Industry 4.0

Industry 4.0

- It was officially revived in 2011 at the Hannover Fair, Germany.
- In 2012 the German federal government assigned
  - two people as co-chairs and
  - five as working groups members who are now recognized as the founding fathers and driving force behind Industry 4.0.

Industry 4.0 Workgroups

Co-chair
Henning Kagermann

Co-chair
Siegfried Dais

WG 1 – The Smart Factory:
Manfred Wittenstein

WG 2 – The Real Environment:
Siegfried Russwurm

WG 3 – The Economic Environment:
Stephan Fischer

WG 4 – Human Beings and Work:
Wolfgang Wahlster

WG 5 – The Technology Factor:
Heinz Derenbach

The Industry 4.0 workgroup members are recognized as the founding fathers and driving force behind Industry 4.0.

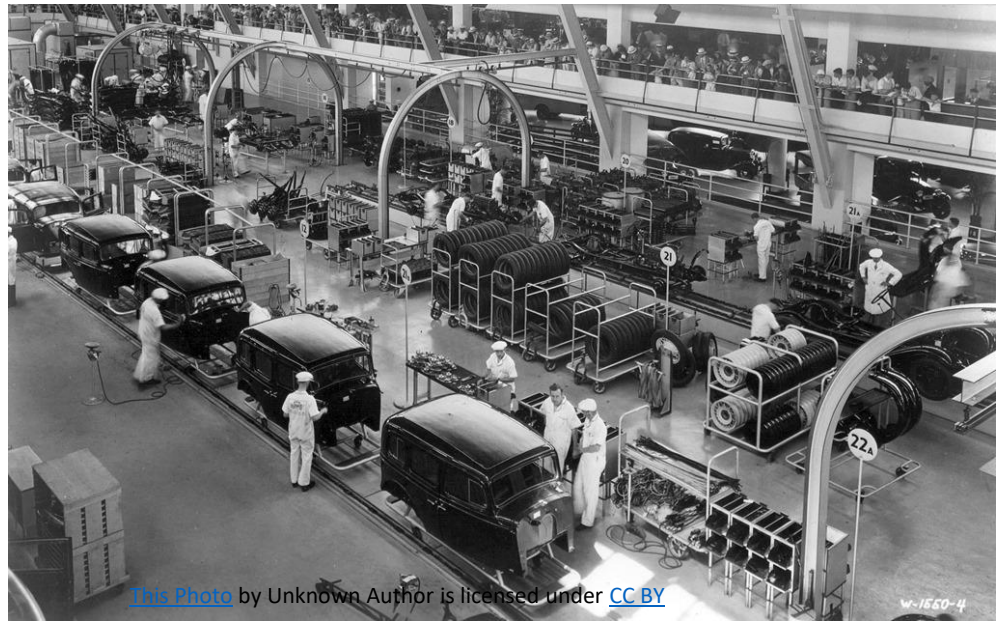
Source: https://www.slideshare.net/MeysamMaleki/industry-40-68780361

The First Industrial Revolution

- Started Britain then spread throughout Western Europe and to North America in the late 18th century
- To introduce machines into production by the end of the 18th century (1760-1840).
- From manual production to steam-powered engines (invented in 1784)
- Water as a source of power
  - Textile industry,
  - Agriculture greatly
- The term "factory" became a little popular.

The Second Industrial Revolution

- Between 1870 and 1914 (although some of its characteristics date back to the 1850)
- Electrification of factories
- Mass production as a primary means to production in general.
  - Steel helped introduce railways into the system



The Second Industrial Revolution

- Introduced pre-existing systems
  - Telegraphs and
  - Railroads into industries.
- Innovations in chemistry, such as the invention of the synthetic dye, also mark such period as chemistry was in a rather primitive state then.
- However, such revolutionary approaches to industry were put to an end with the start of World War I.
- Mass production, of course, was not put to an end, but only developments within the same context were made and none of which can be called industrial revolutions.

The Third Industrial Revolution

- Between 1950 and 1970.
- Much more familiar to us
  - Industries leaning on digital technologies in production.
- Referred to as the Digital Revolution,
- Information Age too.
  - Change from analog and mechanical systems to digital ones.
- A direct result of the huge development in computers and information and communication technology

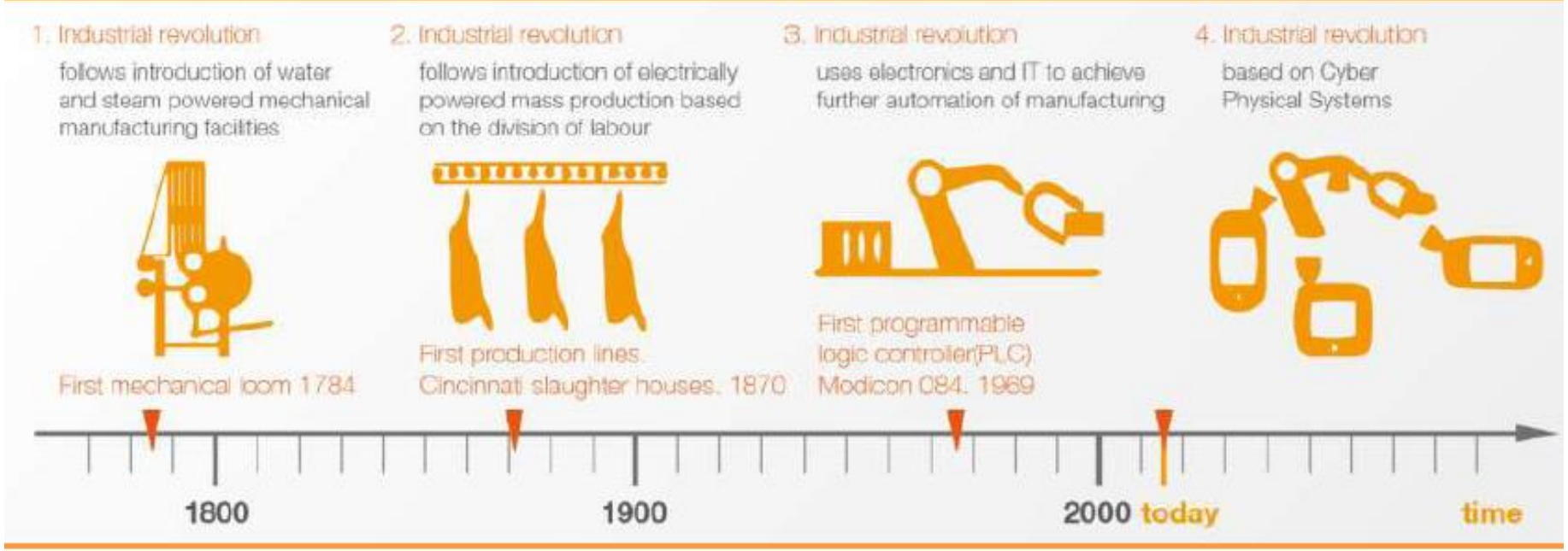
The Fourth Industrial Revolution

- Takes the automation of manufacturing processes to a new level
- by introducing customized and flexible mass production technologies.
  - Machines will operate independently, or
  - Cooperate with humans in creating a customer-oriented production field that constantly works on maintaining itself.
  - The machine rather becomes an independent entity that is able to collect data, analyze it, and advise upon it.

The Fourth Industrial Revolution

- Possible by introducing
  - self-optimization,
  - self-cognition, and
  - self-customization into the industry.
- The manufacturers will be able to communicate with computers rather than operate

Major trends in industrial evolution



McKinsey & Company

"Industry 4.0 is more than just a flashy catchphrase. A confluence of trends and technologies promises to reshape the way things are made."

Source: https://www.slideshare.net/MeysamMaleki/industry-40-68780361

Did not exist in 2006

- iPhone
- iPad
- Kindle
- 4G
- Uber
- Airbnb
- Android
- Oculus
- Instagram
- Snapchat
- Whatsapp

Time to reach 100 Million customers

- Telephone: 75 Years
- Web: 7 Years
- Facebook: 4 Years
- Instagram: 2 Years
- Pokemon Go: 1 Month

Benefits

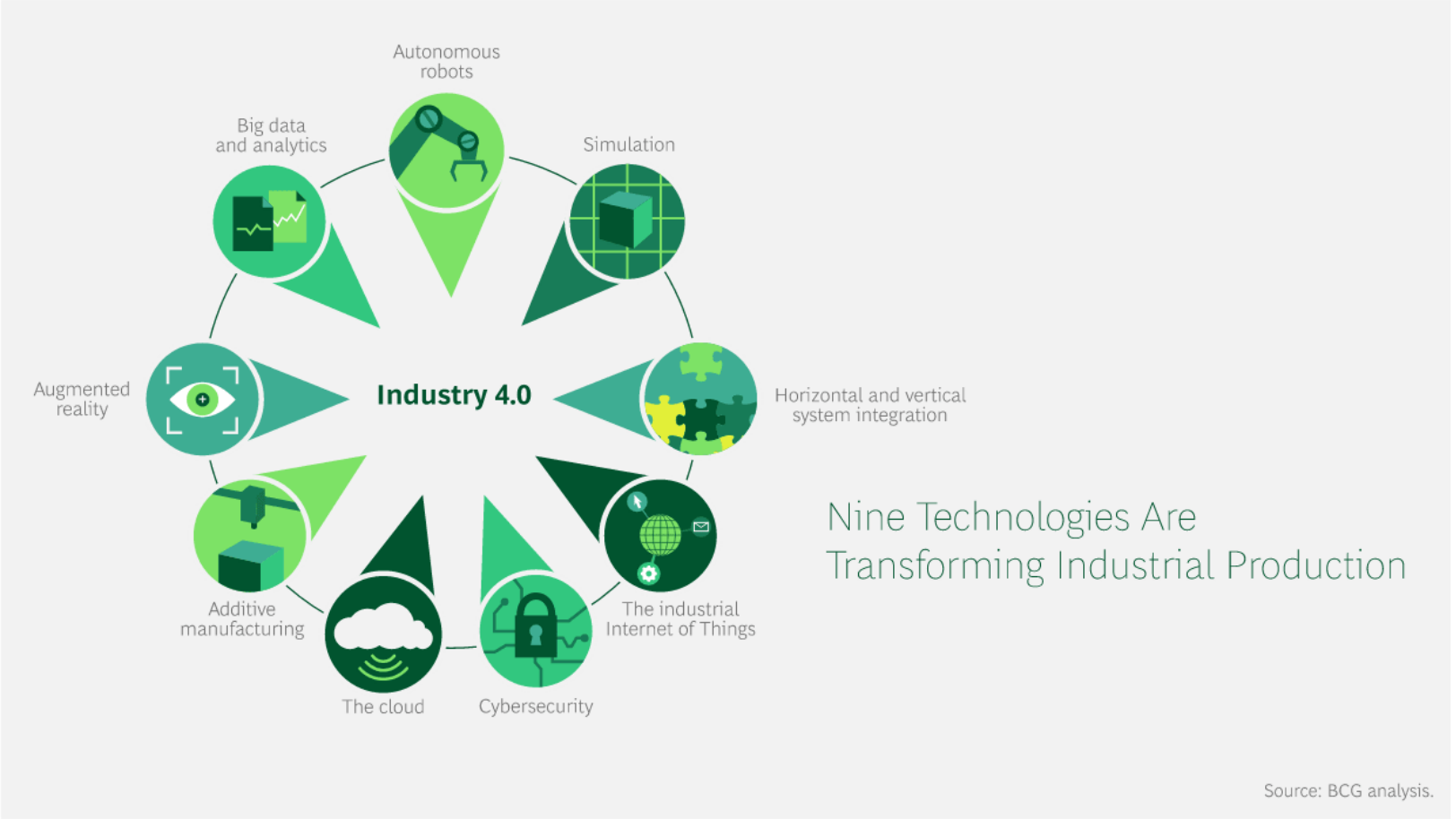
- Increased production efficiency to innovative product and services deployment – the benefits of digitalization are significant.
- Revenue gains
- Increased efficiency and productivity
- Machine downtime reductions
- Improved supply/demand matching
- Enhanced productivity through optimization and automation
- 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

Source: https://www.infopulse.com/blog/the-main-benefits-and-challenges-of-industry-4-0-adoption-in-manufacturing/; https://iiot-world.com/connected-industry/nine-challenges-of-industry-4-0/

How will machines communicate?

- Main role of information and communication technologies (ICT)
- The idea behind Industry 4.0 is to create a social network where
  - Machines can communicate with each other, called the Internet of Things (IoT) and
  - With people, called the Internet of People (IoP).
- Machines can communicate
  - with each other and
  - with the manufacturers

Nine Technologies Transforming Industrial Production



Source: https://www.bcg.com/en-in/capabilities/operations/embracing-industry-4.0-rediscovering-growth.aspx

Nine Technologies Transforming Industrial Production

- Autonomous Robots
  - Robots will eventually interact with one another
  - Work safely side by side with humans and learn from them.
  - Cost less
  - Have a greater range of capabilities than those used in manufacturing today.

Nine Technologies Transforming Industrial Production

- Simulation
  - Used more extensively in plant operations to leverage real-time data
  - Mirror the physical world in a virtual model, which can include machines, products, and humans
  - Allow operators to test and optimize the machine settings for the next product in line in the virtual world before the physical changeover
  - Driving down machine setup times and increasing quality

Nine Technologies Transforming Industrial Production

- Horizontal And Vertical System Integration
  - With Industry 4.0, companies, departments, functions, and capabilities will become much more cohesive, as cross-company, universal data-integration networks evolve and enable truly automated value chains.

Nine Technologies Transforming Industrial Production

- The Industrial Internet of Things
  - More devices—sometimes including unfinished products—will be enriched with embedded computing
  - Allow field devices to communicate and interact
    - both with one another and with more centralized controllers, as necessary
  - Decentralize analytics and decision making, enabling real-time responses
- Cybersecurity
  - The need to protect critical industrial systems and manufacturing lines from cybersecurity threats increases dramatically
    - The increased connectivity and use of standard communications protocols
  - Secure, reliable communications as well as sophisticated identity
  - Access management of machines and users

Nine Technologies Transforming Industrial Production

- The Cloud
  - require increased data sharing across sites and company boundaries.
  - At the same time, the performance of cloud technologies will improve, achieving reaction times of just several milliseconds.
  - As a result, machine data and functionality will increasingly be deployed to the cloud, enabling more data-driven services for production systems.
- Additive Manufacturing
  - Companies have just begun to adopt additive manufacturing, such as 3-D printing, which they use mostly to prototype and produce individual components.
  - With Industry 4.0, these additive-manufacturing methods will be widely used to produce small batches of customized products that offer construction advantages, such as complex, lightweight designs.

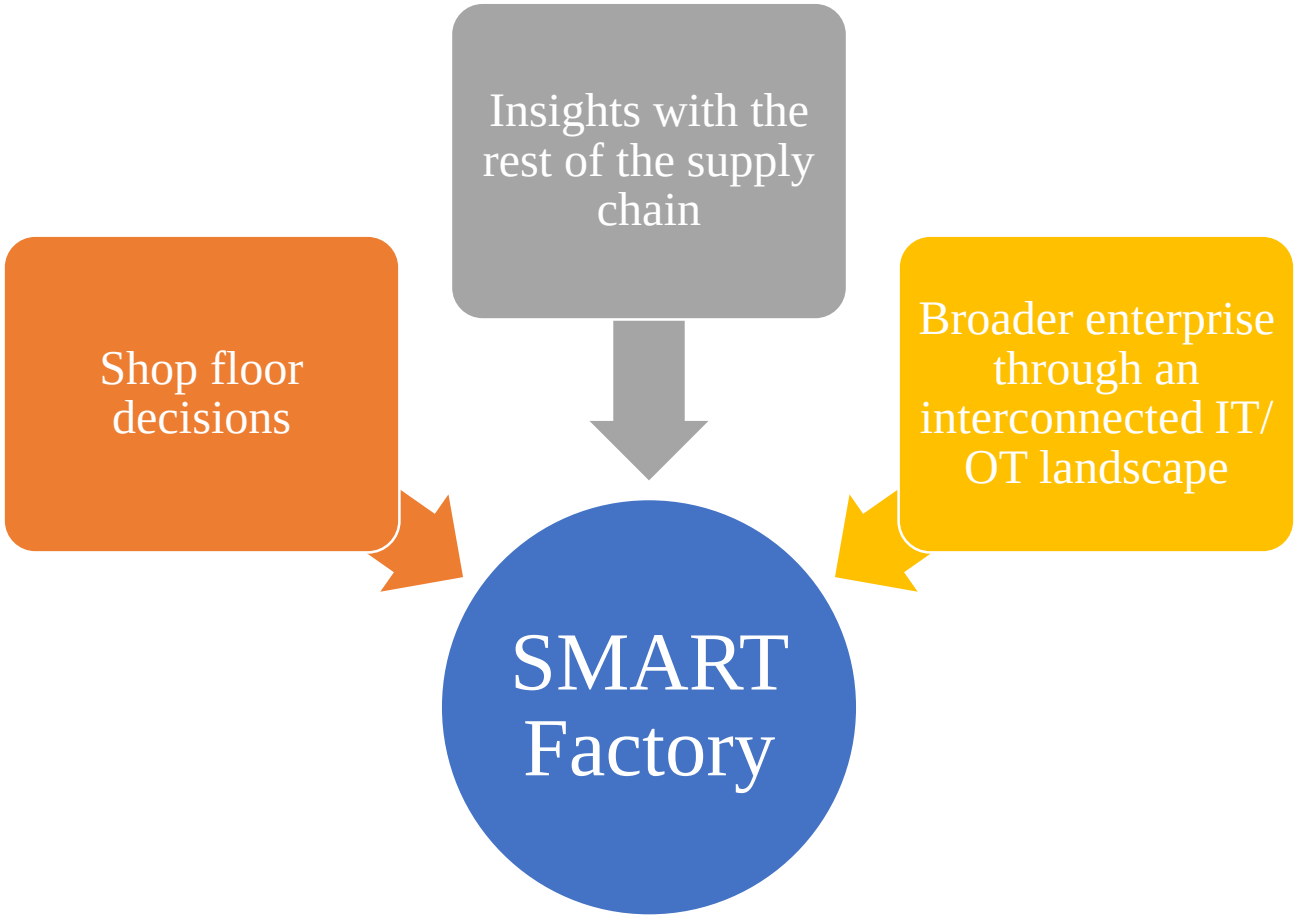
Nine Technologies Transforming Industrial Production

- Augmented Reality
  - Augmented-reality-based systems support a variety of services, such as selecting parts in a warehouse and sending repair instructions over mobile devices. These systems are currently in their infancy, but in the future, companies will make much broader use of augmented reality to provide workers with real-time information to improve decision making and work procedures.

Smart factory

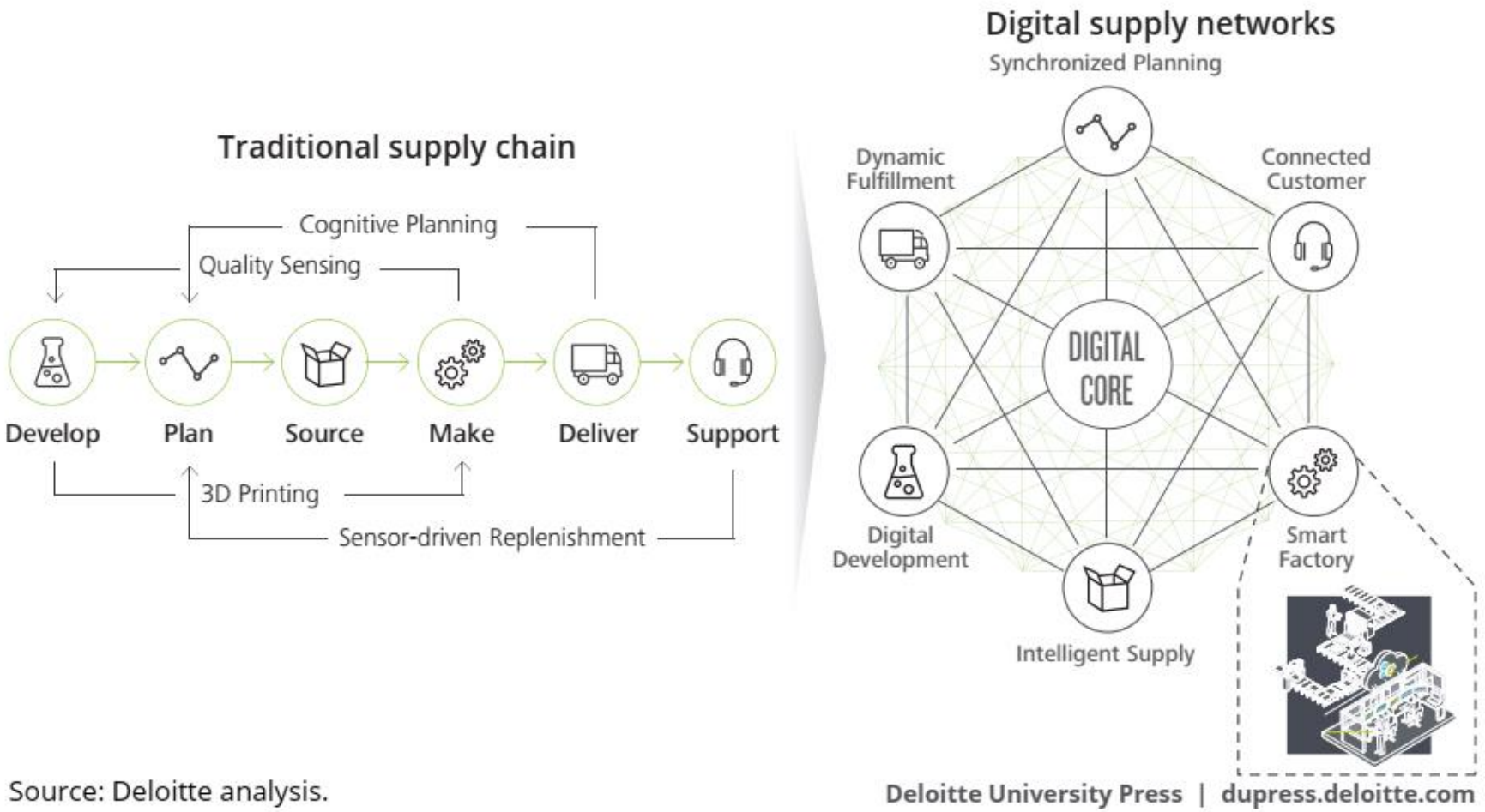
- Automation
- Automation is still in existence, so what's new?
  - Decisions
  - Pump-on/off
  - Light on/off
  - Uses AI approaches
- Digital supply network

Smart factory (contd…)



Smart factory (contd…)

Figure 1. Shift from traditional supply chain to digital supply network



Source: Deloitte analysis.

Smart factory (contd…)

A flexible system

Self-optimize

- Performance across a broader network,

Self-adapt

- To and learn from new conditions in real or near-real time, and

Autonomous

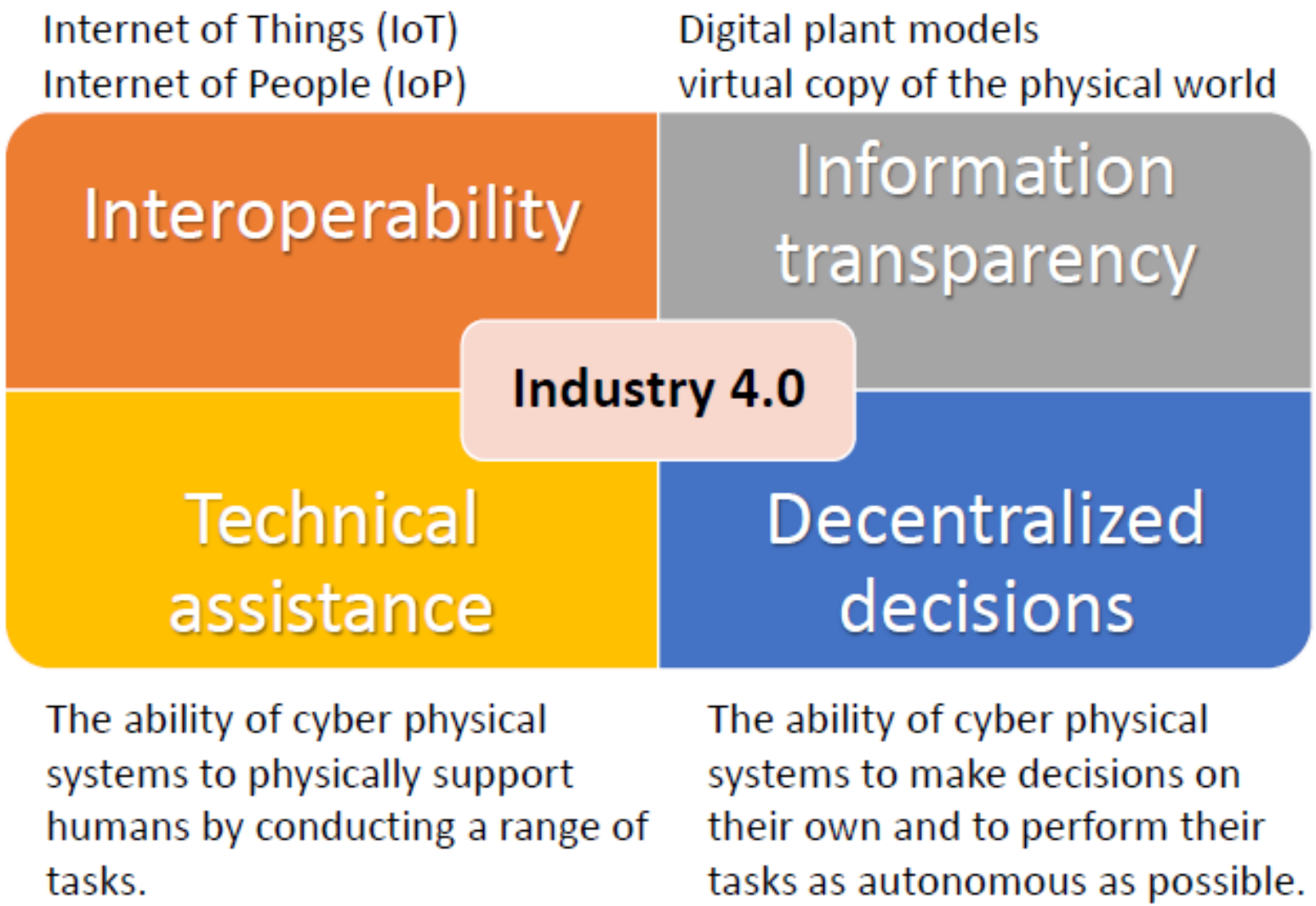
- Run entire production processes

Smart factories

- Can operate within the four walls of the factory,
- Can also connect to a global network of similar production systems, and even to the digital supply network more broadly.
- It represents an ongoing evolution,
- A continuous journey toward building and maintaining a flexible learning system—rather than the “one and done” factory modernization approach of the past.

The true power of the smart factory

- Ability to evolve and grow along with the changing needs of the organization—
  - Whether they be shifting customer demand,
  - Expansion into new markets,
  - Development of new products or services,
  - More predictive and responsive approaches to operations and maintenance,
  - Incorporation of new processes or technologies,
  - or near-real-time changes to production.
- Smart factories can enable organizations to adapt to changes in ways that would have been difficult, if not impossible, to do so before.
  - Because of more powerful computing and analytical capabilities
  - Along with broader ecosystems of smart, connected assets



Source: Google Image

Challenges

- Re-Division of work between Man and Machine
- Communication reliability and QoS
- Cyber security
- Maturity of machine intelligence
- Handling big data
- Social Challenges
  - General reluctance to change by stakeholders
  - Lack of adequate skill-sets
  - Unemployment

Challenges

- Economic
  - High economic costs
  - Business model adaptation
  - Unclear economic benefits/ excessive investment
- Political
  - Lack of regulation, standards and forms of certifications
  - Unclear legal issues and data security

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