

# Industry 4.0

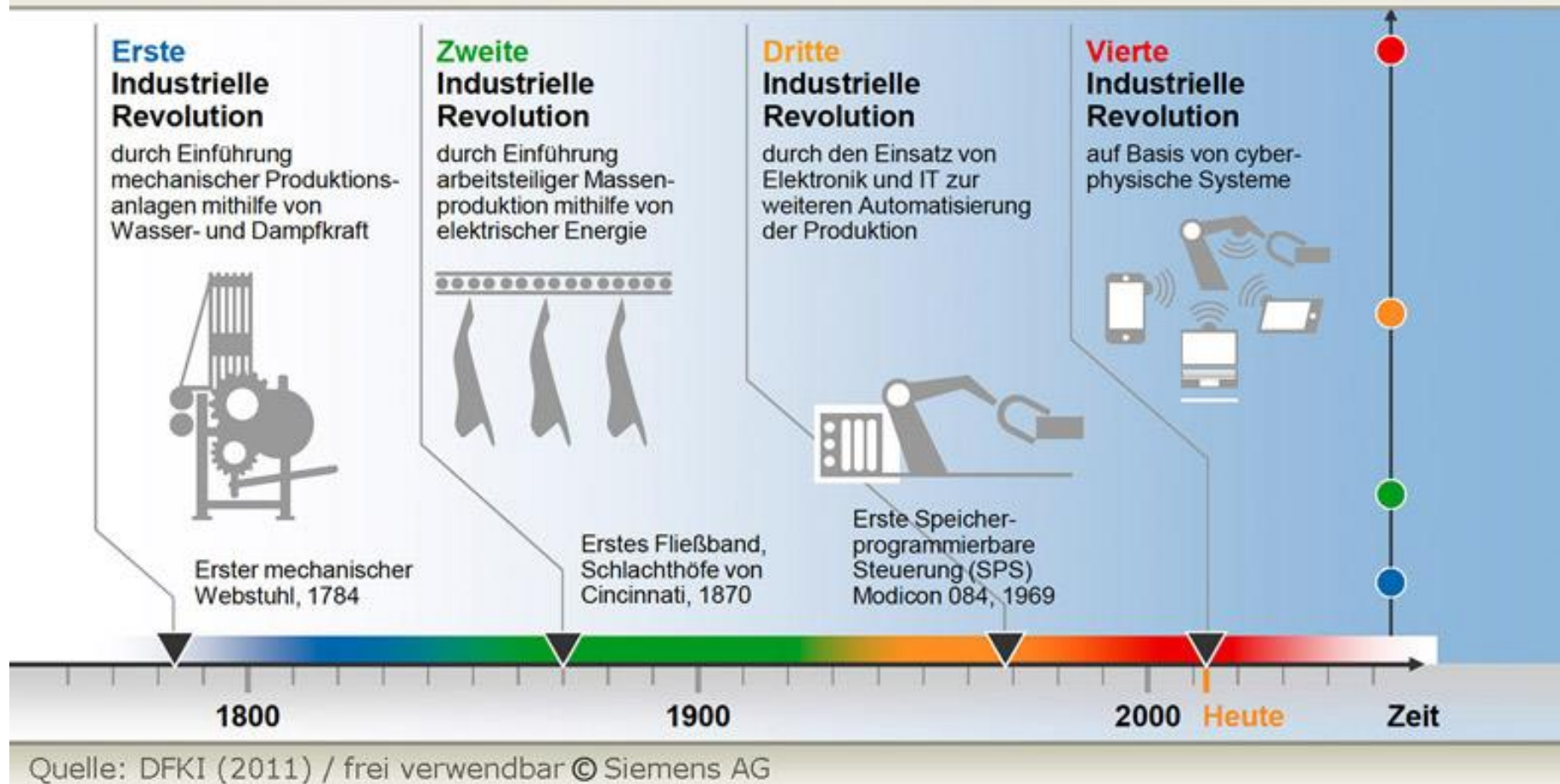
# Component Map

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# Industry 4.0 - Evolution

## Die Evolution zu Industrie 4.0 in der Produktion

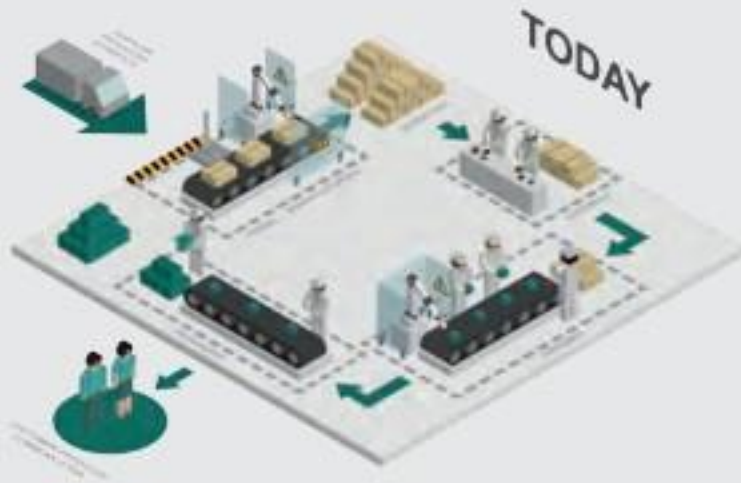


# Industry 4.0 - Evolution

## EXHIBIT 2 | Industry 4.0 Is Changing Traditional Manufacturing Relationships

From isolated, optimized cells ...

...to fully integrated data and product flows across borders



Integrated communication along the entire value chain reduces work-in-progress inventory

Greater automation will displace some of the least-skilled labor but will require higher-skilled labor for monitoring and managing the factory of the future



Machine-to-machine and machine-to-human interaction enables customization and small batches

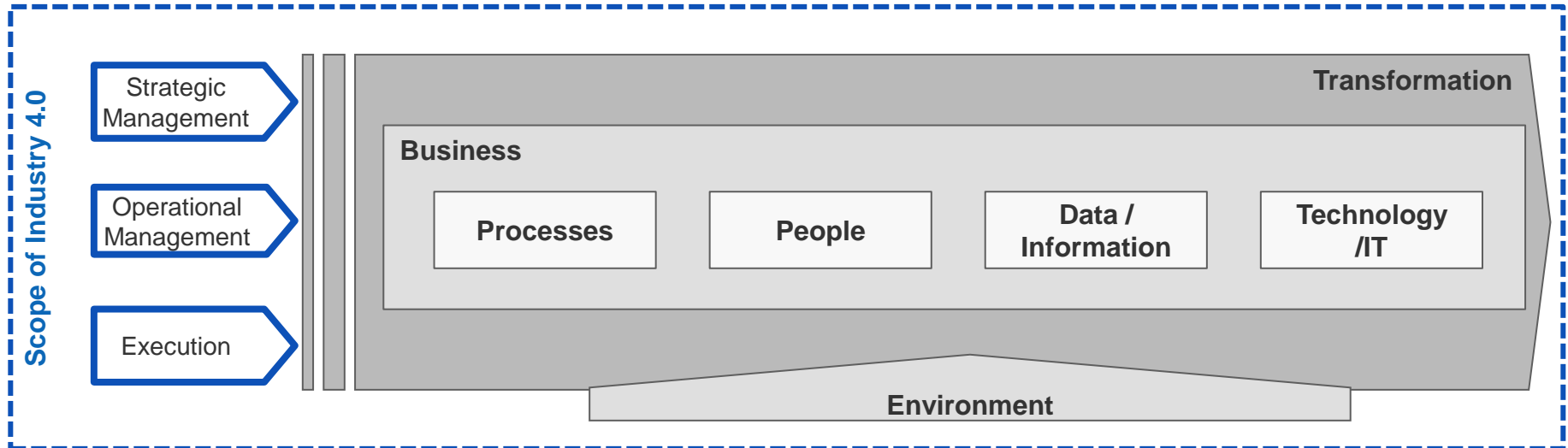
Source: BCG.

# Industry 4.0 – Design Principles

There are **six design principles** in Industry 4.0. These principles support companies in identifying and implementing Industry 4.0 scenarios:

- **Interoperability:** the ability of cyber-physical systems (i.e. work piece carriers, assembly stations and products), humans and Smart Factories to connect and communicate with each other via the Internet of Things and the Internet of Services
- **Virtualization:** a virtual copy of the Smart Factory which is created by linking sensor data (from monitoring physical processes) with virtual plant models and simulation models
- **Decentralization:** the ability of cyber-physical systems within Smart Factories to make decisions on their own
- **Real-Time Capability:** the capability to collect and analyze data and provide the derived insights immediately
- **Service Orientation:** offering of services (of cyber-physical systems, humans or Smart Factories) via the Internet of Services
- **Modularity:** flexible adaptation of Smart Factories to changing requirements by replacing or expanding individual modules
- **Source:** [en.wikipedia.org](http://en.wikipedia.org)

# Industry 4.0 Map - Structure



- To grasp the complexity of Industry 4.0 we distinguish 7 different knowledge areas that are in direct scope and are further structured into
  - Strategic Management
  - Operational Management
  - Execution

# Industry 4.0 Map – Overview

	Environment	People	Business	Processes	Data /Information	Technology / IT	Transformation
Strategic Management	Society and Acceptance	HR Roadmap Ethics Approach	Industry 4.0 Business Model and Roadmap	Target Process Model	Data / BI / Big Data Architecture and Roadmap	Technology / IT Strategy	Transformation Strategy & Approach
	Legal Framework / Intellectual Property	Security and Privacy Framework				Virtualization and Integration Architecture	Readiness Assessment
Operational Management	Standards	Process and Job Redesign New Role, Job Models, Collaboration			Data Management	Maintain Operating Model	Transformation Management
	Shared Platforms	Maintain Privacy	Quality Management	Simulation	Principles	Service Orientation / Management	Establish Leadership
	External Collaboration	External Assessment	Business Continuity Management	(Horizontal) Integration / Interfaces	Security IP Management	Ensure Security and Privacy	Maintain Industry V4.0 Initiatives
Execution	Provide Support	Coaching Individuals and Groups	Sell and deliver Services and Products	Maintain and Optimize Processes	Report Status and Deviations	Operate and improve Environment	Prepare Organization & Individuals
	Provide Best Practice	Train people		Measure KPIs and Reporting	Maintain Security and Privacy		Manage Transformation

# Industry 4.0 Map – Environment

	Environment	The context that drives a company with regards to Industry 4.0 and also puts constraints onto the firm.
Strategic Management	Society and Acceptance	Concept that describes the approach dealing with questions, concerns, resistance and support by company external stakeholders. How will the company foster an environment that supports its I4.0 targets? What are the key messages to external stakeholders? Will the company take direct or indirect influence on the public discussion? How will it support standard development and I4.0 education?
	Legal Framework / Intellectual Property	The company's approach to all legal matter in the context of I4.0. Target ability to deal with legal matters that might have due to the global nature of I4.0 a very international scope, e.g. building up internal legal capabilities, teaming with other companies, outsourcing. Concept to ensure intellectual property, trade marks, brand in a very integrated environment with suppliers and customers around the globe
Operational Management	Standards	I4.0 standards are still evolving: What is the company's approach to influence standard development to secure investments on the long run? Use of open source vs. integrated suppliers standards
	Shared Platforms	Identification and assessment of shared platforms – public vs. private cloud; sharing of production facilities and service teams with partner companies; establishing joint ventures to exploit synergies and influence shared platforms Qualification and validation of shared platforms concerning technical and legal compliance
	External Collaboration	Setting up collaboration agreements and contracts with suppliers and customers locally and around the globe; applying follow the sun principles; establishing networks and I4.0 user communities to take influence on I4.0 technology providers
Execution	Provide Support	As I4.0 integrates suppliers and customers directly with the company it should provide a framework enabling technical, logistical and emergency support for (and from) its partners to allow a seamless production flow Direct or financial support of schools, universities and standard development groups to foster the development of capabilities and methods
	Provide Best Practice	Sharing good I4.0 concepts and implementation approaches with suppliers, customers and partner companies to broaden expertise and to put company's stakes into the environment

# Industry 4.0 Map – People

	People	People are an important dimension in the context of Industry 4.0 as their acceptance and also their future will play an important role in this evolution.
Strategic Management	HR Roadmap Ethics Approach	Concept that describes the personnel development to cope with the changed capabilities and capacity needs linked to the implementation of the I4.0 business model. Considerations on company's ethical values regarding of I4.0 initiatives' impacts on employees and their dependents.
	Security and Privacy Framework	Industry 4.0 is all about data and information that also includes personal data and performance. How will the company ensure that private data is appropriately secured and is compliant with legal and ethical constraints?
Operational Management	Process and Job Redesign New Role, Job Models, Collaboration	I4.0 will change roles and jobs: New job families and job descriptions need to be elaborated; hierarchies to be reconsidered and collaboration between various teams (even to parties outside of the company) in the value chain must be fostered by appropriate personal target settings and incentive schemes. Evaluate and define approaches to new working models (home office, part time, permanent vs. temps, etc.) to allow for a breathing organization
	Maintain Privacy	Define and implement frameworks and controls ensuring that personnel privacy matters are safeguarded and that allow also appropriate reporting to data protection authorities and stakeholders as workers councils and unions
	External Assessment	Industry 4.0 will require the collaboration with a wide population of staff that is also outside of the company's direct control. Assessment procedures on qualification and loyalty to company's values and regulations need to be setup allowing to qualify external staff quickly and appropriately. Collaboration with partners, suppliers and customers to be considered → see also "Environment Collaboration"
Execution	Coaching Individuals and Groups	Support and teach organizational units, leaders and individuals with coaching, job rotation, external internships, etc. to adapt to the changed requirements of a I4.0 environment. Identify high potentials and influencers that foster a I4.0 working culture
	Train people	Identify training needs and train / educate staff to work effectively in the company's I4.0 business model. Define new training curricula adapted to 4.0 requirements Apply certification principles where required



# Industry 4.0 Map – Business

	Business	How shall the business model look when the firm has achieved the Industry 4.0? What is the business roadmap to this state?
Strategic Management	Industry 4.0 Business Model and Roadmap	Establish and communicate the company's Industry 4.0 vision to internal and external stakeholders. Define key building blocks of the business model and balance with resource and change capacity. Define key business goal indicators for brand, sales, production, finance and quality – define road map that allows achievements in foreseeable measurable steps. Establish 4.0 business case and plan and build into mid to long term budget plan (3 – 5 years)
	Security and Privacy Framework	Establish a security and privacy framework that ensures that company's intellectual properties, production secrets and processes, suppliers and customers intimacy are also protected and secured in a very integrated environment
Operational Management	Process and Job Redesign New Role, Job Models, Collaboration	Identify and define key partnerships with suppliers and customers to implement and support the target 4.0 business model. Establish forums and collaboration models that foster cooperation of the various parties in the value chain. Appoint I4.0 end process owners
	Quality Management	Establish a quality framework that integrates potential external suppliers and ensure appropriate validation, certification, audits and metrics are available to always ensure that quality of products and services are compliant to regulatory and customers expectations
	Business Continuity Management	Industry 4.0 is dependent on the constant availability of the technology infrastructure of the company, suppliers and also customers. Identify potential points of failure along the value chain, assess risk and impact and establish appropriate mitigation actions in a business continuity management plan. Ensure that where mitigation measures are manual also appropriate expertise is still available
Execution	Sell and deliver Services and Products	Establish an organization that is fit to sell and deliver products and services according to the company's Industry 4.0 business model. Perform customer satisfaction surveys and supplier's performance reviews Regularly review the I4.0 business model and adapt to internal and external needs for change

# Industry 4.0 Map – Processes

	Processes	Process model covers the whole business landscape and makes sure interfaces and job profiles are adequately addressed.
Strategic Management	Target Process Model	Define target end-to-end process model of the value chain and the supporting domains. The model also includes interfaces and segments which are outside of the own business' control. Analyse current and target capacity flows and describe key 4.0 business process requirements. Define Key Indicators to measure efficiency.
	Security and Privacy Framework	Identify current and future company's key unique process advantages against competition and develop a security framework that allows maintaining unique process advantages also in the target business process model. What controls are needed to measure compliance to security and privacy aspects.
Operational Management	Process and Job Redesign New Role, Job Models, Collaboration	Assess impact of new process model on job profiles and roles. How does it fit into your organization and how are interfaces to other companies along the processes covered. What special agreement on process level are required.
	Simulation	For the development of new or the adjustment of existing processes a simulation instrument is required. With the many interdependencies processes will be tested against a risk profile.
	(Horizontal) Integration/ Interfaces	As part of the process integration horizontal integration over all (sub-) suppliers / departments is key. Standardized self adaptable interfaces are required to reducing maintenance effort.
Execution	Maintain and Optimize Processes	Process Management with intelligent management software which is capable to automatically analysing performance, gaps, and security risks. Additionally measures will be proposed automatically through automated system. This analysis and proposals have carefully to be assessed and fed back to process re-design.
	Measure KPIs and Reporting	Measure KPI in the processes and report against the KPI in an intelligent, consolidated way.

# Industry 4.0 Map – Data / Information

	Data /Information	Data /Information
Strategic Management	Data / BI / Big Data Architecture and Roadmap	I4.0 characteristics is the intelligent management of big data. Therefore an adequate architecture and road map is required which defines major building blocks and the way how data is converted into meaningful information, on what level the aggregation should be done and how this fits into the business and the process model. Define Data ownership and data governance.
	Security and Privacy Framework	Aspects of securing data and private information on data level. Intelligent and efficient encryption methods and key handling with the respective control is needed.
Operational Management	Data Management	Define and introduce adequate data management and data control procedures. Establish a respective data governance structure and review periodically.
	Principles	Establish data management principles and controls with reporting support.
	Security IP Management	Establish proper Intellectual Property (IP) Management on data / information level. Especially when manufacturing processes information leaves the company and gets opened and used in other stakeholder's premises this will challenging.
Execution	Report Status and Deviations	Day-to-day reporting of status and deviations, aggregated on different levels.
	Maintain Security and Privacy	Regular assessment together with compliance and legal representatives to ensuring sufficient protection and good performance.

# Industry 4.0 Map – Technology / IT

	Technology / IT	Technology / IT
Strategic Management	Technology / IT Strategy	Mid- to long term roadmap how company's technology / IT will evolve. E.g. artificial intelligence, big data, autonomous decision taken, intelligent reporting, machine2machine communications, internet of things, robotics, manufacturing automation, independent learning, etc. Link these development to the process and business model and quantify risks.
	Virtualization and Integration Architecture	Build a robust and scalable architecture for "easy" horizontal and vertical integration which supports security and performance requirements.
Operational Management	Maintain Operating Model	Distributed, shared and virtual Technology / IT models allow further flexibility in the operations model with shared resources, managed services etc. which have to planned carefully and adjusted with the HR strategy.
	Service Orientation / Management	Due to further virtualization and abstraction of technology and IT, service orientation will increase. Key are standardization of services, ease of integration and level of management.
	Ensure Security and Privacy	With new technology and IT more data will be distributed and no longer under direct control of the owner. Therefore standard security (reliability, integrity and availability) must be "built in" into technology and IT. Frameworks which also allow comprehensive assessments of level of security end-to-end will become more important.
Execution	Operate and improve Environment	Carry out all necessary tasks to operate the environment on the agreed / defined level. Handle exceptions in a controlled manner and feed back identified improvements.

# Industry 4.0 Map – Transformation

	Transformation	Transformation
Strategic Management	Transformation Strategy & Approach	Transformation Strategy from Industry 3.x to 4.0. How will existing elements be transformed or integrated. How should the business and the organization adapt to the changes. What risks have to be managed.
	Readiness Assessment	Identify readiness of the existing business, processes, technology, people to transform to I4.0. What are critical points and how can they be managed towards an efficient transformation.
Operational Management	Transformation Management	Manage the transformation program/projects. Maintain stakeholders and manage transformation risks accordingly. Establish the infrastructure for managing a “virtual world Industry 4.0” effectively, e.g. communications
	Establish Leadership	Establish Leadership for the transformation as a whole. Make sure key stakeholders e.g. CEO, COO, CTO fully support the transformation and actively contribute to the implementation.
	Maintain Industry V4.0 Initiatives	Establish the Industry 4.0 initiative/project portfolio and manage resources, know-how and strategic objectives effectively.
Execution	Prepare Organization & Individuals	Establish trainings and awareness events. Convey the compelling Industry 4.0 story and seek for feedback. Identify weak points and prepare counter measures.
	Manage Transformation	Deliver the transformation projects as agreed.

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