

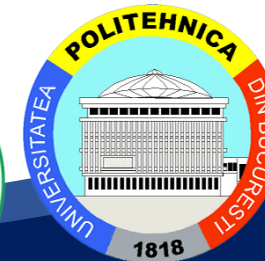


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III Man-Machine Collaboration on a Shop Floor

Evolution of Man-Machine Collaboration

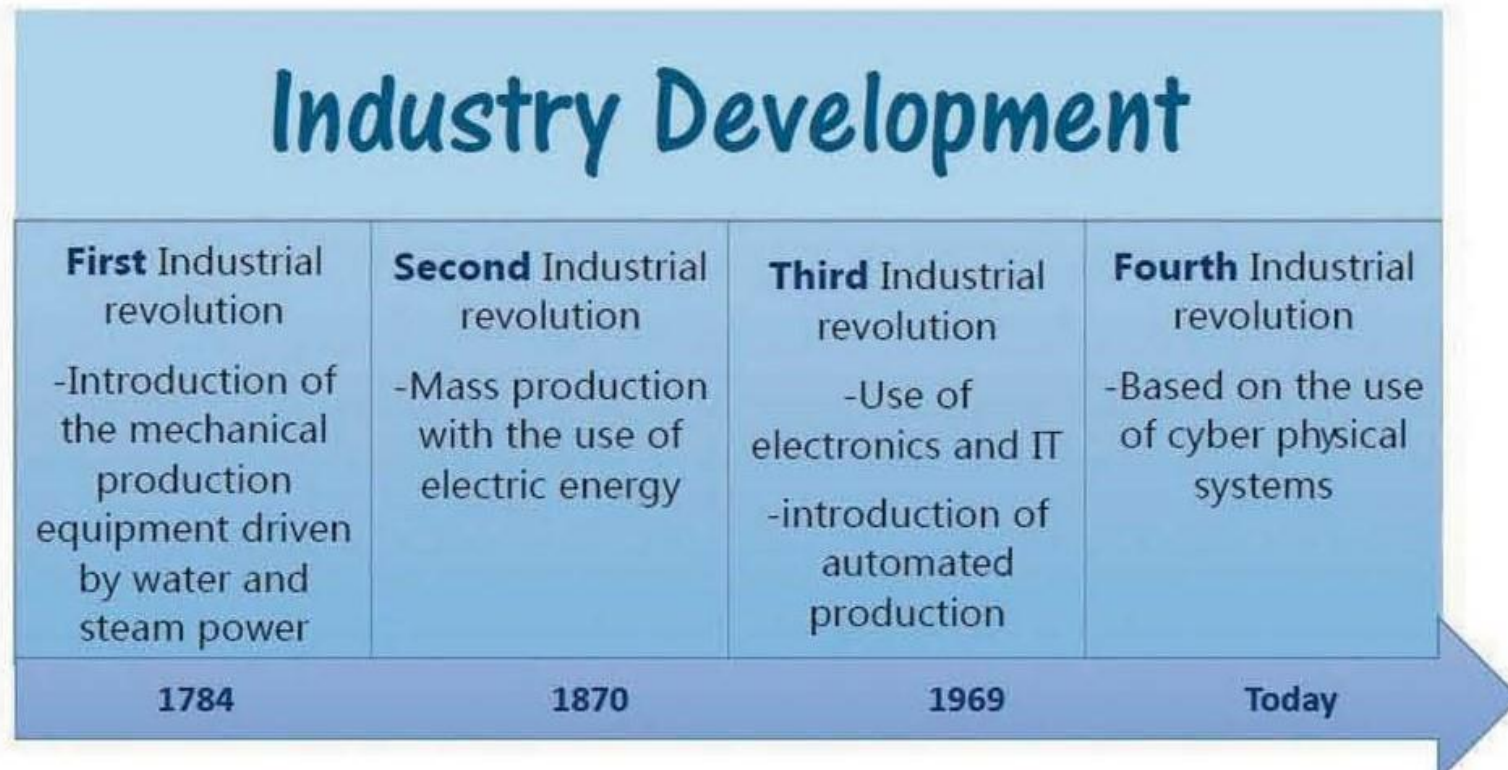


Curriculum Development
of Master's Degree Program in
Industrial Engineering for Thailand Sustainable Smart Industry



Evolution of Man-Machine Collaboration

Industry 4.0 evolution : The term 'Industry 4.0' describes the Fourth Industrial Revolution, preceded by three other Industrial Revolutions



Source: Drath & Horch, 2014

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Evolution of Man-Machine Collaboration

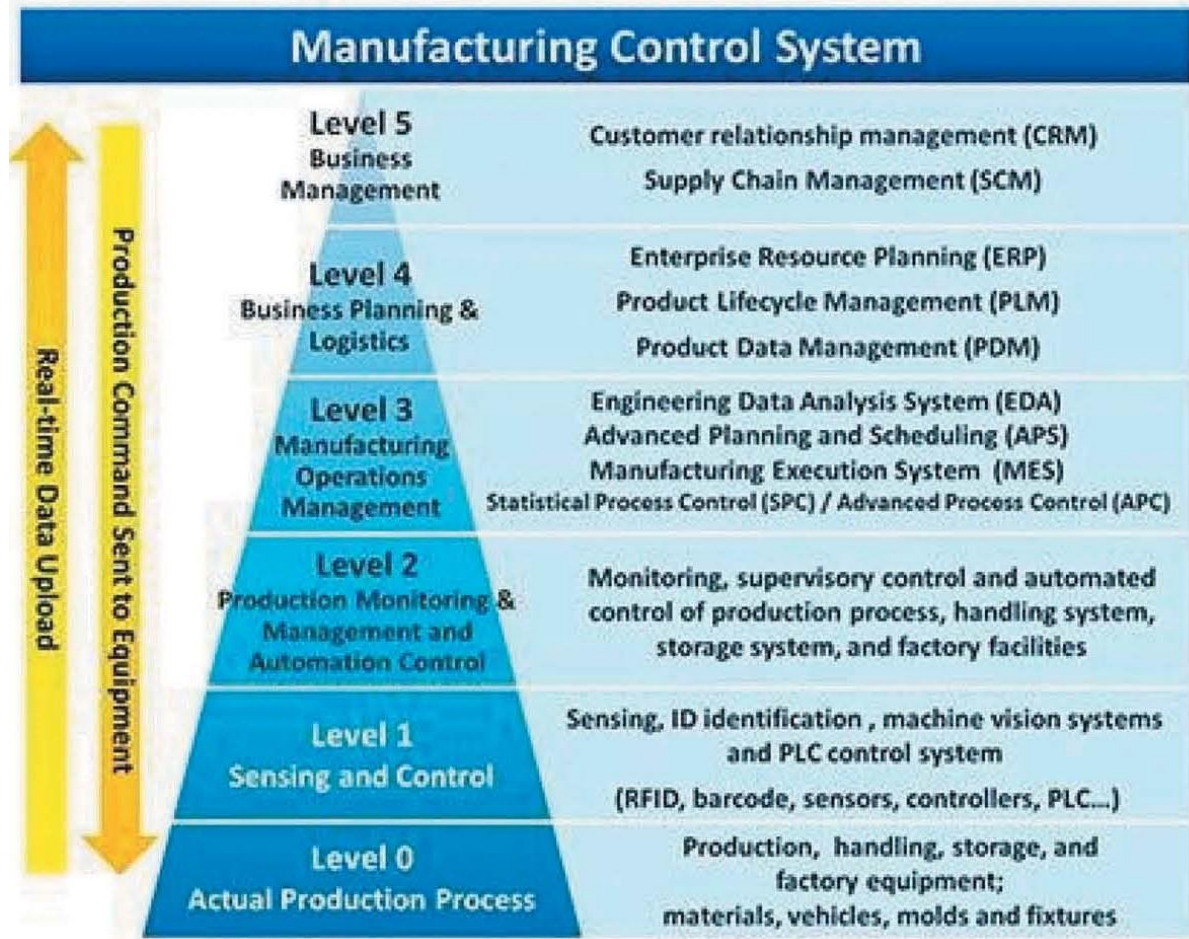
- Industry 4.0 is a new concept of manufacturing, involving the industrial automation and integrating new production technologies, to improve work conditions and to increase productivity and quality.
- Industry 4.0 brought a great change in the interaction between workers and machines.
 - The term 'machine' indicates every kind of dynamic technical system including
 - automation
 - decision support equipment and software

Source: Drath & Horch, 2014

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Evolution of Man-Machine Collaboration



Machines in new concept

- Move from level 1 to level 3 (manufacturing level, system and management level) or level 4 (enterprise resource planning)
- the automation supports human work not only in the production phase, logistics and data collection but in business management and ERP too



Evolution of Man-Machine Collaboration

- The new paradigm of Industry 4.0 is a revolution, which allows communication between humans and machines throughout a highly networked environment (Gu & Liu, 2013), using
 - Automation technologies like Cyber-Physical Systems (CPS)
 - Internet of Things (IoT)
 - Cloud computing





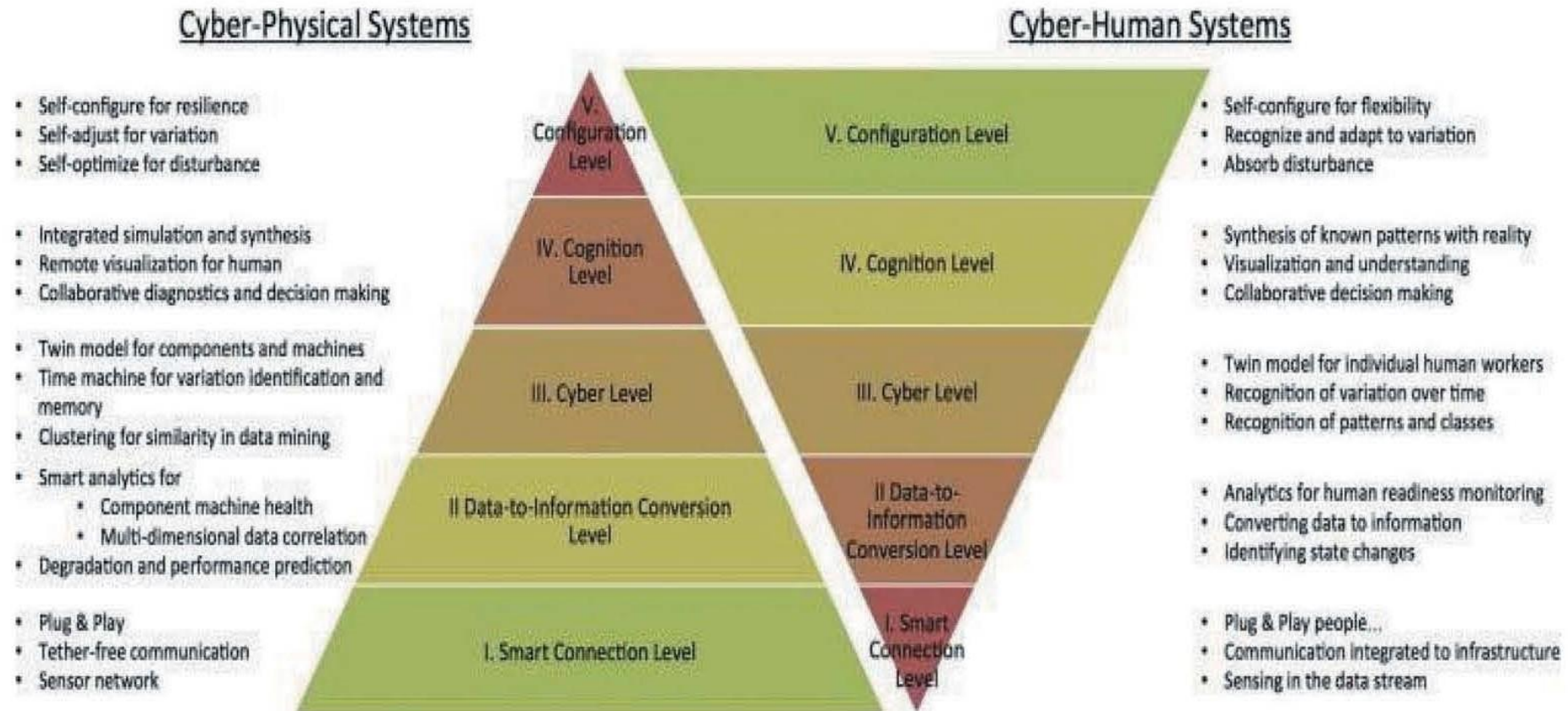
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- Cyber-human system (CHS) is an update of the simple CPS including some consideration on
 - how the human element must be integrated
 - How human factor is crucial in the higher levels
- CHS has the ability to feedback information at each level
- The configuration level of CHS acts as the supervisory control to ensure the decisions, made at the cognition level



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The CHS framework compared to the CPS



Source: Krugh & Mears, 2018

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Evolution of Man-Machine Collaboration

- Man–machine interaction (MMI) or with the name of Human–machine interaction (HMI)
 - an interaction and communication between human users and machines in a dynamic environment through several interfaces.



Evolution of Man-Machine Collaboration

- The history of HMI can be split up into four time zones.
 - 1940 to 1955: developers tried to find the limits of human possibilities
 - 1955 to 1970: researchers tried to model the humans like machines and design products accordingly.
 - 1970 to 1985: the technology was used to automate many tasks, which normally required humans.
 - Since 1985: workload, cognitive process, emotional human–robot interaction models are taken into account.





Evolution of Man-Machine Collaboration

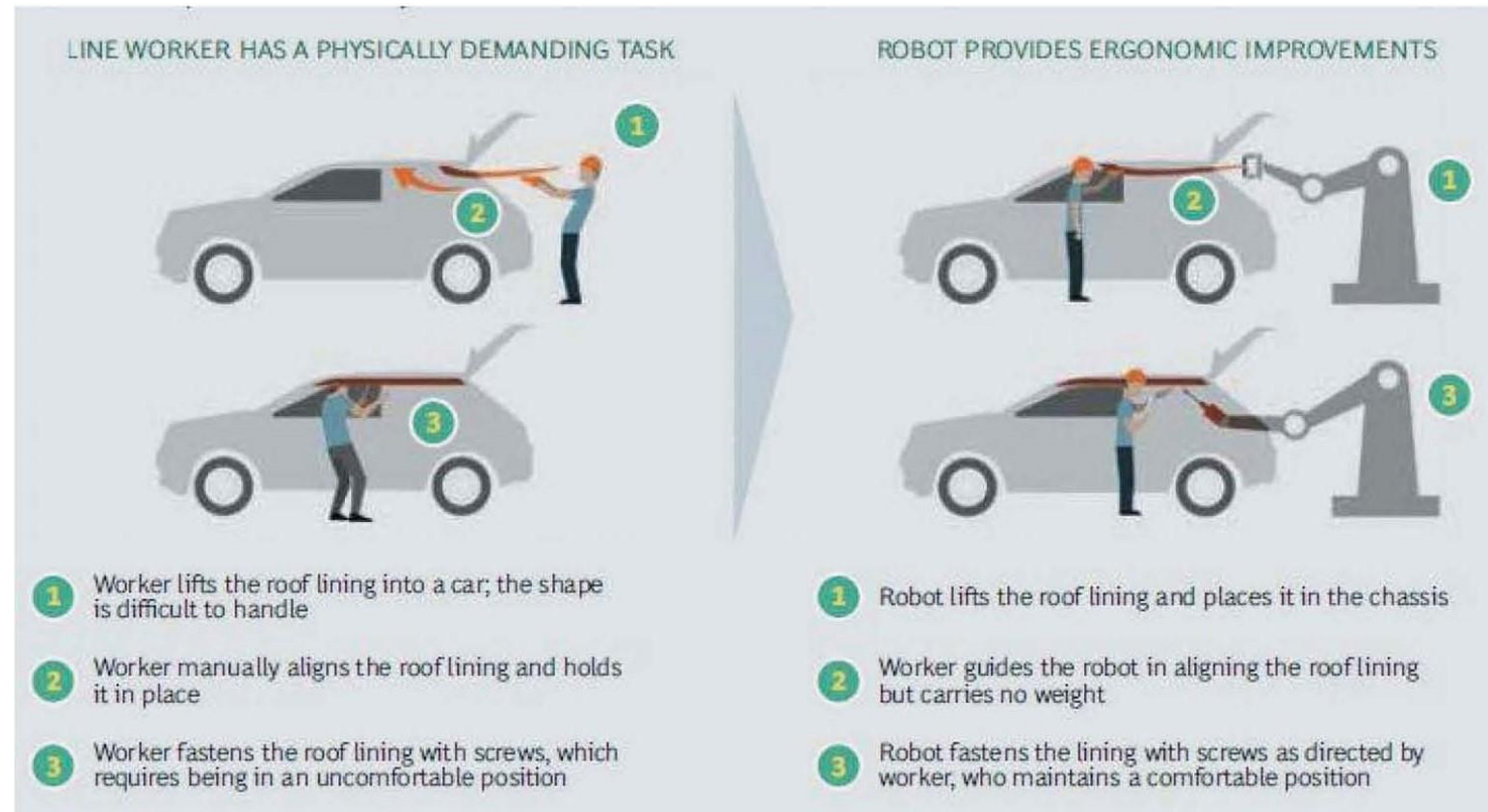
- Human–machine interaction deeply changed through years and in Industry 4.0 reached a great innovation
- Some pillars of the Fourth Industrial Revolution:
 - Big data and analytics
 - Robot-assisted production
 - Self-driving logistics vehicles
 - Augmented reality and additive manufacturing





Evolution of Man-Machine Collaboration

Use of robots in the production as ergonomic help



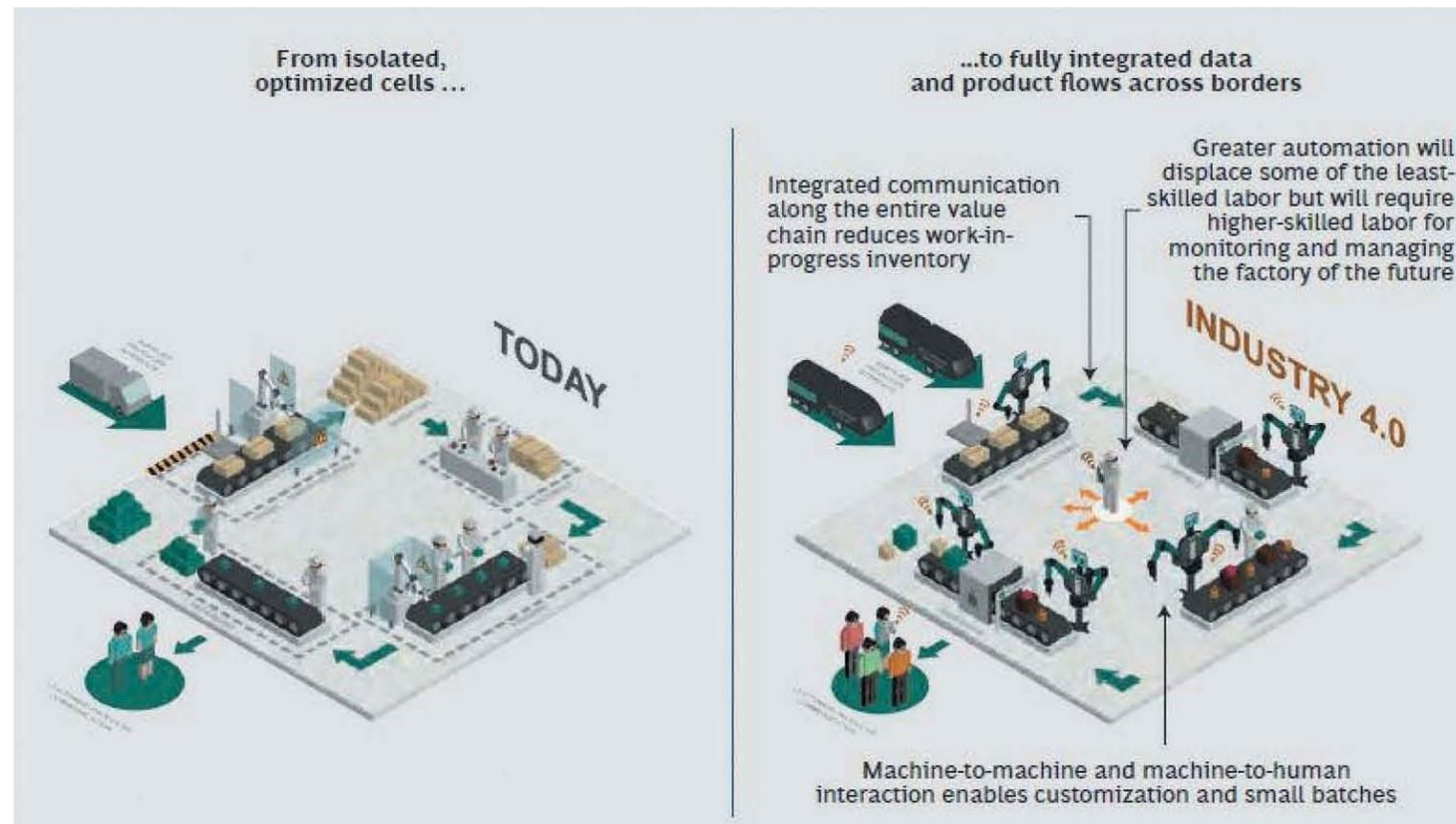
Source: Ferdows & De Meyer, 1990

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Evolution of Man-Machine Collaboration

The supply chain in industry 4.0



Source: Ferdows & De Meyer, 1990

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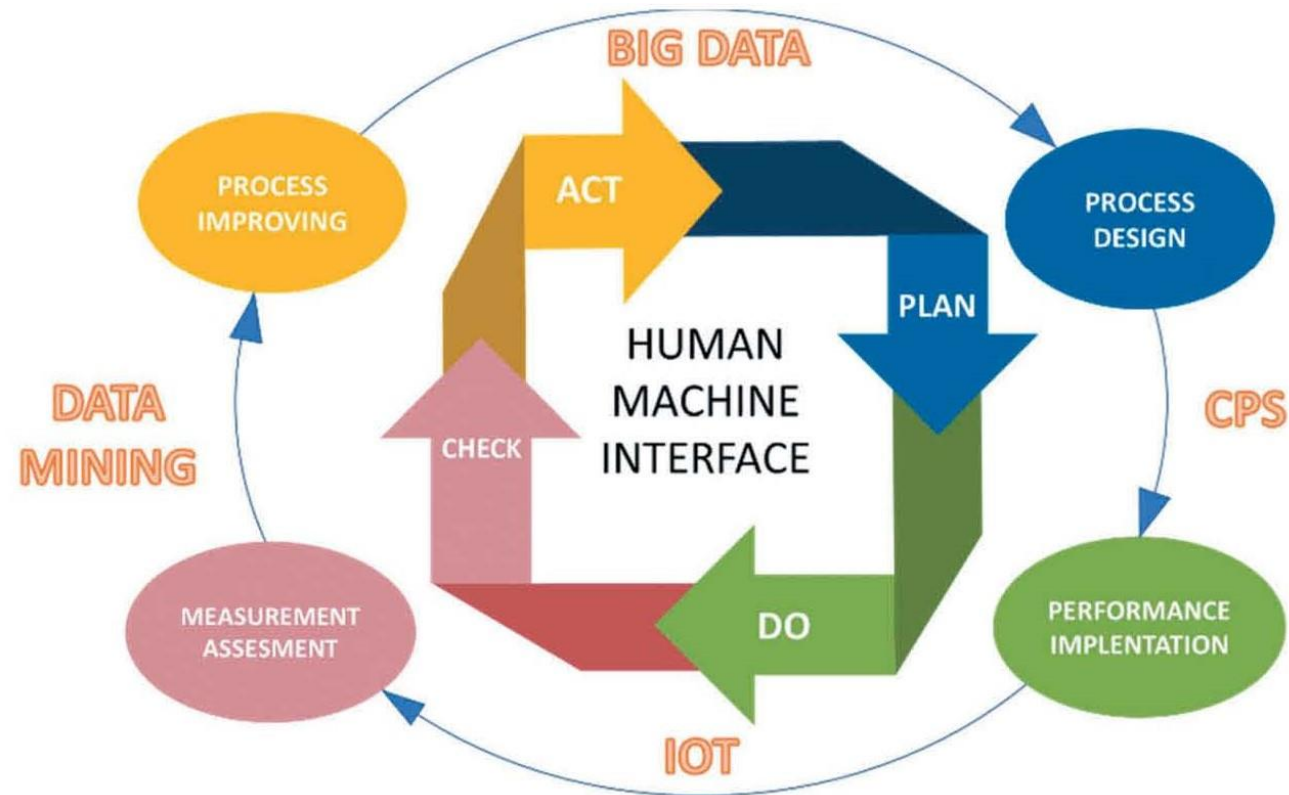
Evolution of Man-Machine Collaboration

- Man-machine collaboration in total quality environment
- The Industry Enabling Technologies 4.0 (Cyber-physical systems (CPS), Internet of Things, Data Mining and Big Data) are integrated with the standard Deming cycle (PLAN – DO – CHECK – ACT)
 - A model designed for continuous quality improvement from a long-range perspective



Evolution of Man-Machine Collaboration

New man-machine collaboration in industry 4.0 from design to management



Source: Nardo, Forino and Murino, 2020

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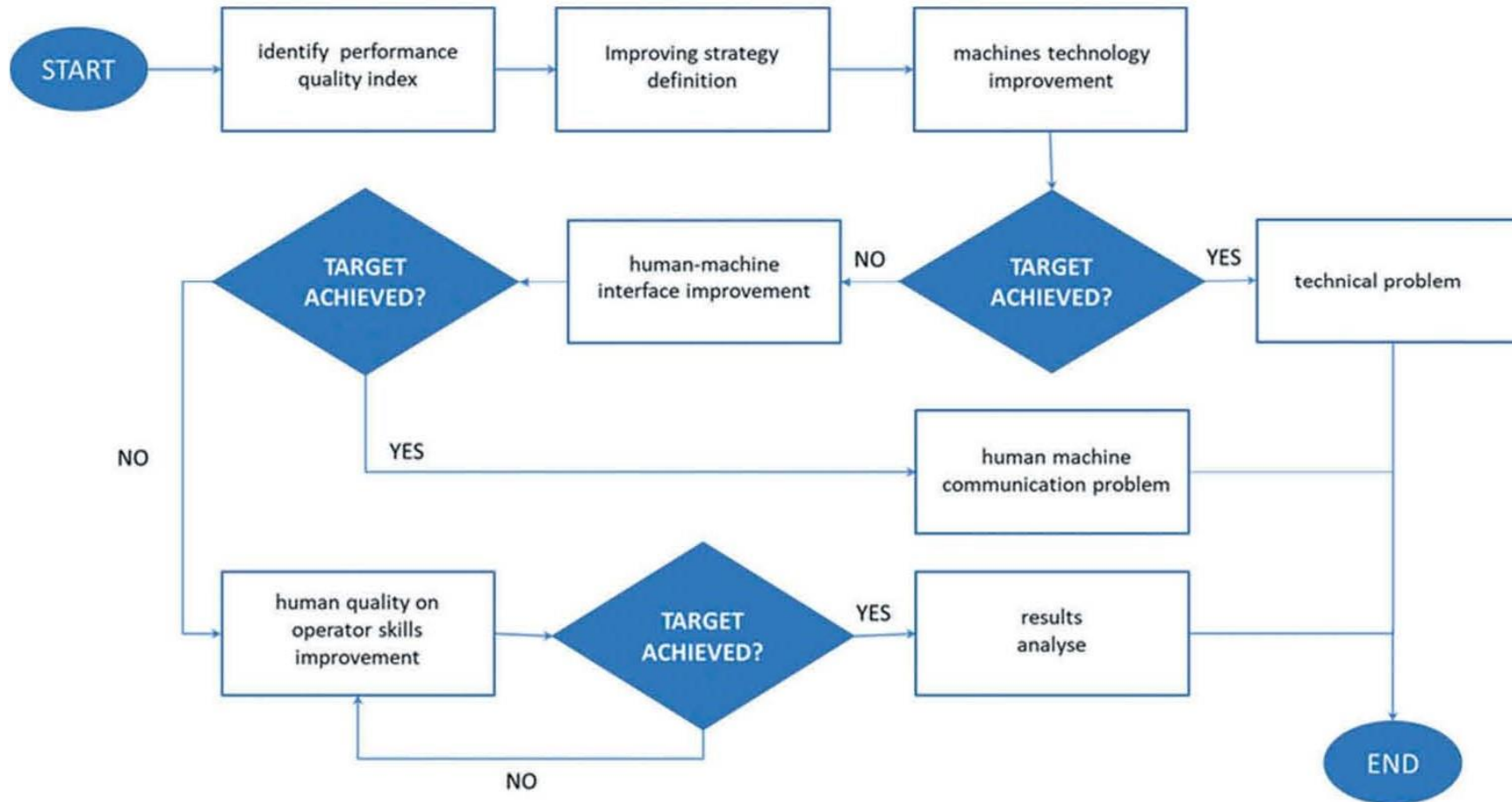


Evolution of Man-Machine Collaboration

- The goal of automation will be to provide devices that will collect data and aggregate them and then provide them, in the most user-friendly way, to the person in charge of making appropriate decisions based on the data available.



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Source: Nardo, Forino and Murino, 2020

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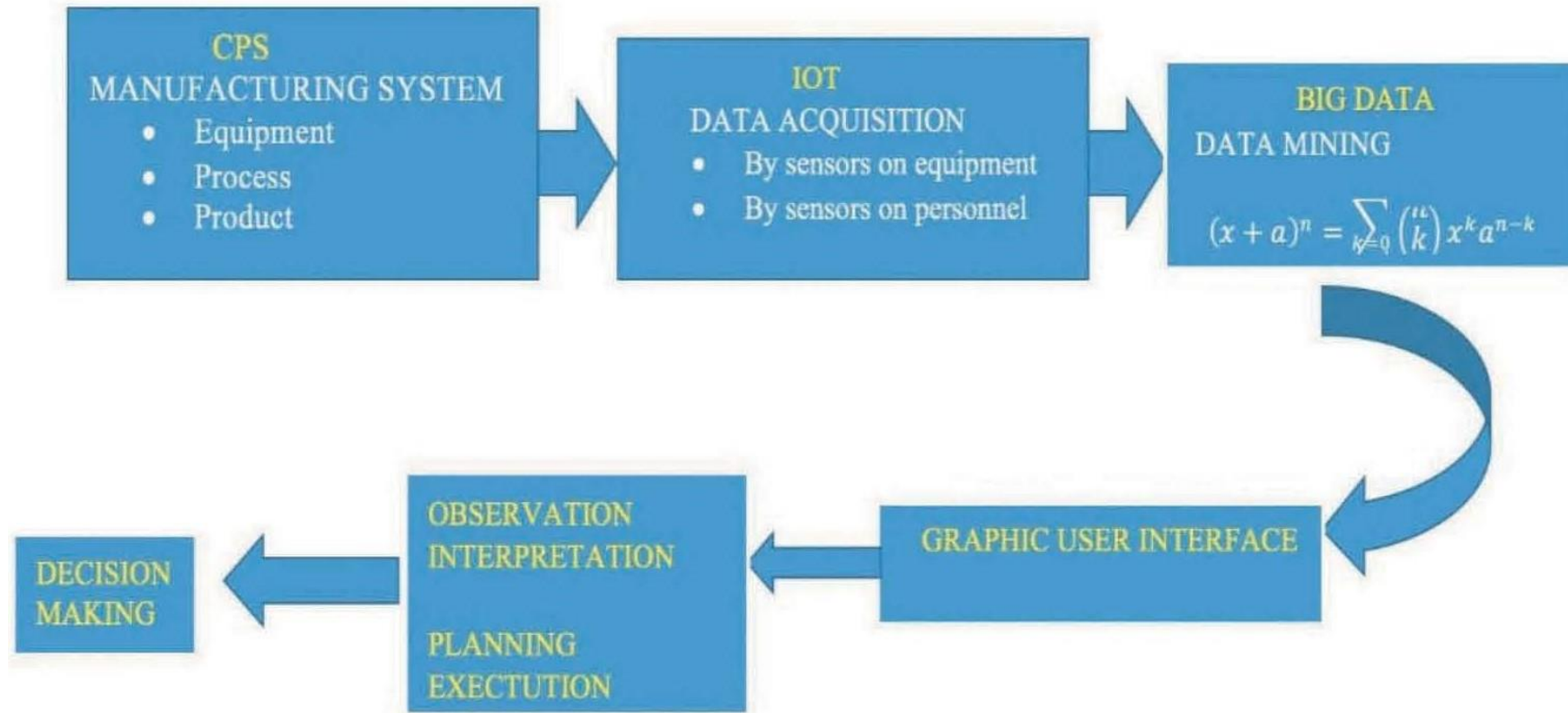
Evolution of Man-Machine Collaboration

- Organizations must have human resources with new skills to analyze and understand the growing demand for innovation.
 - Multitasking people with skills that are not strictly related to their direct work environment and above all related to information technology will be increasingly requested.



Evolution of Man-Machine Collaboration

From the CPS Framework to the decision-making phase





Evolution of Man-Machine Collaboration

- One-third of the skills required of employees will include skills that are not considered crucial for the role played today.
- In Industry 4.0-era, companies are no longer simply required to invest in technological infrastructures, but it becomes essential:
 - Driving and anticipating change: the ability to solve complex problems and critical thinking to help organizations adapt quickly to changes in perspective. Database analysis must involve data scientists to turn data into strategic business suggestions.
 - Valuing the human factor before technology: all companies need to reconsider their human resource models





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Thank You

Together We Will Make Our Education Stronger



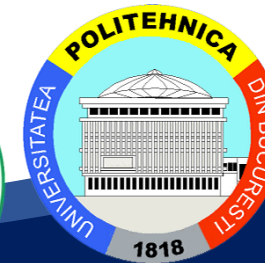
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