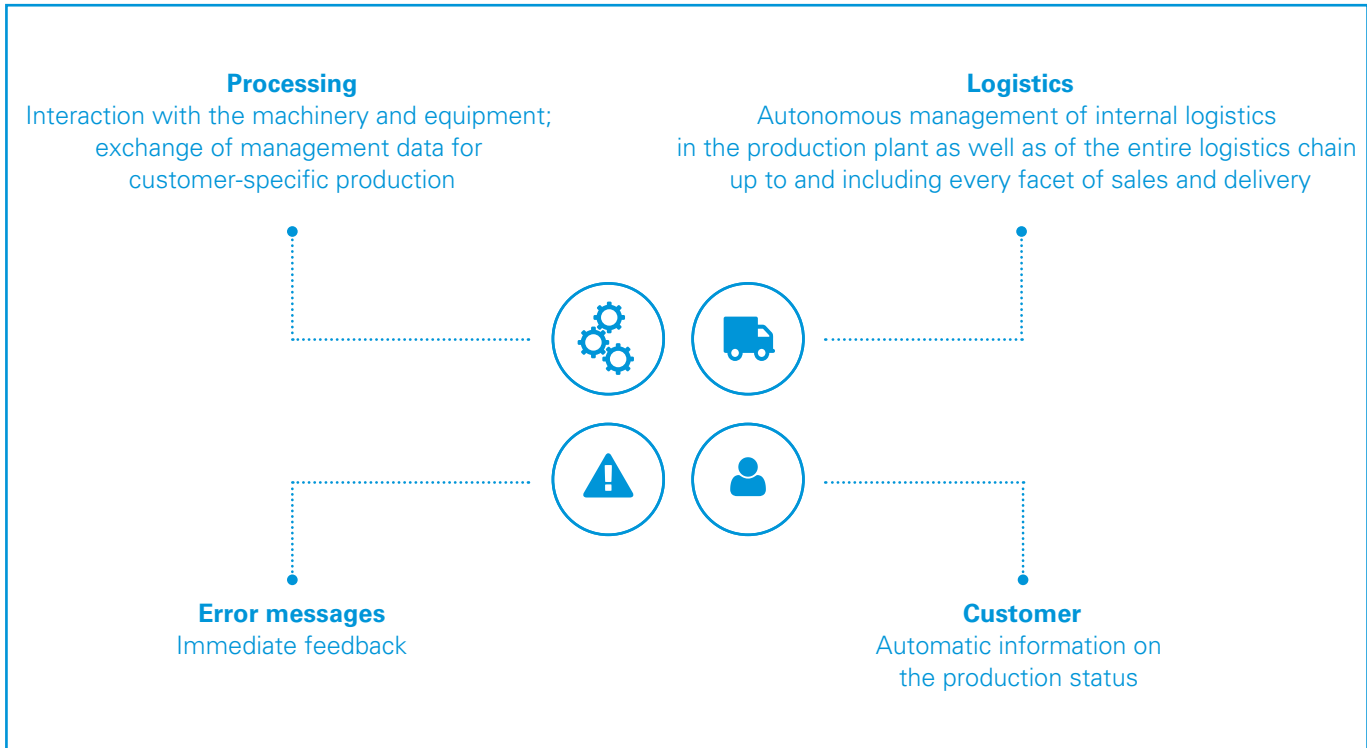
Finally, the lawyers of KPMG Law specialising in employment law will provide you with support in adhering to the general legal framework and in including the social partners (works council and union) in good time and in a legally compliant way.

4 Alignment of the machine, equipment and logistics park to Industry 4.0

USING AUTONOMOUS MACHINES TO PRODUCE SHORTER INNOVATION CYCLES, HIGHER QUALITY AND LOWER COSTS

To the extent that ICT technologies penetrate the company processes, the technological innovation cycles of the manufacturing industry will also change. The shortening of the product innovation cycles also entails a continual adjustment of production capacities: New materials have to be assessed for their own added value and processed, possibly with new production technologies. New technologies and features have to be integrated into solutions,

and the capabilities necessary for this have to be developed. It may be that completely new production facilities have to be planned and built for each new product generation. In order to achieve the goal of efficient supply with the best possible capital goods, the company's own value added network has to be expanded and relevant developments have to be continually followed.



Source: KPMG 2016

Fig. 14: Areas affected

To the “factory of the future” via flexible equipment and technology concepts

Ever shorter investment cycles and increasing requirements for flexible manufacturing platforms demand rolling product lifecycle management that is integrated in the added value. The rolling investment planning that results ensures greater planning security. The quality of the planning also benefits from Industry 4.0: The integrated financial planning links the profit and loss account, balance sheet and cash flow statements as well as sub-planning – including sales planning, human resources planning and investment planning – with each other. This increases planning quality and reduces planning expenditures.

In preparation for the “factory of the future”, ever more flexible machinery and technology concepts such as additive manufacturing procedures and intralogistics are making their mark. Additive manufacturing procedures have developed from a cost-intensive niche technology to a rapid production technique for a wide number of products with the most varied of materials. One of the greatest advantages of additive manufacturing (AM) is the almost complete freedom of the developer in the product design. To make use of these opportunities requires new knowledge, abilities and skills. For direct digital production, the majority of the production and process parameters must already be defined and laid down in the product development phase. The only limits are the external dimensions of an object. Additive manufacturing can often reduce costs thanks to its lower consumption of materials.

In-house production, warehousing and packaging logistics is generally taken on by the companies in the manufacturing industry themselves. Depending on the business model, this can also be the task of suppliers or external service providers (intralogistics). An increasing number of logistics service providers are taking over not only the order picking and pre-assembly for the manufacturing industry, they are also becoming integrated as suppliers directly in the value chain of the company. Industry 4.0 technologies will create new possibilities for further shifting the boundaries to logistics. The integration of logistics in the “factory of the future” will succeed thanks to fully automatic warehousing and transport concepts, robotics and real-time data processing for the planning and management of the workflows. In the Industry 4.0 vision, the products themselves can choose their transport modes and even independently define the path to the customer on the basis of an efficient calculation of the route. Logistics conditions can then be negotiated and booked automatically on the basis of the product DNA.

OUR CONSULTING APPROACH

KPMG supports you with a comprehensive approach as you identify the relevant levers in your company and successfully implement trend-setting production technologies such as additive manufacturing. In this process, our analyses take into consideration a broad spectrum of specific requirements that can effect such things as the business model, the supply and value chain and even legal* questions. Of central importance is your company's product – both in terms of the technical feasibility of manufacturing by means of 3D printing, the specific business case, also with regard to the digital networking and relevant design possibilities, as well as logistics.

Our specialists support you in the financial and investment planning in order to show you the financial impact that your investments and the implemented changes in performance have on the result. The focus here is the quickest possible amortisation of the investment as well a reasonable internal interest rate. In addition, we help you calculate the effects of strategic decisions on investments in Industry 4.0 technologies on the financial position, cash flows and financial performance of your company.

Of course we also provide you with support in revising or redrafting planning, budgeting and reporting processes. On the basis of your core skills, the production model and individual parameters – such as your depth of added value, your production technologies and the material capabilities – we work together with you to develop sustainable production strategies. We optimise the production networks and processes and support you in cross-linking your organisational structure and in embedding new technologies and operating processes. Furthermore, we provide you with support in the design of interfaces to other participants in your value chain and in connecting the relevant IT systems, so that you can exchange data with your environment without system discontinuities.

The company's own material flow and integrated logistics management concepts must guarantee security of transport and supply and fulfill all sustainability and compliance requirements. We support you in developing the relevant concepts. »

When it comes to reducing the tied-up capital through active liquidity management and the management of the working capital items, take advantage of our services from the field of Working Capital/Cash Management. Our specialist staff provide you with support in developing flexible and adaptive logistics networks and connecting them to powerful ERP systems and logistics platforms. Here too, the goal is a consistent flow of data and information.

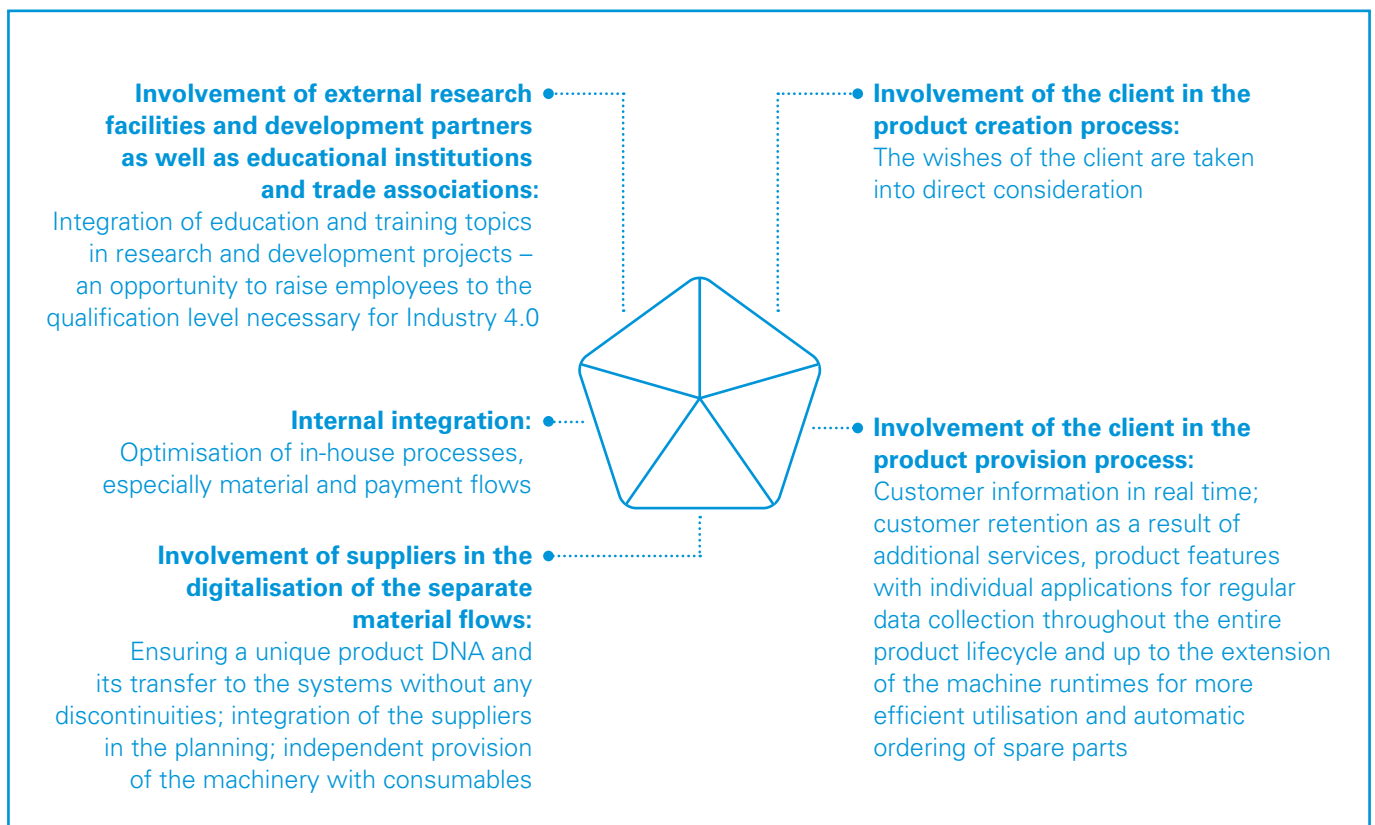
KPMG Law supports you in identifying risks associated with IP rights and in developing and setting up IP and knowledge management according to your requirements. In addition, KPMG Law will also help you develop and implement (tax-efficient) licensing models. And of course we provide training for you and your employees in IP and IP management.

5 Restructuring of the value chain

TRANSPARENCY THROUGH EXTENSIVE INTEGRATION

More than ever before, the commercialisation of innovation is part of the R&D process. Companies have to extend their R&D departments beyond their own value added networks and vertically implement them: The scope of available knowledge is expanding too rapidly, areas of research and development are becoming too complex, innovation and product cycles are becoming too short. While the pressure to co-operate is rising on

the one hand, the consistent digitalisation and networking of research and development is offering more and more opportunities in return. As a result, companies can collect knowledge and ideas through web-based innovation and crowdsourcing platforms, test the ideas and integrate them in their innovation processes. Integration now extends beyond the previous boundaries.



Source: KPMG 2016

Fig. 15: Extensive integration

Taking advantage of favourable energy prices

In addition to the inclusion of the partners involved in creating value, further opportunities of digital integration present themselves, such as comprehensive energy efficiency management (e.g. in accordance with ISO standard 50001 Energy Management Systems). Using the available data, the systems can calculate the most favourable periods for production and subsequently negotiate autonomously with electricity suppliers. In “smart buildings”, the building services technology and home automation are already digitalised and networked – with the result that energy efficiency, comfort and safety are all increased.

Faster administrative decisions

As part of the modernisation of administration and as a result of e-government projects such as electronic tax returns, aspects of the “factory of the future” are also emerging in the area of administration. The digitalisation of data files and the automation of administrative processes are advantageous for companies, which can thereby avoid “bureaucracy costs” and can expect quicker decisions and approval processes. In addition, efficient public administration with lossless connections to EU, federal, state and municipal authorities enhance the status of Germany as a business location. Industry 4.0 thus provides all parties communicating with the administrative authorities with higher-quality and more extensive digital services, enhanced interfaces and more transparency.

OUR CONSULTING APPROACH

Our specialist staff will help you to analyse your value chains in terms of your individual requirements and risks. We will use the results to support you in the development of cross-functional business scenarios, the implementation of a global organisation with integrated processes and the design of a demand-driven value chain. You can subsequently measure the performance of these processes and thus review their effectiveness. Working together with you, we also create the conditions for an economically sensible implementation of sustainability and compliance requirements. The impacts of the resulting measures on your enterprise value will also become apparent by means of concrete figures.

Transparency, compliance and cost savings throughout the value chain are the key strengths of our approach: In terms of transparency we place a special focus on your capital flows with regard to the sustainability of your operating and strategic risks. Without standardised structures, compliance is difficult to track. With globally standardised and optimised workflows and organisational structures, on the other hand, the compliance of your value chain can be constantly reviewed. In addition, the compliance performance is measured and presented as part of the financial result. Sustainable cost savings can be realised with all relevant stakeholders and through the optimisation of the company assets.

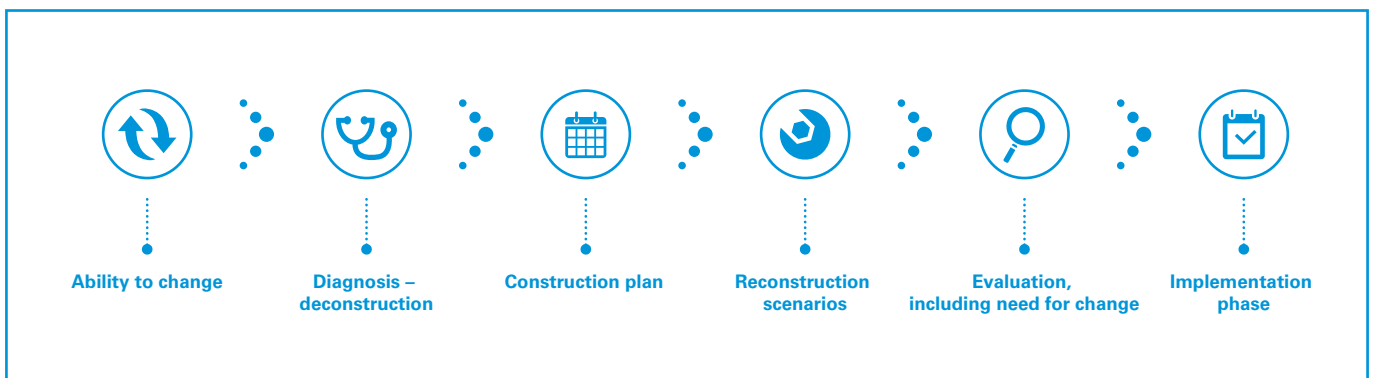
We will also be at your side at the end of your value chain – in the alignment of your supply and services streams from tax viewpoints: We provide you with support so that your supply and services streams fulfill, as far as possible, all compliance requirements, and we help you increase the transparency of transfer prices, value added tax, customs and trade barriers.

6 Adjustment of the business model and development of new revenue models

SKILFUL DATA ANALYSIS OPENS UP NEW OPPORTUNITIES

The recognition that companies are (have to be) in a constant process of change can be regarded as a given. However, as a result of the digital transformation, this change is taking place at a speed never seen before. In the medium term, rigid business models will therefore be too slow to respond and will thus lag behind the competition. To prevent this, current business models must be

comprehensively geared towards the digital transformation. What is also important here is to transfer the previous core competences to the future business model. In the manufacturing industry, this means determining the drivers of the changes, recognising industry convergences and identifying disruptive technologies.



Source: KPMG 2016

Fig. 16: From information to innovation

The relevant findings must then be evaluated in terms of the business model. In our view this continual monitoring process forms part of the set of core competences of all companies in the manufacturing industry. Of course it should not be the only source: Further findings on the creation of a market model are also supplied by research

and development. Data evaluation – for example as part of process and equipment monitoring – is likely to gain in importance and make an interdisciplinary understanding of engineering and computer sciences a further core competence.



Taking fundamental decisions on the basis of data

The evaluation of data produces the first approaches for adjustments, new revenue sources and practical revenue models. The planning of innovative products and services creates the general conditions for the new performance model. The data also supplies the basis for an initial calculation of the financing requirements – including legal conditions and compliance requirements. Plus: Important fundamental decisions, such as structuring the value chain, searching for suitable co-operation partners and take-over targets or defining the industrial footprint can also be taken. The new added value model begins to take shape.

To implement this model, the company requires core competences that in the future are geared more strongly to new solutions than to a specific product offer. This can mean, for example, making use of material and manufacturing skills for new solution portfolios, such as pay per hour, pay per piece or pay per value (source: Fraunhofer IAO).

Ensuring knowledge transfer through convergence in R&D

A convergence of the development work must follow the convergence of technologies. In addition to the development work of established industrial companies, start-ups, spin-offs from universities and research institutions as well as co-operative development platforms in particular are challenged to present interdisciplinary and integrated approaches to solutions.

It is precisely the co-operation within related technology segments that enables application expertise to be transferred, thus creating an added value for the manufacturing industry in itself and the basis for joint products and services.

Maintenance as a service with a future

The recordable data from operations, status and environment of the product can also be used to develop a forward-looking maintenance process and thus additional services: In the case of preventive maintenance, the most vulnerable parts can be tested and maintained on a key date defined in advance. This also allows warehousing to be minimised, as maintenance operations can be planned. In maintenance based on reliability, differentiated monitoring techniques recognise when machinery has to be maintained, predict malfunctions and maximise productivity with the lowest possible costs for repair and maintenance.

The measurement of physical values such as temperature, speed and load torque, etc., is already widespread as part of the regular or constant recording of the status of the equipment in order to protect the plant. Further areas of application of preventive data recording include:

- Quality assurance through data recording during processing (e.g. tool monitoring)
- Status monitoring through remote diagnostics
- Benchmarking on the basis of the most varied of operating data from the most varied of data sources and technical expertise as the basis for intelligent consultancy services
- Assistance systems to support the service employees or for training and qualification measures – possibly awarded to external parties subject to a fee

OUR CONSULTING APPROACH

Our consulting approach is based on the customer benefit, the added value architecture and the revenue model. The spectrum of our approach here ranges from optimisation to transformation of the business model:

To begin with, we work together with you to analyse your current business model from cross-functional and holistic perspectives. In the second step, we use regulatory, market-related, technological and competition-based parameters to define necessary innovations and transformations. Subsequently, we offer you support in setting a new course to secure your company's sustainable success: We identify the drivers of change, sector convergences and disruptive technologies as well as their impact on your business model. By screening alternative business models and ideas, by analysing markets and the competition, but also on the basis of customer surveys and trend scouting, we accompany you on the next part of your journey – whether it is opening up additional revenue sources, adapting your current business model or developing a completely new one.

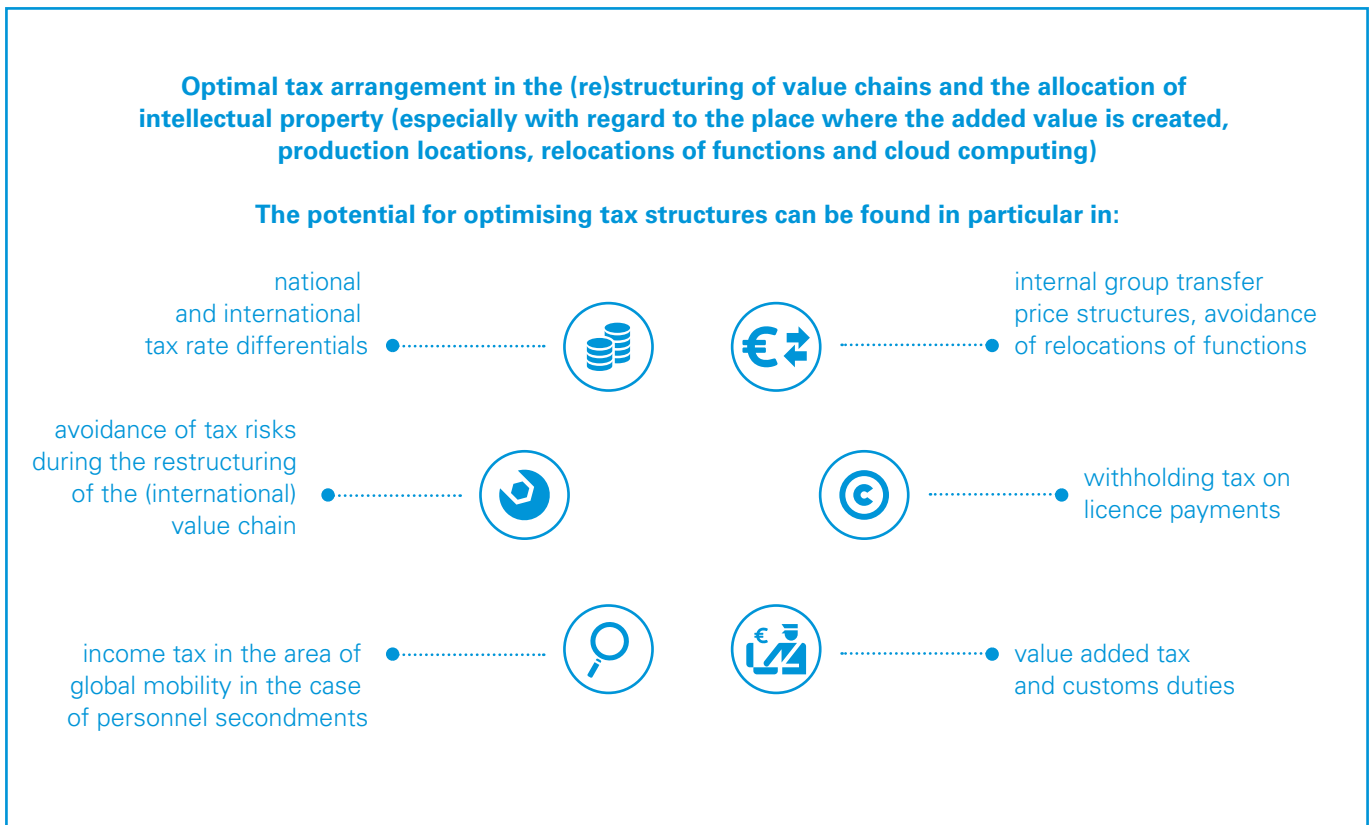
As your fixed contact for analysis, design and implementation, we also support you as you implement the new business organisation, the company processes and IT structures. In addition to the operational implementation of the new or adapted business model, we help you set up continual monitoring for all relevant performance indicators.

7 Tax dimension of Industry 4.0

DIGITALISATION MAKES IT DIFFICULT TO LOCATE SERVICES

The fact that the implementation of Industry 4.0 brings with it more than just economic and technological changes has hardly been discussed up to now. But this change has a significant legal and regulatory dimension.

Decision-makers must therefore not lose sight of the issues of tax law on the road to the “factory of the future”.



Source: KPMG 2016

Fig. 17: The tax dimensions of digitalisation (added value, licences, income tax, customs)

Relocation of the value creation

Intangible assets (intellectual property or IP) such as customer data, expertise, patents, etc., are already key drivers of a company's success today. This will be true to an even greater extent in the "factory of the future". Thanks to technological developments, large and complex data volumes (big data) can now be used for the first time by companies. The added value emerging from that process becomes an autonomous production factor in the context of Industry 4.0. On account of the increasing importance of intangible factors, shifts in the basis of taxation between different countries can also arise: In some circumstances, the added value in the "factory of the future" can move away from the place of production to the place of research and development or the place of marketing and market research. For that reason, value chains may have to be redefined and transfer price systems revised.

From tax planning perspective, opportunities and risks for IP-driven success models are derived in particular from the high level of mobility. How will the basis for taxation be defined in this case? In addition, technical developments such as cloud computing can lead to the loss of tax reference points. The structural organisation of an industrial corporation will thus have to take into account at which level or in which legal units IP is created, where the legal and economic ownership of the IP resides and where the later use of the IP arises in the context of the performance of services.

Taxation at the place where value is created

In terms of forward-looking planning, it appears absolutely possible to achieve positive effects from the tax rate differentials between different jurisdictions. However, restructuring and reorganisation projects implemented without expert tax knowledge are vulnerable to tax risks. For example, a company restructuring can unintentionally result in tax-related circumstances (abuses) such as exit taxation or a relocation of functions. Against this background, as part of the OECD initiative against Base Erosion and Profit Shifting (BEPS for short), investigations are currently underway into how tax on company profits can be ensured at the place where value is created. In this respect, specific measures to be implemented on a national basis are being discussed that will make it difficult to relocate the IP to another territory and that are intended to neutralise the financial advantages of a relocation. Licensing structures are directly connected to the increasing importance of IP for the "factory of the future" and its use; in other words: How does remuneration take place if IP is handed over to others in or outside the group?

The group-wide and cross-company use of production and process knowledge is moving in the same direction. For tax purposes, these structures can be employed as formative elements in order to bundle company profits in the optimal way in tax terms. In addition, licensing structures regularly (and will almost certainly continue to) bring up international transfer pricing and withholding tax questions that are prone to discussion.

Difficult definition of income tax, customs and value added tax in virtual teams and services

The further international networking in the run-up to Industry 4.0 will lead to teams from different specialist areas and companies across several locations – including home offices – using a common data source and driving joint projects to an increasing extent. As a result, it will become more and more difficult to define the locations of companies and activities. In particular the decentralised virtual co-operation of international personnel raises the question of where income tax has to be paid and which regulatory and compliance requirements have to be fulfilled.

The reorganisation of purchasing and sales processes and of the related structures is also relevant for tax purposes. The provisions at the place of performance apply in the case of customs duties and value added tax. But what do we do when the services are performed virtually – and possibly in a country where the company is not even present?

The requirements will also change fundamentally in tax consulting. Tax departments will have to realign their established processes as IT solutions relieve or even replace the support in tax matters that is currently still very staff-intensive. The trend towards electronic tax audits is already becoming clearer; this is also something that gives the tax authorities access to internal company databases, but at the same time offers the opportunity to avoid errors in declarations.

OUR CONSULTING APPROACH

Our foresighted approach covers all relevant areas of national and international tax consulting. Through the global KPMG network of consultants, our specialists have direct access to the specialised knowledge and the experience of all KPMG member companies in the field of foreign tax law. In addition, our national and international specialists cooperated closely with each other, for example on value added tax, customs duties and transfer pricing in order to integrate all tax issues in an effective tax plan.

We use the new value chains to optimise tax structures. To this end, we examine your structures at an early stage to identify tax potential and risk, for example with regard to the exit taxation mentioned earlier. Furthermore, we provide you with support in fulfilling documentation obligations, identifying the arm's length transfer price and implementing the processes necessary for withholding tax purposes in a way that satisfies compliance requirements. Our aim is to reduce your tax burden in a legally compliant way and to avoid liquidity outflows.

The comprehensive and resource-efficient use of all tax-related data in your company is a key building block for minimising risks for the "factory of the future". By using big data analyses, we obtain within the shortest timeframe an overview of your business relationships and all transactions that are relevant for value added tax and important for profit tax, income tax or under customs law. In addition, we protect your big data against excessive access by the tax authorities.

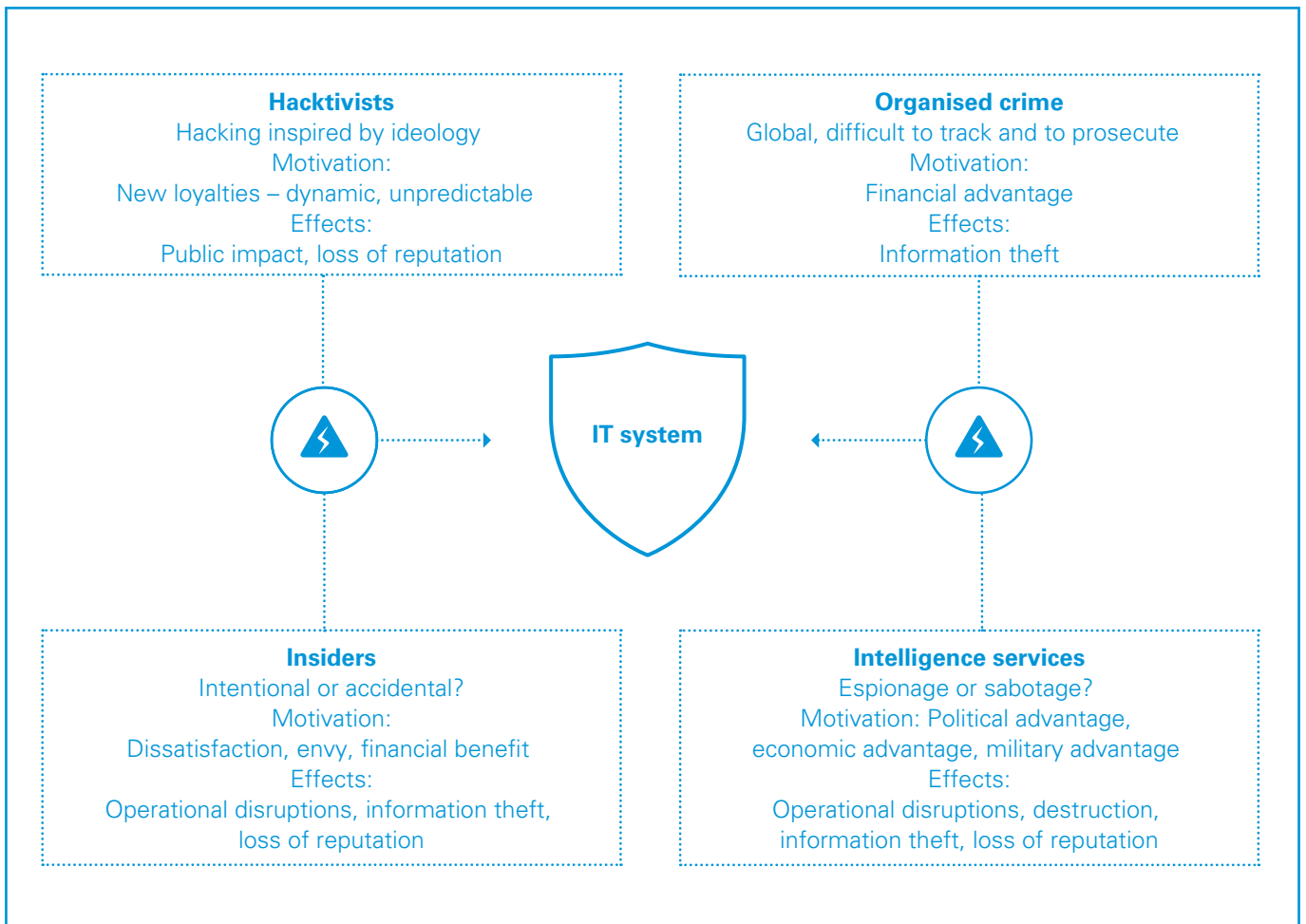
Today's tax consulting can no longer get by without the use of IT applications. With TaxOne, KPMG offers a unique fully integrated and web-based system for your tax management. The tax processes are highly automated and appreciably improved in the process – also with regard to tax risks.

8 Cyber security

PRECAUTION FOR THE FLIP SIDE OF TRANSPARENCY

Just as the “factory of the future” offers new opportunities for companies in a networked ecosystem, new challenges are also posed for information and cyber security. Industrial espionage, data theft, sabotage by

competitors and terrorist attacks on critical infrastructure providers are just some of the threats facing operators of Industry 4.0 infrastructure.



Source: KPMG 2016

Fig. 18: Security risks for Industry 4.0 infrastructures

Standard security is no longer enough

Standardised technical security solutions are by no means adequate for systems of this kind today, as they are blind to modern attacks. Only a co-ordinated bundle of measures that has a targeted effect on the relevant risks of the individual infrastructure landscape can offer protection and at the same time keep the costs of cyber security in an appropriate balance.

In addition to preventive steps, tailored solutions for actively identifying and handling cyberattacks belong to the repertoire of a cyber security programme. Only in this way can it be guaranteed that the equipment and the data processed is secure and available.

OUR CONSULTING APPROACH

The selection and co-ordination of the suitable defence mechanisms for securing networked production facilities are critical factors for the success of Industry 4.0. Thanks to our industry expertise and our experience in securing industrial facilities, IT systems and applications, we can draw up a comprehensive and authentic picture of your individual threat situation and – based on a comprehensive risk analysis and a review of the current security standards in your company – select and implement suitable counter-measures with you.

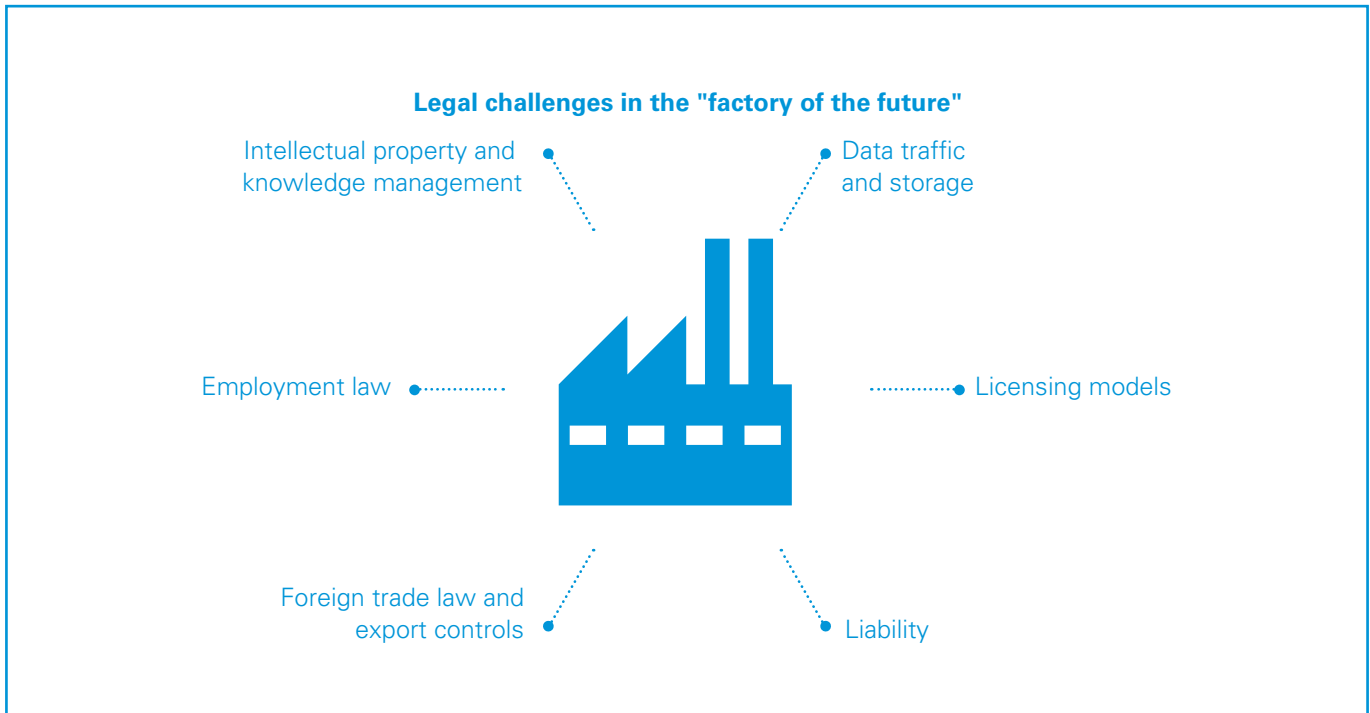
Furthermore, we support you in the implementation of security-related compliance requirements and security standards, such as ISO/IEC 27001 and ISA/IEC 62443. Our methodology for a holistic cyber transformation programme also includes modules for the organisational integration in the company (e.g. governance, processes, awareness and training measures) in order to anchor and continually develop cyber security sustainably in your company.

9 Compliance with complex legal requirements

DOVETAILING OF LEGAL WITH TECHNOLOGICAL AND BUSINESS SKILLS

In the transition to Industry 4.0, the responsible company bodies must fulfill a number of legal requirements and regulations as part of the organisational duties in order to avoid substantial liability risks. In the final analysis, errors in automation and networking, but also in the manage-

ment of the massive and (mostly) extremely valuable data volumes can end fatally both for the company and for the company's executive bodies in the event of a breach of duties.



Source: KPMG 2016

Fig. 19: Legal challenges in the "factory of the future"

Industry 4.0 needs legal department 4.0

In addition to excellent professional expertise, the legal practitioners in the legal departments of the future will require an in-depth understanding of the relevant business processes. In the face of the ever-accelerating pace of innovation, in-house lawyers will have to be creative to deliver to the company's management bodies secure, but at the same time simple and practical solutions for complex legal problems. To this end, they will have to dovetail more closely with other business units (e.g. operating divisions, tax, HR) and work in interdisciplinary teams. The legal department 4.0 will additionally have to take on other duties – for example in project and contract management.

From the mind to the system

Today, intellectual property rights such as patents and expertise make up the key part of the enterprise value in a majority of companies. The protection of IP and expertise is therefore of crucial importance not only for the success of the company, but also for its continued existence. As a result of increasing digitalisation and networking, companies are increasingly being compelled to document their own expertise in order to make it available for new processes. Once it has been digitalised, the expertise – also the expertise of third parties in terms of compliance – has to be technically and legally secured. The possibilities for personal control continue to decline as a result of autonomous machine-to-machine (M2M) communication and cloud computing.

On top of that, there are different protection levels specific to each country as well as the responsibility for protecting sensitive data in the next stages in the value chain. This applies to the personal data of employees as well as to licences – after it has been clarified what the subject matter of the licence is, e.g. a 3D printing file, a patent or the physical product design.

Are people liable for machines?

The decreasing human involvement in individual processes raises a large number of questions relating to liability – for example in the event of defective programming, misrouted data links or breakdowns in the transmission of data. Who is liable for failures and errors, what is the most sensible way to monitor the systems and who assumes the product liability? And how is the liability in the export of data or in the use of specific technical infrastructure to be regulated?

The legal risks will have to be identified in advance by the companies involved. For that reason, liability management matched to the individual company will become ever more important in future. The company's own risk potential will have to be identified. It will subsequently be important to reduce the identified risks, for example through the design of contracts, internal requirements, technical measures and above all employee training.

OUR CONSULTING APPROACH

In-house lawyers will have to provide comprehensive and critical preparatory support for the fourth industrial revolution from the very beginning. KPMG Law develops holistic solutions for you so that you can overcome the complex legal challenges involved in the transition to Industry 4.0.

We provide support, for example in the development of strategies for establishing and expanding as well as for securing the position of our clients in new markets and sales channels. Here it is important not only to ensure legal protection of intellectual property, such as patents, trademarks, designs, copyrights and domains. Our support also involves effective expertise management as well as a legally flawless organisation of data protection and data security, for example in the context of data transfers or the involvement of external service providers. Our legal consulting in the area of strategic intellectual property asset management is increasingly gaining in importance in this context. With the design and optimisation of (IT toolbased) IP asset management, we not only make a contribution to securing your entrepreneurial value, but we can often even increase it.

Together with the audit experts, we provide multidisciplinary consulting in all risk management and compliance projects in terms of specific risks arising in the areas of intellectual property and technology law as well as data protection. We also offer you extensive experience in connection with the establishment and expansion of international licensing structures that take tax requirements into consideration.

Other focal points of the activities of KPMG Law include:

- Legal consulting and the legal management of large-scale IT projects from the tendering, through closing and up to implementation and go live phases (e.g. RFPs, LoLs, NDAs, project, operating, service, software development and licensing contracts as well as escrow agreements)
- Multidisciplinary consulting in transactions and restructuring operations: In addition to classic M&A transactions in the area of technology (share and asset deals), we provide support in outsourcing projects (e.g. BPO, IaaS, SaaS, PaaS as well as public, private and hybrid cloud solutions) »

- Consulting in complex technology transfer projects, joint ventures and other technology-oriented transactions, including transition services agreements and implementation of regulatory requirements
- Restructuring of IP portfolios
- Support in all subject areas related to liability through the use of innovative IT tools in the design and implementation of made-to-measure liability management systems
- Legal support in measures to avoid and resolve disputes as well as representation before the courts in the context of national and international court and arbitration proceedings

With our support, the responsible management bodies of the company can fulfill their organisational duties and avoid substantial liability risks in the context of the changes described above.

The C level agenda

Industry 4.0 is a management issue. Management levels must organise the process of change and transformation with commitment and responsibility. Despite the imponderables we have described, clear development trends are already emerging. Working groups and standardisation committees are creating reliable general technological conditions. Pilot projects are generating reference values for the analysis of economic efficiency. The alignment of the organisational and operational structure on a customer-customer process can already be realised today. In this section, we assign the necessary tasks to the individual managers responsible for them and provide recommendations for possible action.

1 CEO AGENDA

The strategic helmsman

As an entrepreneur, the CEO understands the requirements of the market placed on the company that he leads. He should act as an initiator of ideas for realising Industry 4.0. A wide variety of skills are required for this in all sub-areas – from market development, through product definition and production strategies all the way up to flexible delivery systems. And important in all of this are the “regency of the customer’s requirements” and the fulfillment of the shareholders’ demands. Ever shorter innovation cycles and delivery times require the greatest possible flexibility, which can be realised only through the integration of all those involved in the process. The development of an Industry 4.0 strategy, the realignment of the company’s structures, the drafting of investment plans, the assessment of technologies and the fulfillment of potential for optimisation are the key items on the CEO’s agenda:

- Industry 4.0 as an integrated element of the corporate strategy (Industry 4.0 strategy)
- Strategy for implementing the project/roadmap/schedule/milestones
- Strategy for implementing the technology-based customer-customer process
- Reorganisation of the value chain

2 COO AGENDA

Responsible for operations

The COO manages the company in operational terms based on productivity and effectiveness criteria. The sphere of responsibility of the COO across the company also covers the company’s value added network, including purchasing and supply chain.

- Operational excellence – increasing the attraction for customers as well as mastering processes and technologies
- Ensuring the quality and competitiveness of the product and service portfolio
- Development and implementation of systems for increasing productivity and for ensuring profitable growth
- Making Industry 4.0 strategy operational
- Co-ordination of the project management agreed at the company level for Industry 4.0

3 CFO AGENDA

The leader for compliance and data evaluation

Controlling, governance and risk and financial management are at the top of the CFO’s agenda. But the development of a sustainable product portfolio and innovation also play an important role. On top of that come “big data and analytics” and digital added value controlling as

a result of Industry 4.0. Consistent data availability in real time and appropriately powerful evaluation tools offer the CFO an improved decision-making basis. Other topics include:

- Strategic investment planning for the company's own "Industry 4.0-compatible" product and service portfolio and also for the necessary production technologies
- Capital requirements planning – identification of the future capital requirement (long term) and liquidity requirement (short term)
- Development of tools and instruments for measuring the increase in productivity
- Integrated and continual tax planning
- Ensuring the fulfillment of compliance requirements

4 CIO AGENDA

The driver of digitalisation

The CIO implements the digitalisation of the company. All real business processes are to be digitally mapped and networked with each other in IT systems. Essentially, the CIO is faced with the challenge of developing the numerous embedded (closed) systems and applications into a system that encompasses all company networks. Further challenges include:

- Physical security and protection of the Industry 4.0 plant against unauthorised access from outside
- Securing the availability and consistency of the IT systems
- Protection against unauthorised access to data/services (network security)
- Energy efficiency and remaining risks for the plant (e.g. environmental damage)

5 CHRO AGENDA

The trainer and team manager

Of greatest relevance for the CHRO in conjunction with Industry 4.0 are HR issues such as a personnel and functional strategy coordinated with the new organisational structure, strategic personnel (deployment) planning,

personnel development and support as well as adequate remuneration and incentive systems. In addition, individual business, procedural, tax and legal issues relating to the HR transformation projects have to be addressed. Essential topics include:

- Development of an HR strategy and HR functional strategy co-ordinated with Industry 4.0
- Development of an HR organisation strategy, including HR processes and HR IT environment, appropriate for Industry 4.0
- Identification of the skills and abilities missing in the company, requirements profiles
- Roadmap/securing of the necessary knowledge transfer and development
- Training and continuous professional development in terms of the new processes
- HR controlling for targeted management
- Concept and roll-out of internal communication
- Management of critical stakeholders and various interest groups

6 CLO AGENDA

The lawyer for change

In the context of Industry 4.0, the legal department has to manage increased liability risks and the company's own intellectual property rights. In addition, the changes to supplier and customer relationships accompanying Industry 4.0 demand a new way of thinking about the legal structure and the contents of the relevant contractual relationships. The tasks here additionally include:

- Implementation of a strategic IP and knowledge management system (including IP compliance)
- Review and adjustment of the existing sales structure
- Review and adjustment of the data protection and IT security concept
- Implementation of co-ordinated liability management
- Adjustment of existing contractual relationships
- Review and adjustment of the internal organisation with an eye on questions of export control laws

For your notes

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