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# The Paradigms of Industry 4.0

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The aim of this seminar is to give an introduction into the Industry 4.0 topic from the author's perspective and to discuss the challenges, issues and opportunities of the emerging new manufacturing paradigm.

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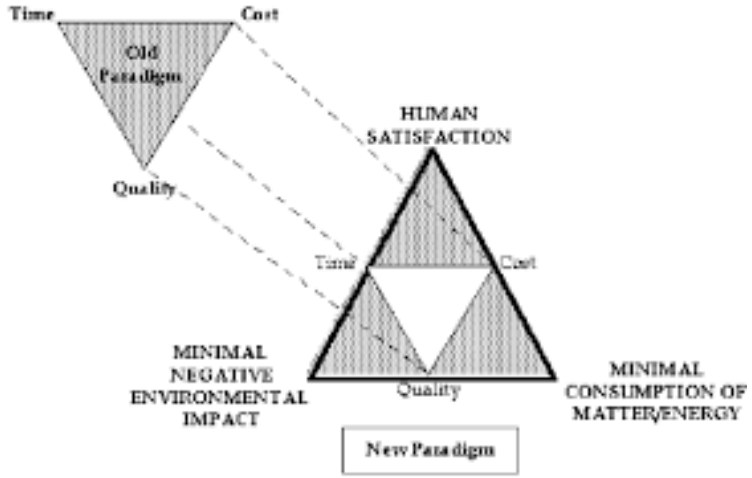
# About the Term Paradigm

- The *Oxford English Dictionary* defines a *paradigm* as "a pattern or model, an exemplar; a typical instance of something, an example“

- The emergence of a new paradigm is preceded by the accumulation and articulation of scientific and technological knowledge that can potentially be transformed into radical innovations (Dosi 1982)

- A paradigm does not impose a rigid or mechanical approach, but can be taken more or less creatively and flexibly.

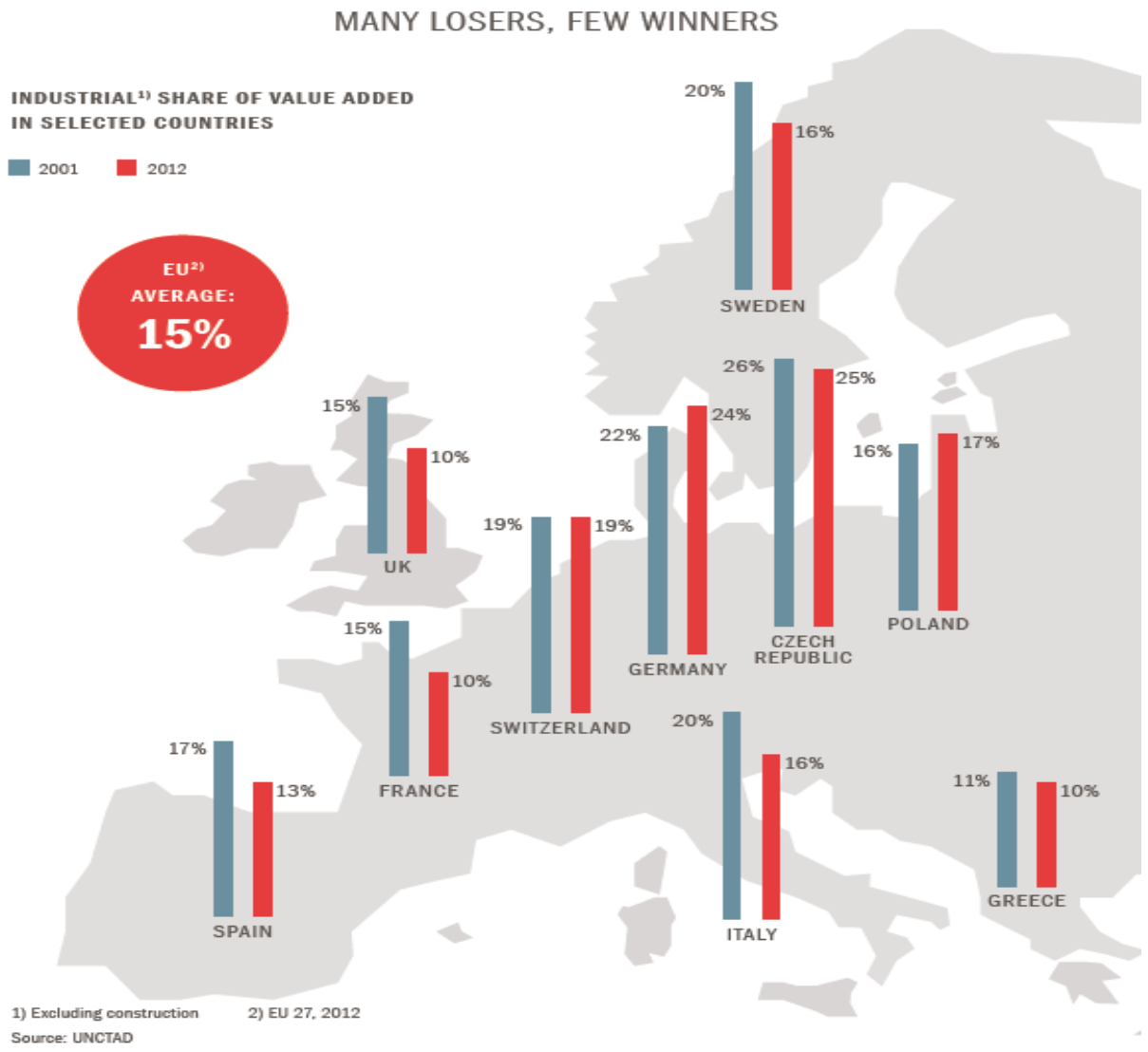



# Some European cognitions regarding manufacturing

- European **manufacturing industries contribute 22 % to GDP -** Gross domestic product (probably before the enlargement of EU) and employ 40 million people.
- **Each job in industry creates two jobs in service sectors** connected to industry.
- **Europe will never become** a competitive knowledge-based economy **without strong and competitive manufacturing industry**.
- Manufacturing industries must be transformed so that they will **not rely on natural resources but on knowledge and innovation.**
- **European economy**, which would be based **on services only, cannot survive**.

Source: *ManuFuture* – a vision for 2020

# Why Industry 4.0?




Source: Roland Berger 2015

# Why Industry 4.0?

- While in industry the **classical organization and methods** of work, which are based on *The Principles of Scientific Management* founded by **F.W. Taylor** a hundred years ago, still prevail.
- While the **Lean Production principles** introduced by Japanese companies in the fyfties and sixties (fifty years ago) have brought some changes in work principles but they **become obsolete** as well.
- While the **developments in sciences** have introduced new cognitions and technologies are being intensively developed.
- While the **information-communication technologies** (ICT) open totally new possibilities.
- While the **world has been changed**. It has become global, open, and competitive.
- While it has been recognized that **one has to deal with natural resources** more carefully and that natural equilibriums have to be maintained.
- While **manufacturing has become more complex** and one has to deal with this complexity.

Source: *ManuFuture* – a vision for 2020

# Why Industry 4.0?

- The Industry 4.0 – the term was introduced by the German academicians and engineers just a few years ago (2011/12) as **an idea for provoking** their **politicians** that they should do something for keeping the leading position of the German industry.
- At that time, the European **industry was in a deep recession**.
- Now, Industry 4.0 has emerged into a **new industrial paradigm**, which is reshaping the research, development and innovation in manufacturing industries worldwide.

Source: *ManuFuture* – a vision for 2020

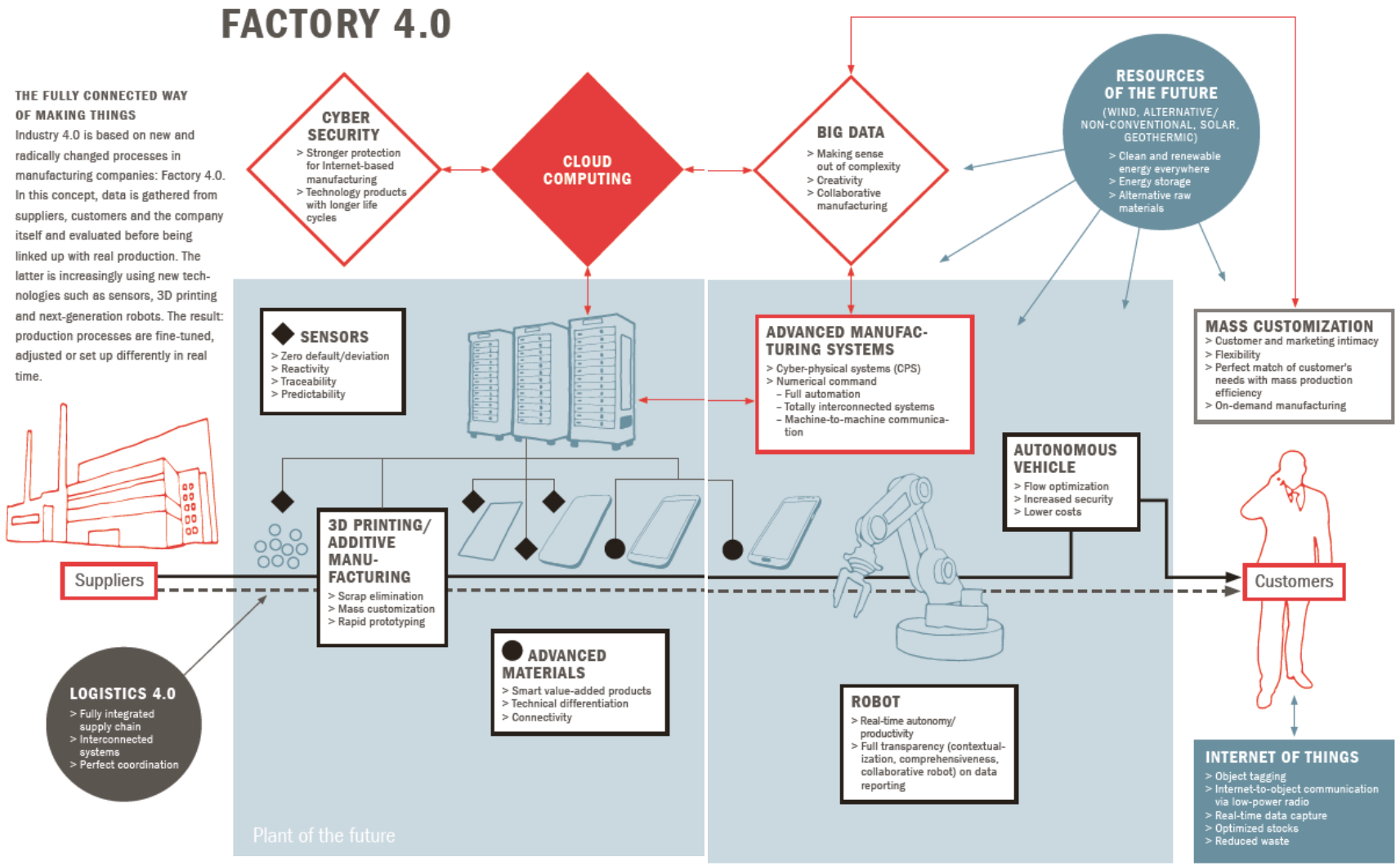
# Industry 4.0 – the definition

Industry 4.0 signifies the promise of a new Industrial Revolution—one that marries advanced production and operations techniques with smart digital technologies to create a digital enterprise that would not only be interconnected and autonomous but could communicate, analyze, and use data to drive further intelligent action back in the physical world. It represents the ways in which smart, connected technology would become embedded within organizations, people, and assets, and is marked by the emergence of capabilities such as robotics, analytics, artificial intelligence and cognitive technologies, nanotechnology, quantum computing, wearables, the Internet of Things, additive manufacturing, and advanced materials.

Source: Deloitte Insights, 2017

# Industry 4.0 – the main paradigms

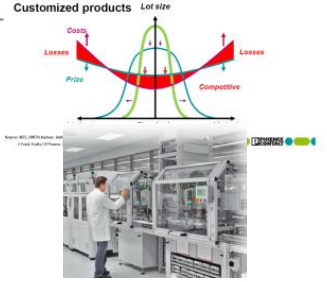
# Vision of the Factory 4.0



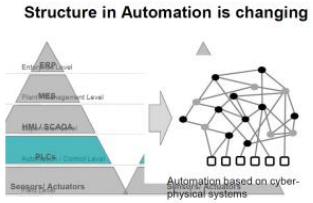

Source: Roland Berger 2015

# Principal properties for I4.0 in the INCASE Project

- “**Mass customization**”: from “large batches” with few variants to “lot size 1” custom products: how to stay competitive?
- “**Modularization**”: plug and produce solutions in discrete and continuous processes
- “**Collaboration**”: product design and production design in parallel ! (Enhance each other, common Data Model, “**digital twin**”)
- “**Adaptive**”: machines and production concepts react in a flexible way to new requirements
- “**Point-to-point communication**”: humans and production plants use Internet technologies and communicate directly without hierarchy.
- “**Efficient**”: production needs to be economic, resource efficient and sustainable

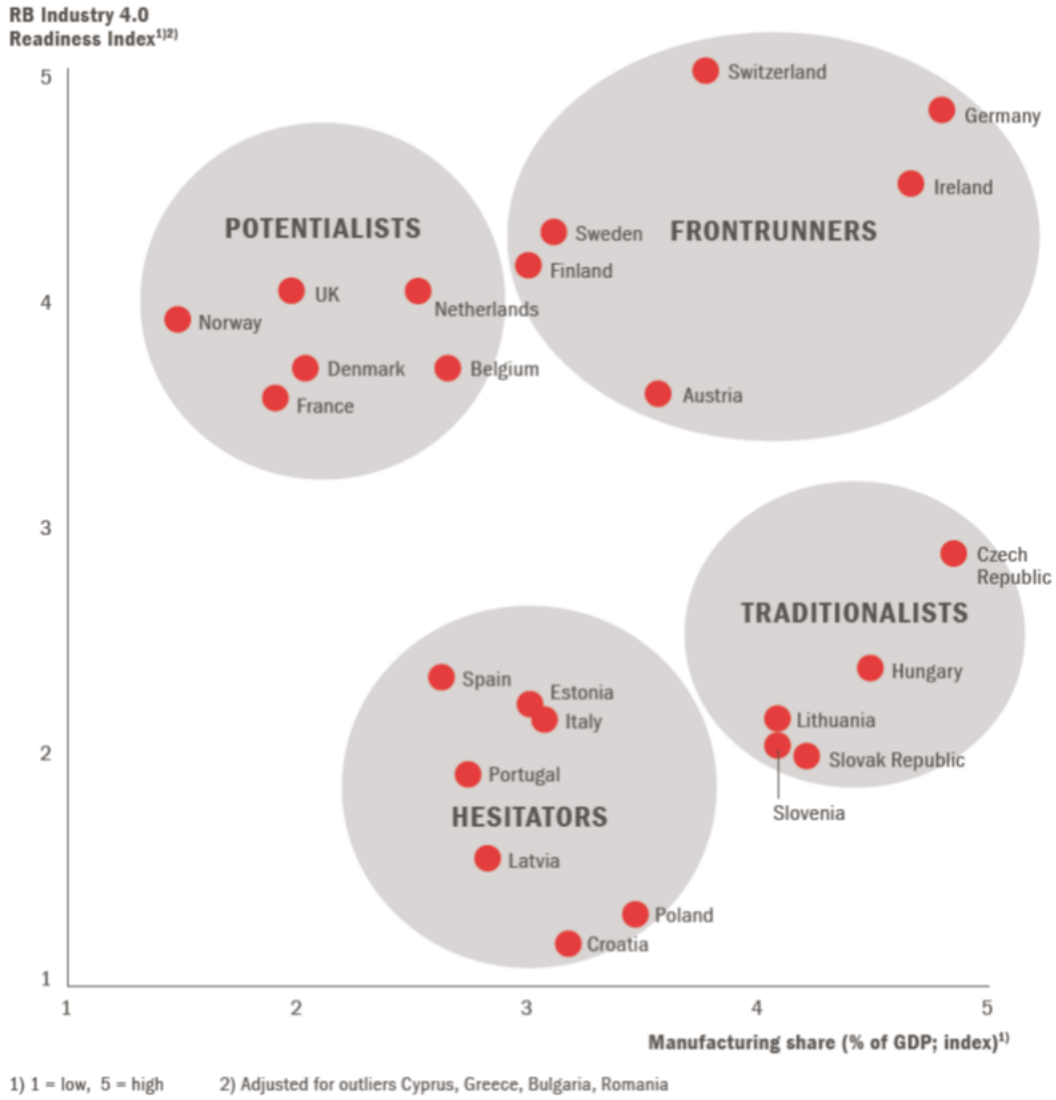




# Industry 4.0: the benefits

- Enhanced productivity through optimisation and automation
- Real-time data for real-time supply chains in a real-time economy
- Greater business continuity through advanced maintenance and monitoring possibilities
- Higher quality products as a result of real-time monitoring, IoT-enabled quality improvement and cobots
- Better working conditions and superior sustainability
- Personalisation opportunities that will earn the trust and loyalty the modern consumer

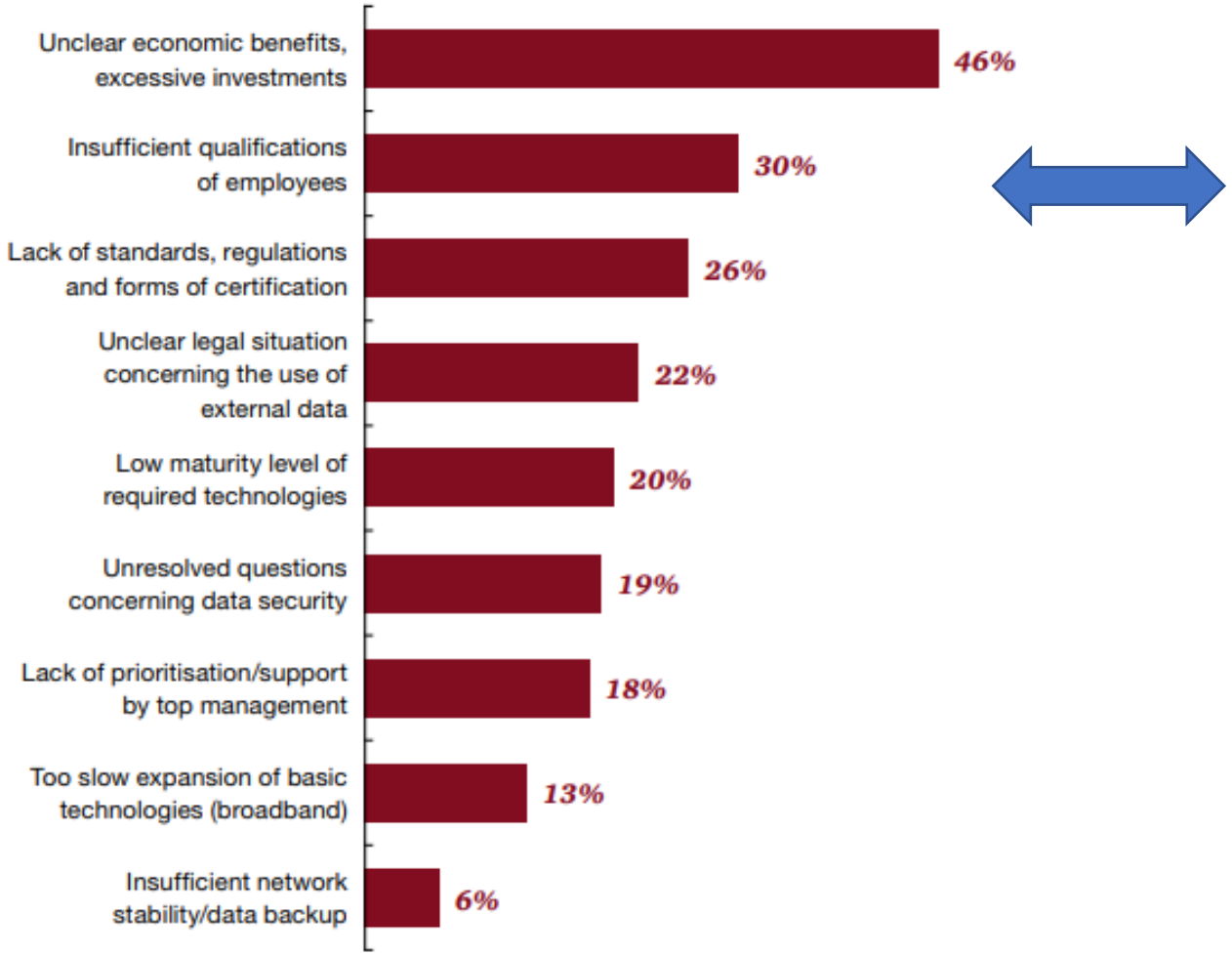
# Is the industry ready for Industry 4.0?




Source: Roland Berger 2015

# Challenges for the successful implementation of Industry 4.0

## (PricewaterhouseCoopers, 2014)




Here we have to act!

# Innovative ideas to shift the activities of their business units to Industry 4.0.

**SCHINDLER**

Swiss-based leading global provider of elevators and escalators Schindler has developed a "digital toolbox" for its 20'000 service employees. Equipped with an iOS-based device and app, field staff can run maintenance, repair and overhaul service and receive feedback about defect analysis and spare part availability in real-time. Installed elevators and escalators are today fully integrated into Schindler’s value chain through the "internet of things."

**KUKA**

German robotics and automation specialist Kuka is introducing innovative lightweight robots for industrial application. The small robots are designed as "intelligent industrial work assistants.“ They are multifunctional and sensitive. Their ability to detect potential collision or clamping situations and to respond intelligently allows them to collaborate with human coworkers side by side. Those human-robot work processes are opening up new areas that were previously closed to automation. By being guided along the desired path robots learn new movement patterns directly from their human co-worker. In the end no specialized knowledge is needed to steer it.

# Innovative ideas to shift the activities of their business units to Industry 4.0.

**PIRELLI**

Italian tire manufacturer Pirelli sees the Modular Integrated Robotize System (MIRS) that condenses the 14 traditional phases of tire production into just three. The MIRS robots produce tires seamlessly, without interruption. There is no need to add semifinished products, no interim stocks and less energy is consumed. The average lead time from raw material to finished product has been cut in half. Every part of the process is controlled by integrated software, from robot motion to raw material replenishment, from tire size selection to vulcanization and quality control. The Mini Cooper S was one of the first cars to be fitted with tires made in this way; the new Bentley was the most recent model to follow suit. Pirelli's productivity has jumped sharply.

**DASSAULT SYSTÈMES**

French software provider Dassault Systèmes is pushing the integration of product development and production. This initiative's core is a 3D platform designed as a common work environment for the company, where designers and engineers can, for instance, simulate new products jointly and in real time. The connected 3D environment can also be used via cloud computing.

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