Factory of the Future (FoF)

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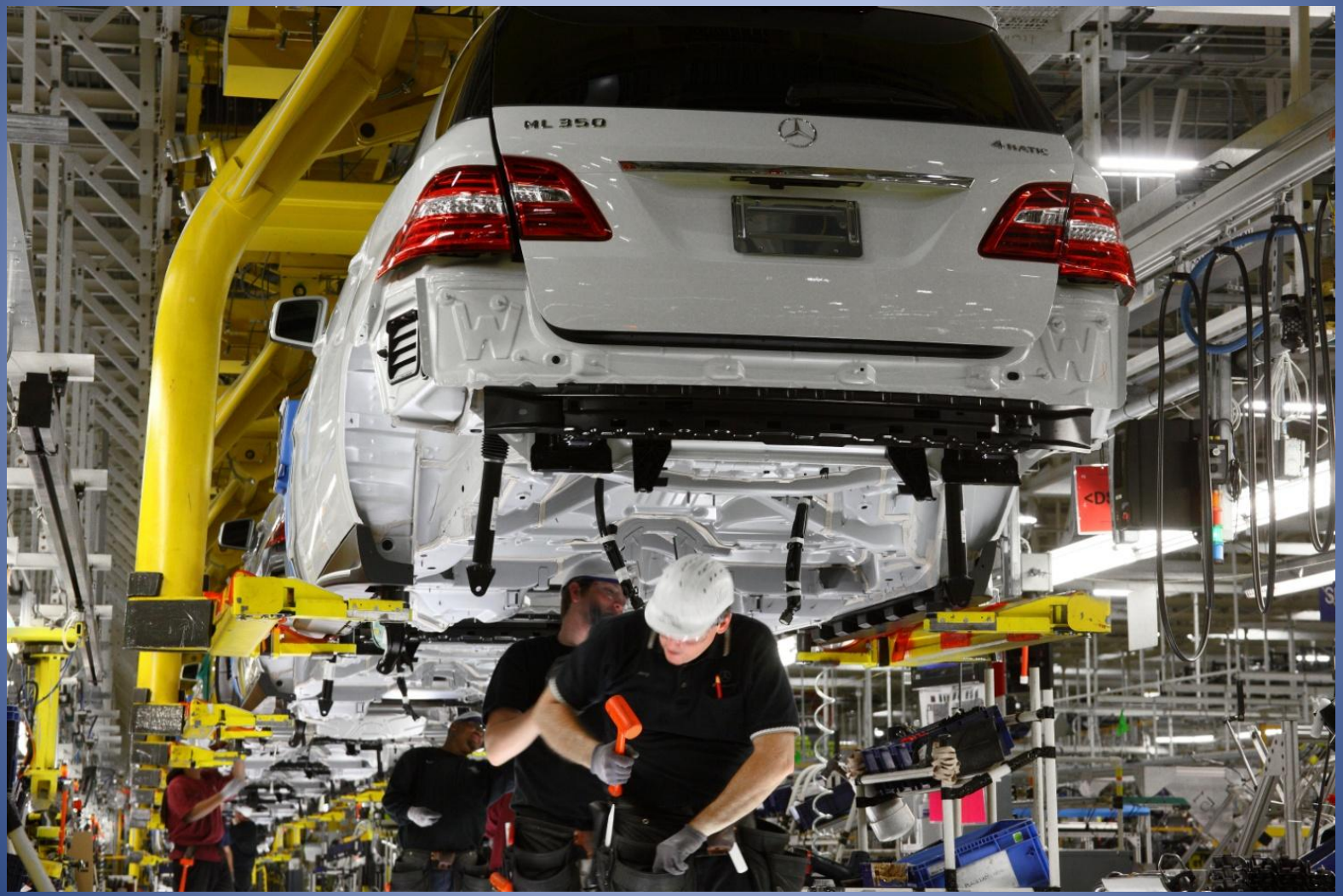
Introduction

- What will the production world of the future look like?
- How will humans and machines communicate with each other?
- Will our working worlds be adaptable to our needs?

Current manufacturing environment



Introduction

Manufacturing has been thought to be a process that turns raw materials into physical products, and the factory, in managing fragmented communications protocols and automation practices, is the structure where manufacturing happens.

Today, drivers such as technology, sustainability, optimization and the need to meet customer demands have once again encouraged the transformation of the manufacturing industry, to become adaptive, fully connected and even cognizant of its own power quality.

Introduction

- This transformation is characterized by the globalization of value chains in organizations, with the goal of increasing competitive advantages, creating more value add-ons and reducing costs through comprehensive sourcing.

- One of the most significant trends in manufacturing is the makeover from industrial Ethernet and industrial wireless communications to that of improved information technology (IT) solutions involving the union of conventional automation with cyber-physical systems combining communications, information and communication technology (ICT), data and physical elements and the ability to connect devices to one another.

What is Factory of the Future (FoF)?

- Seamless and fully integrated system of systems (SoS) matching end user requirements in the manufacturing process, can be described as factory of the future (FoF).

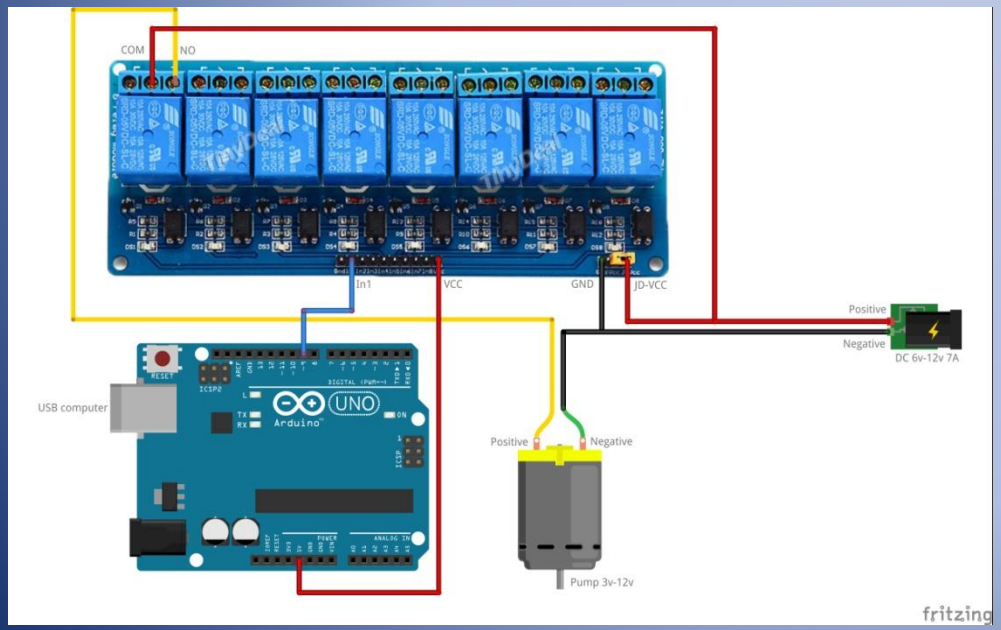
- Advantages: Due to the rapid evolution of IT in the second part of the 20th century, engineers are now able to create increasingly complex control systems and integrate the factory floor.
- The automotive industry, for instance, has been transformed radically by the development of automation.
- This often results in higher end quality and reliability throughout the assembly chain to the advantage of the consumer.

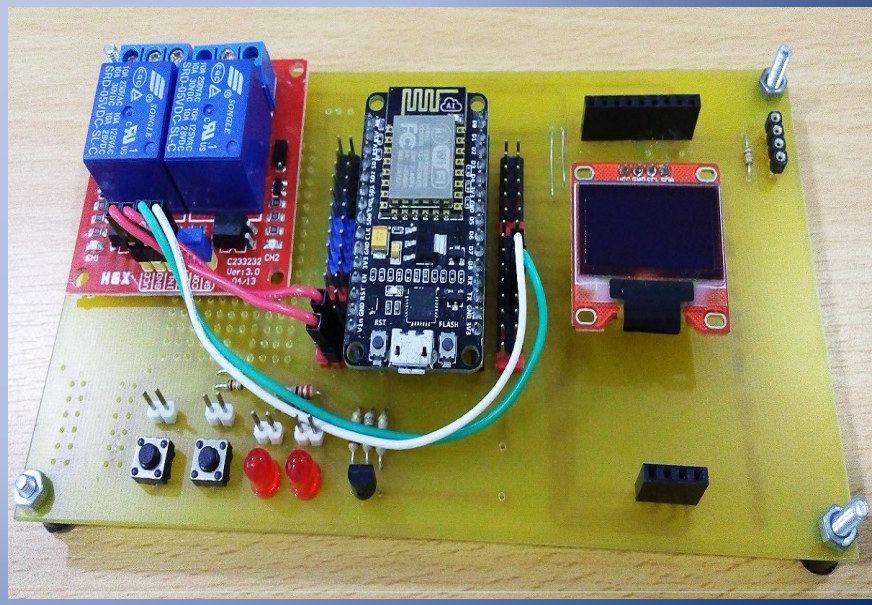
Introduction

- The ultimate goal of the factory of the future is to interconnect every step of the manufacturing process. Factories are organizing an unprecedented technical integration of systems across domains, hierarchy, geographic boundaries, value chains and life cycle phases.

Experience

- Arduino controls devices, can be programmed by computer
- Wifi, internet etc. makes everything wireless.





Important Terms

Cyber-physical systems – CPS : smart systems that encompass computational components (i.e. hardware and software) and physical components seamlessly integrated and closely interacting to sense the changing state of the real world

Internet of Things –IoT : infrastructure, technologies and applications that bridge the gap between the real world and the virtual world

Additive manufacturing : fully automated production of a product from a virtual model through 3D printing or use of similar Technologies

Horizontal integration: supply chain integration into a holistic IT landscape between different stages of production and the respective resource and information flow within a factory and across companies along the value chain.

Vertical integration: information integration and system interoperability across technological and business levels in production and logistics (sensor, control, production, manufacturing, execution, production planning and management level)

Market of Smart Factory

- The global smart factory market is expected to total nearly USD 67 billion by 2020, increasing at a compound annual growth rate of 6% from 2014 to 2020. Communication, automation, robotics and virtual simulation will change the product sector as we know it today.
- There are many initiatives underway, such as smart manufacturing, Industrie 4.0, e-Factory or Intelligent Manufacturing.

Current Manuf. Environment

business models and manufacturing systems have adapted respectively, since manufacturing demands are always related to the needs of societies.

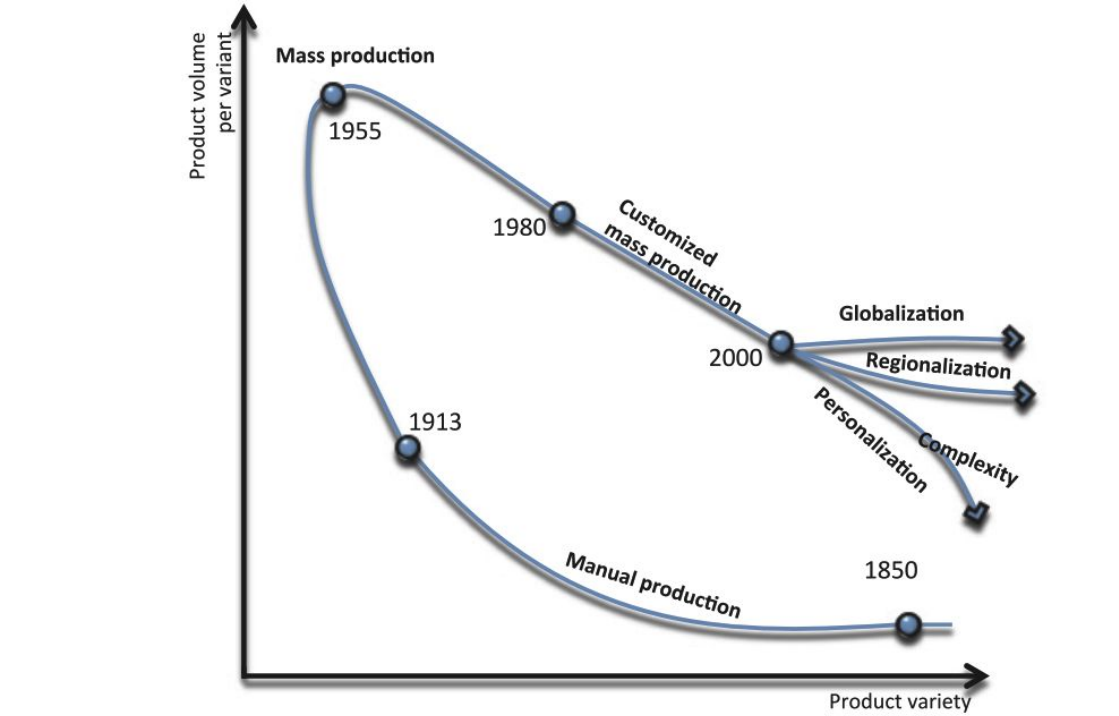


Figure 2-1 | Evolution of production [2]

Smile curve of value addition in production industries

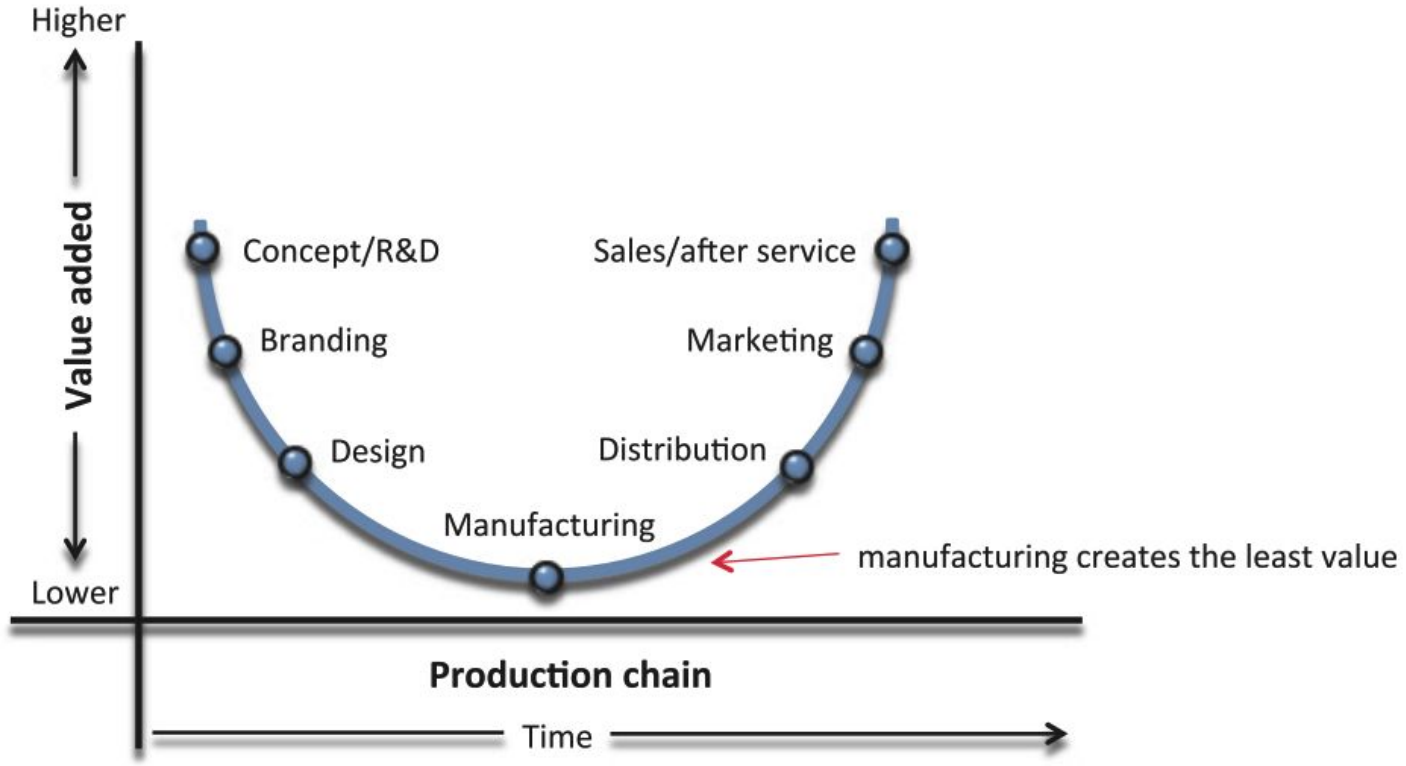


Figure 2-2 | Smile curve of value added in production industries [3]

Cont..

The exploitation of appropriate IT systems in manufacturing is essential. Depending on their degree of maturity, such systems support the management of knowledge and complexity throughout value chains, i.e. the full range of value adding activities in production across multiple organization units, via visualization, integration and connection and intelligent analysis of production systems.

Companies cannot survive without Recognizing and integrating a multitude of value chains.

In modern production ecosystems, value chains need to be bi-directional, with every link supporting the flow not only of goods but of information as well. Information silos must be broken down within and between partners, if supply chain and production processes are to be optimized across organizational boundaries

Concepts of the FoF

- Trends in manufacturing are moving towards seamless integration of physical and digital worlds in order to enable fast integration, feedback and control loops throughout distributed manufacturing infrastructures.
- This requires integrity and consistency of distributed data throughout the whole product and production lifecycle
- These new concepts of manufacturing in the factory of the future, and in related business models and technologies are:

Concepts of the FoF

- Open value chain: Product lifecycles are becoming shorter and shorter now-a-days. Value chain systems need to become more adaptable, agile and resilient and need to be optimized with regard to capital expenditure.
- Progress in IT development and its application to the logistics industry enables close-to-real-time numerical simulation and optimization of value chain planning and execution.

Concepts of the FoF

- Flexible production: production systems have to adapt to fast-changing customer demands.

Kind of flexibility	Explanation
Volume	Range of output levels that a firm can economically produce products
Product/variant	Time it takes to add or substitute new parts into the system
New design	Speed at which products can be designed and introduced into the system
Market (location/time)	Ability of the manufacturing system to adapt to changes in the market environment
Delivery	Ability of the system to respond to changes in delivery requests
Process	Number of different parts that can be produced without incurring a major setup
Automation	Extent to which flexibility is housed in the automation (computerization) of manufacturing technologies

Figure 3-1 | Kinds of manufacturing flexibility (excerpt) [7]

Concepts of the FoF

- Human-centered manufacturing: IT systems can introduce new relations between humans and the workplace into the factory of the future.

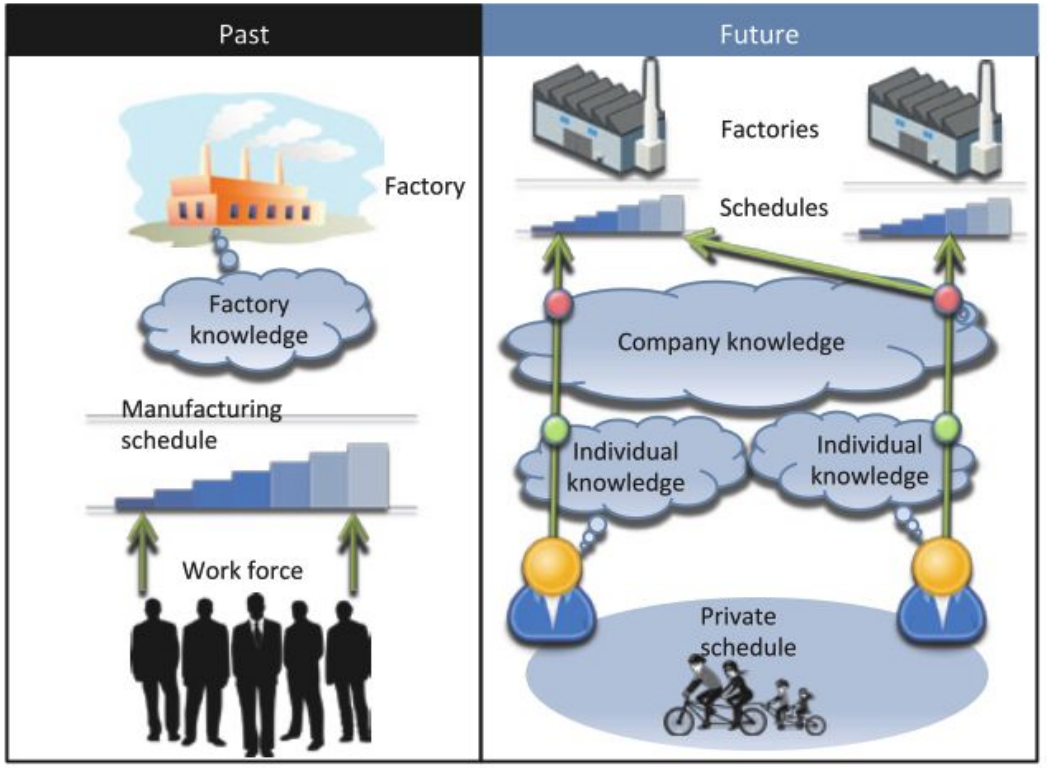


Figure 3-2 | Relation between humans and factories in the past and in the future

Concepts of the FoF

- Business models:(ICT) leads to implementation of innovative business models:
  - Crowdsourcing: blend of “crowd” and “outsourcing” and describes the process of obtaining ideas, services or content from a large, collaborative group of participants rather than from traditionally specified employees, contractors or suppliers. What are the 5 reasons for it?

Concepts of the FoF

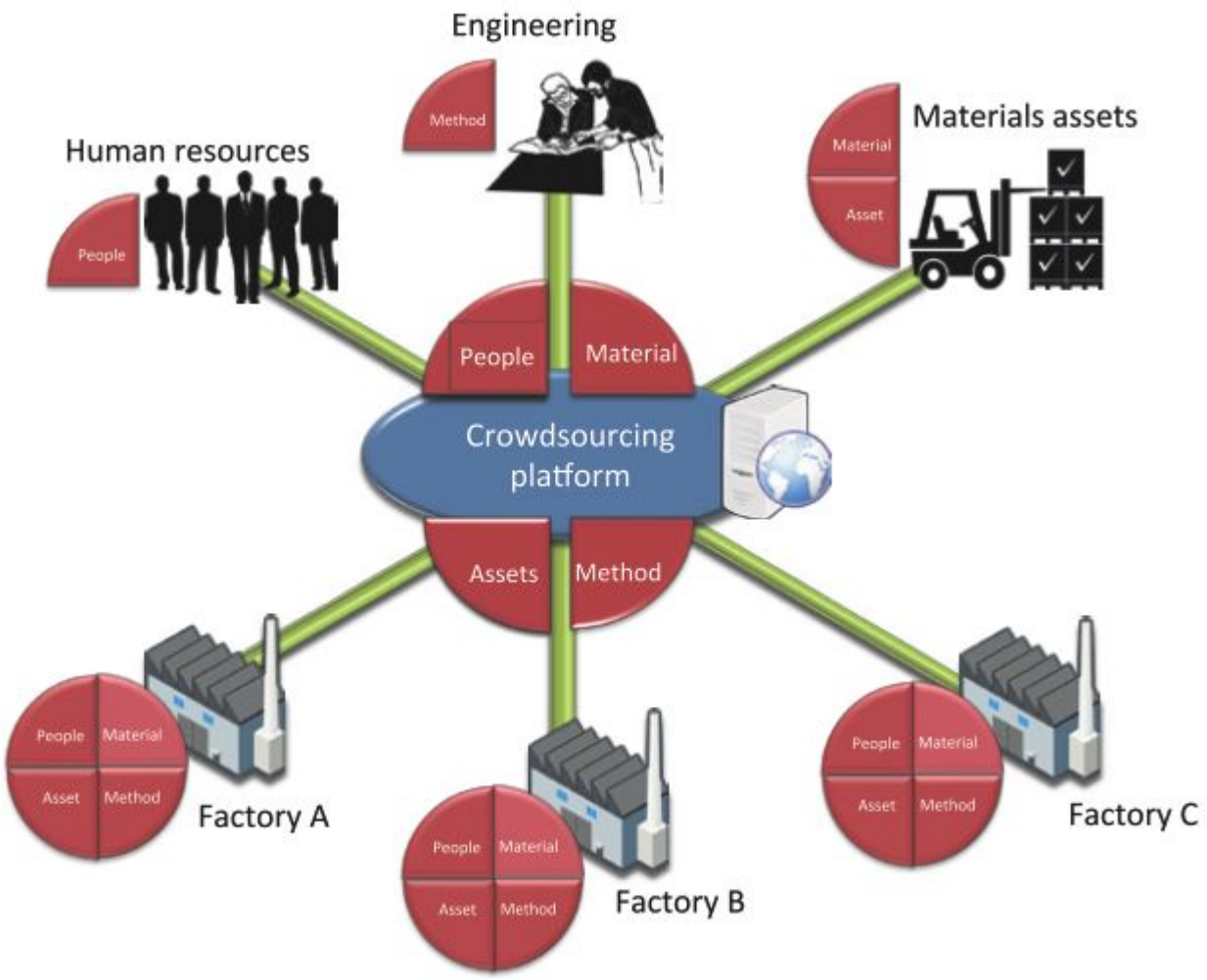


Figure 3-3 | Crowdsourcing

Concepts of the FoF

- Business models:
  - Anything-as-a-service-anything-as-a-service (XaaS) is not restricted to product design and production. It can involve the entire product lifecycle, including product design, manufacturing, usage, maintenance and scrap or recycling, and cannot only provide services to be executed by other persons, but also those implemented by integrating IoT components.
  - It adds aspects such as product-service integration to the business model options, which is achieved by embedding intelligence and connectivity into both industrial and consumer products, allowing manufacturers to leverage their knowledge of the product, or to gather additional knowledge from intelligent products, in order to provide additional value-added services.
  - also enables them to transform their experience with the customer from a one-time transaction to an ongoing relationship.

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Concepts of the FoF

- Business models:
  - Symbiotic ecosystem: attention is focused also on other domains involving manufacturing ecosystems, such as energy and Smart Cities.
  - global platforms which integrate diverse ecosystems in such a way as to consider the impacts they have on one another and to exploit resulting synergies enable the improvement of infrastructures beyond pure production system and production network perspectives.
  - ”Symbiotic” is a biological term that describes multiple types of organisms living together in a mutually reciprocal relationship.

Concepts of the FoF

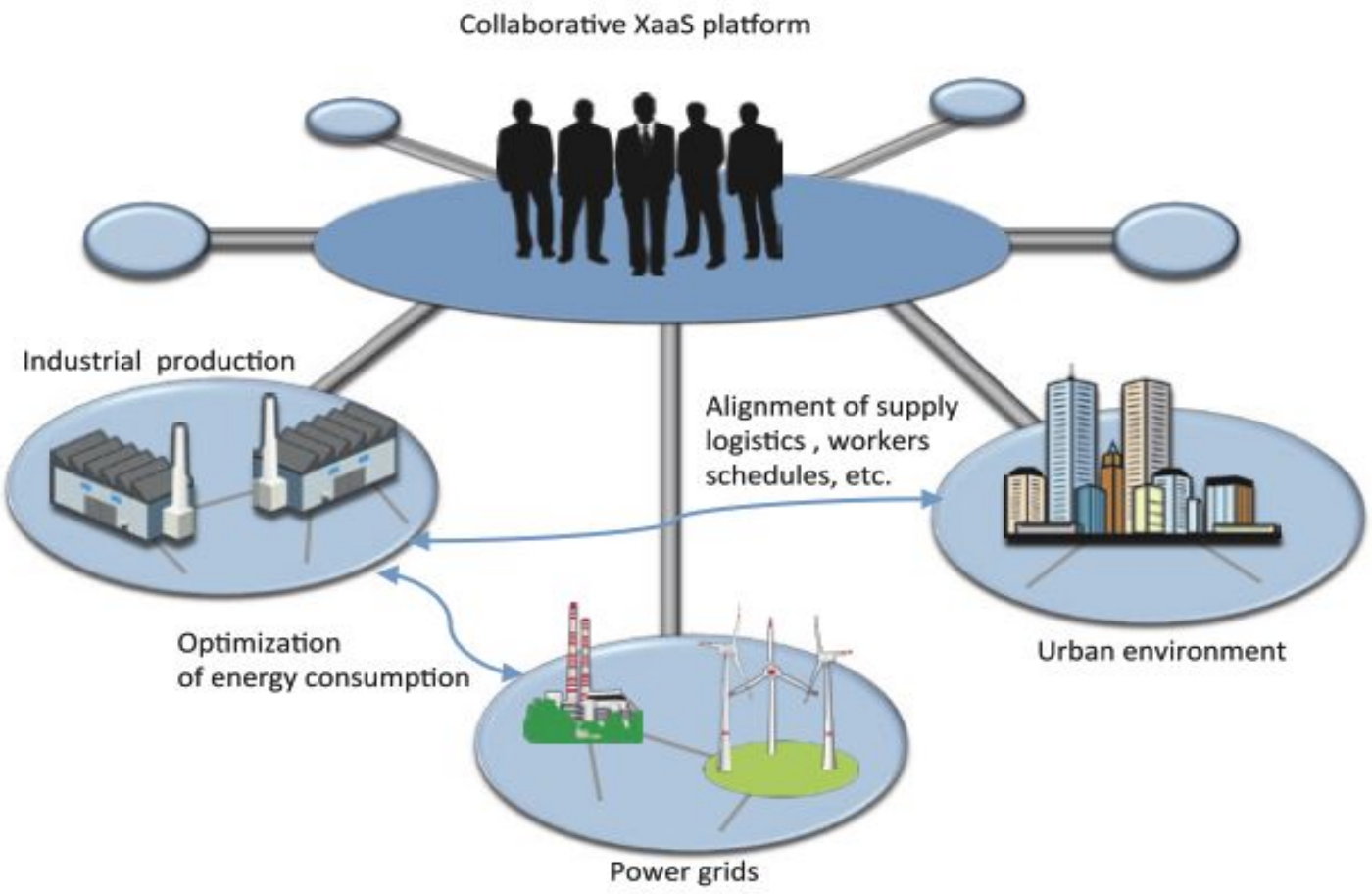

Figure 3-4 | Symbiotic ecosystem

Driving Technologies for FoF

- Technology challenges/needs
  - Connectivity and interoperability
  - Seamless factory of the future system integration
  - Architecture for integrating existing systems
  - Modelling and simulation
  - Security and safety System

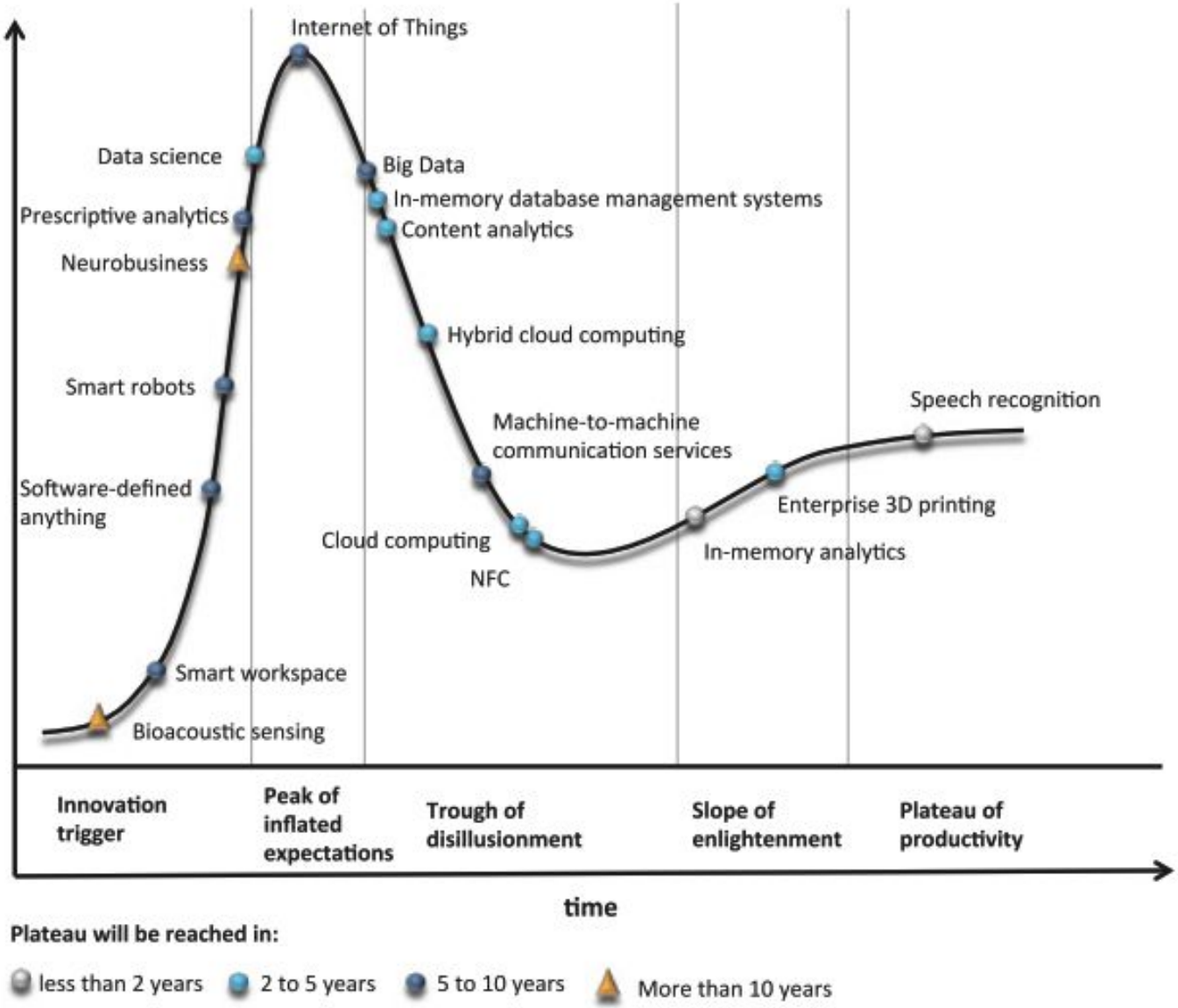

Figure 4-4 | Hype cycle for emerging technologies, 2014 [17]

Driving Technologies for FoF

- Enabling technologies
  - Internet of Things and machine-to- machine communication
  - Cloud-based application infrastructure and middleware
  - Data analytics
  - Smart robotics

Thank