



Co-funded by the
Erasmus+ Programme
of the European Union



Introduction to the Fourth Industrial Revolution

Rui M. Lima, Cristiano Jesus
(School of Engineering of University of Minho)



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

What does the concept of Industry 4.0 best represent for you in practical terms?

O que melhor representa para si, em termos práticos, o conceito de Indústria 4.0?

Mentimeter



13

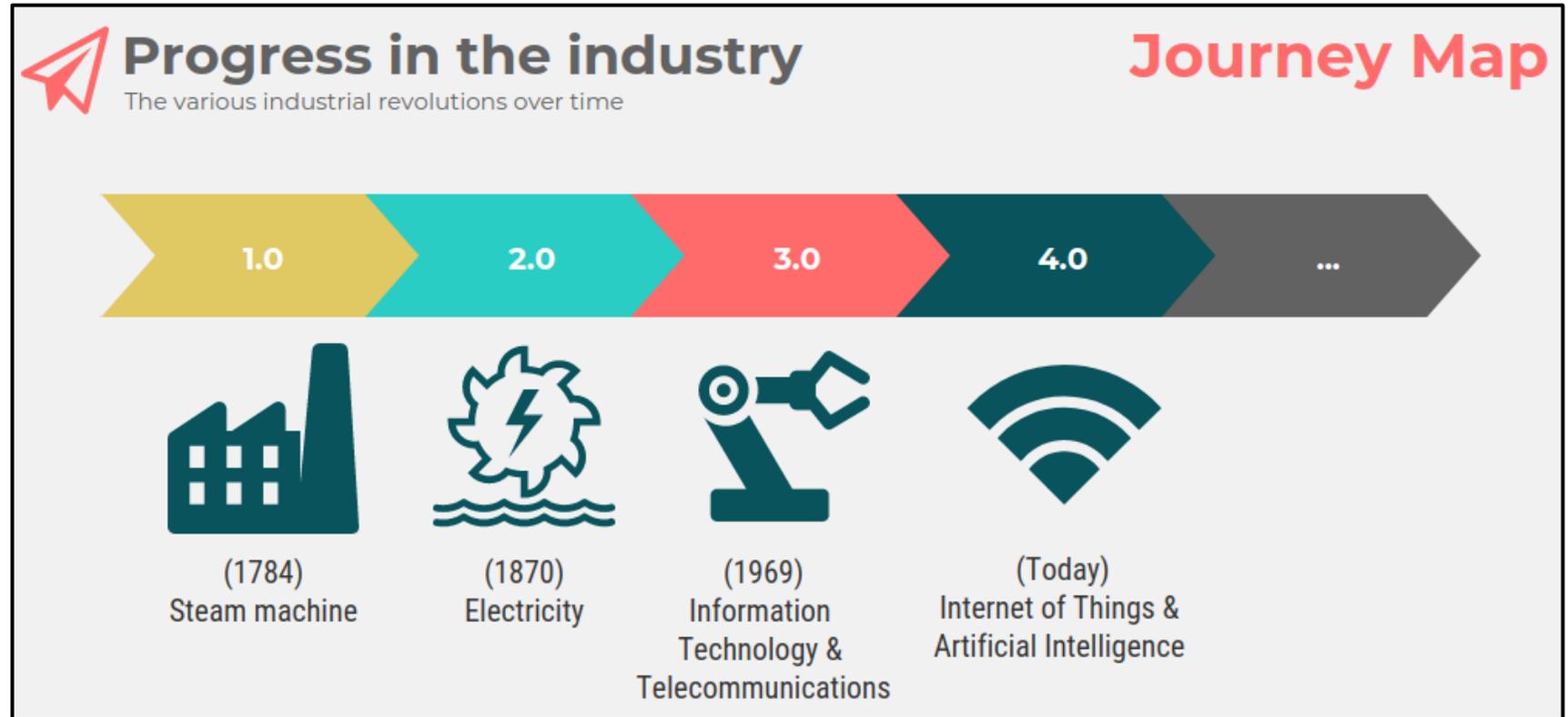
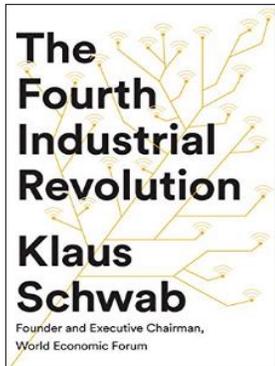
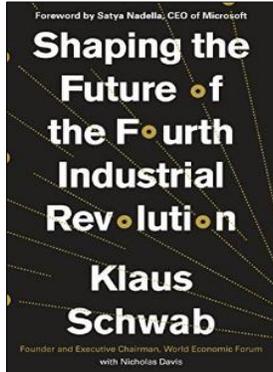
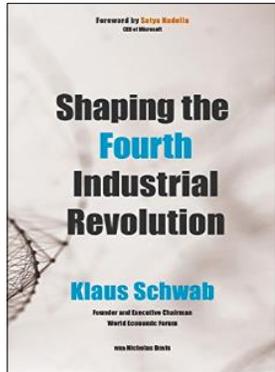


- Automatization
- Technology
- Internet of things
- Globalization
- Big data
- Simulation
- Digital transformation

Industry 4.0

Understand the different perspectives on the subject and position yourself before creating your competence development planning.





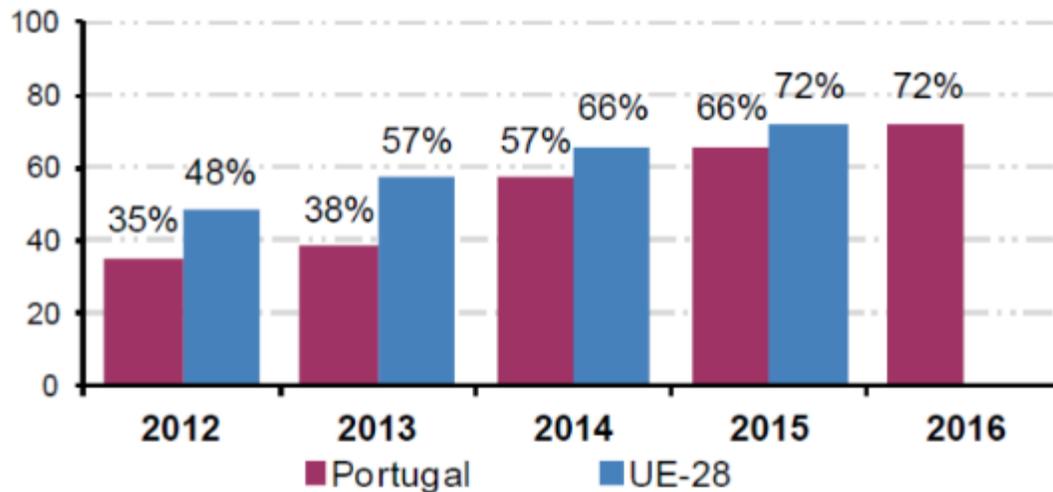
MSE 4.0 Industry 4.0



- Germany – Industry 4.0
- Portugal – Portugal i4.0
- USA – Manufacturing Renaissance
- Netherlands – Smart Industry
- United Kingdom – High Value Manufacturing
- France – Industrie du Futur
- Spain – Fabricacion Avanzada
- Italy – Fabbrica Intelligente
- Belgium – Made Difference
- Switzerland – Industrie 2025
- Austria – Produktion der Zukunft
- Greece – Operational Programme
- Sweden – Produktion 2030
- Finland – Industrial Internet Business Revolution
- Poland – Digital Manufacturing for SME
- India – Smart Manufacturing
- Singapore – Precision Manufacturing
- China – Made in China 2025
- Japan – Innovation 25' Program

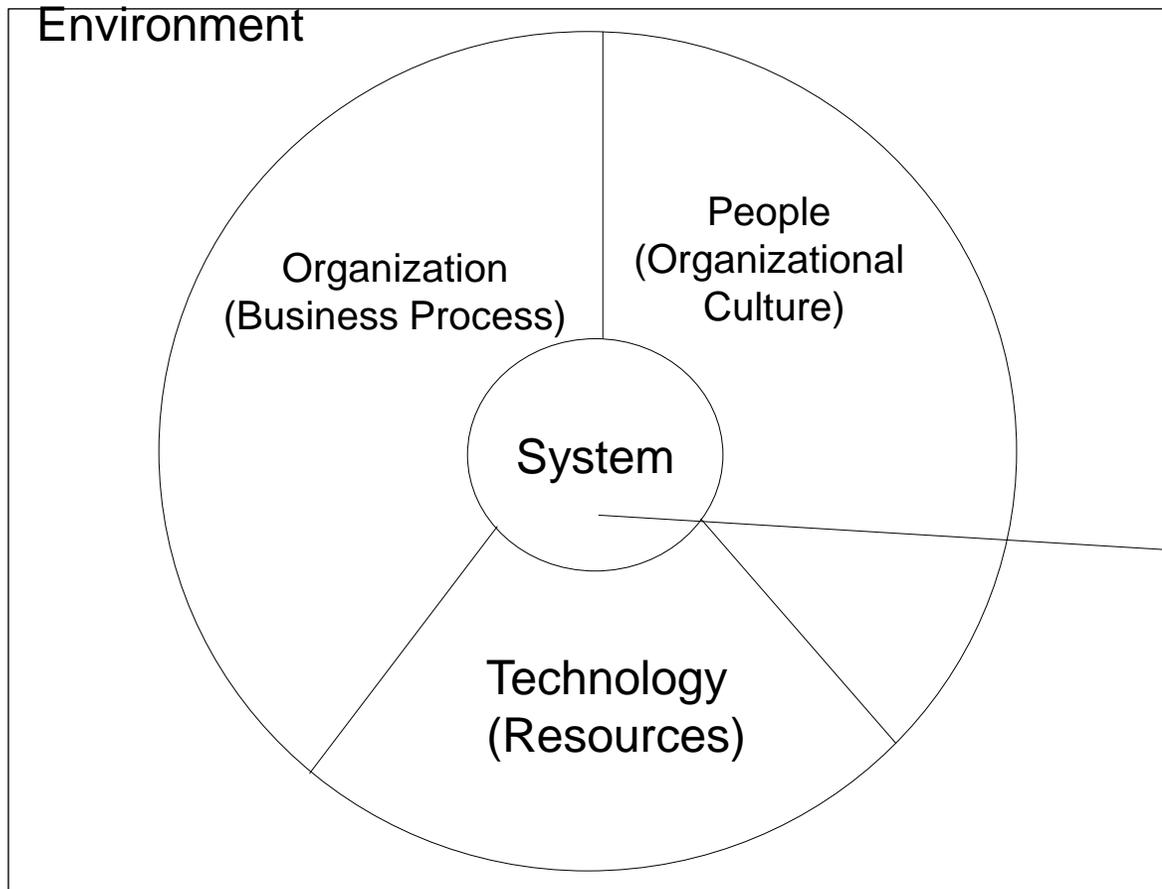


Proportion of people aged 16-74 using the Internet in portable devices, Portugal and EU-28, 2012-2016



National Institute of Statistics, Portugal

- By 2030, a large part of the global population will have a mobile phone;
- Transition from product to service
 - Netflix, Spotify, Uber, Airbnb, etc.
- Transition from security in the profitability of assets through scale production to variety at the level of product configuration.



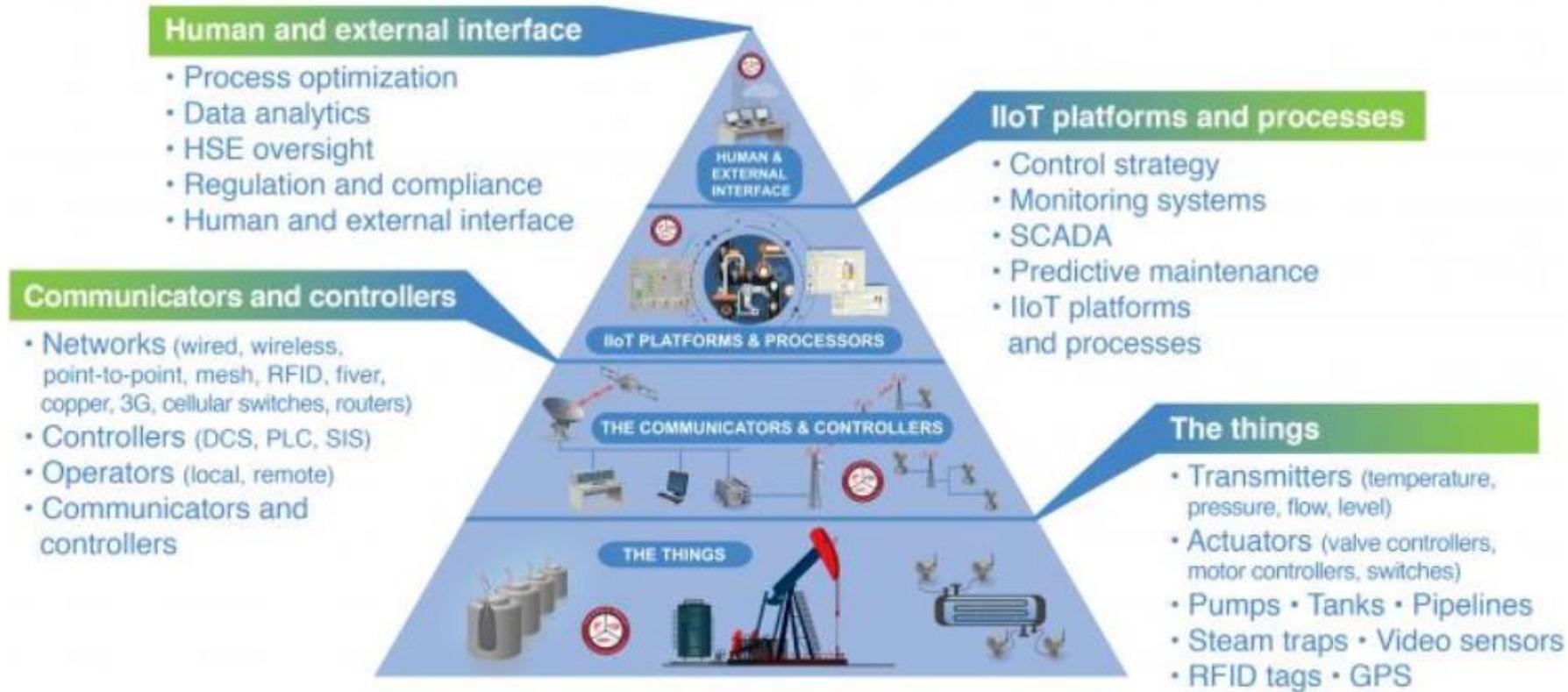
The ultimate goal is to become an agile company, capable of continuous and agile adaptation to a changing environment.

The company as a complex system

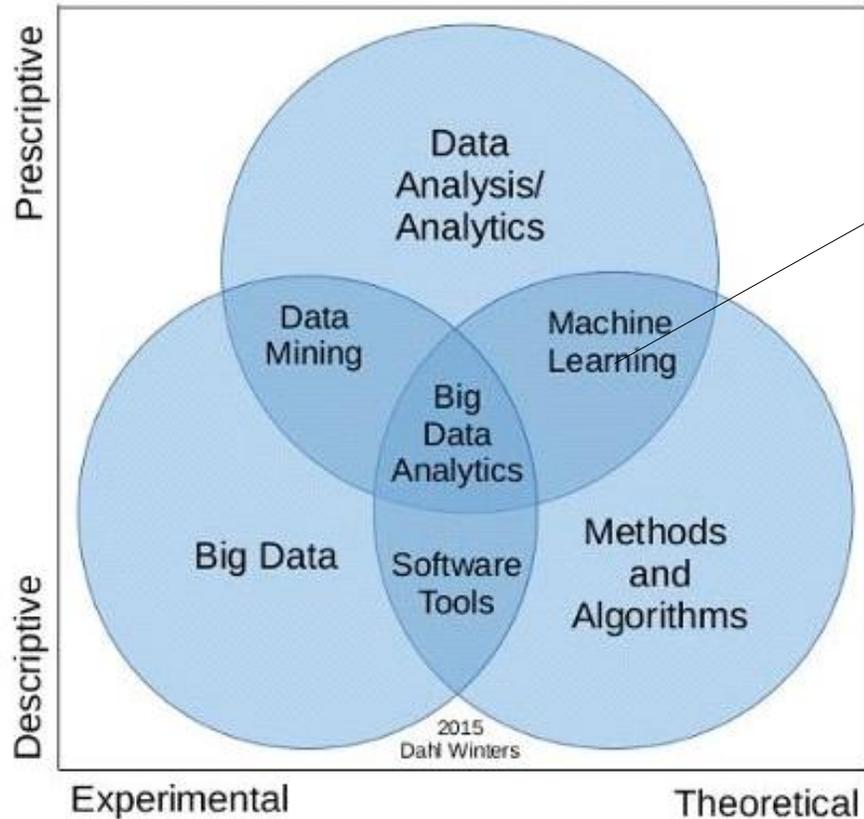
Source: Laudon, Kenneth C.; Laudon, Jane P. (2019).

Information Systems. Pearson.

The Industrial Internet of Things

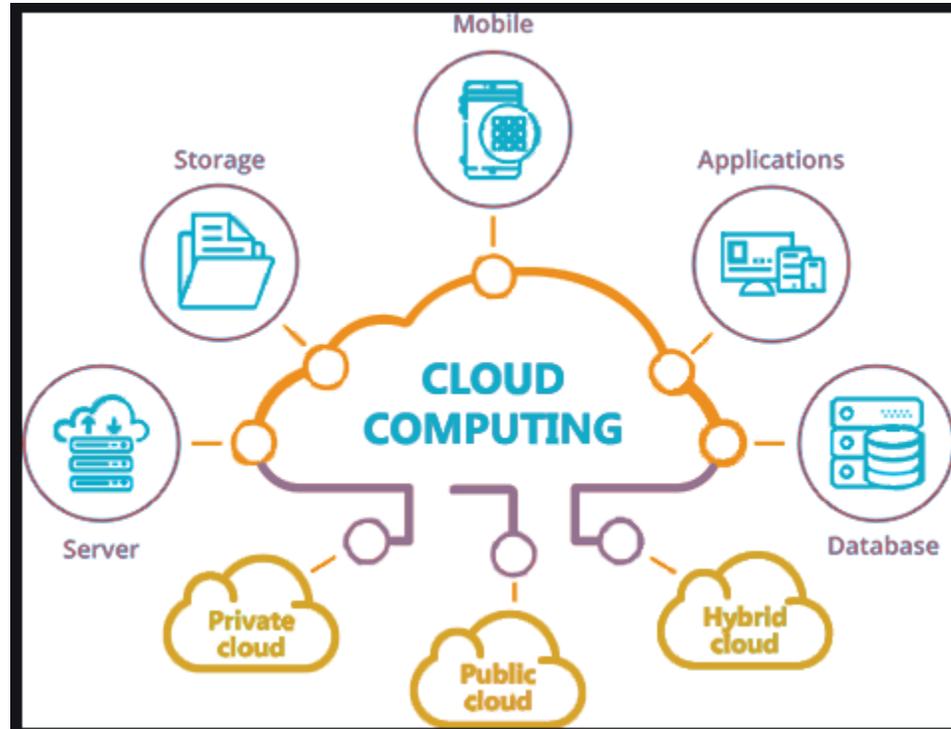


The Fields of Data Science



Deep Learning

Source: Understanding Different Components & Roles in Data Science (Divya Singh)

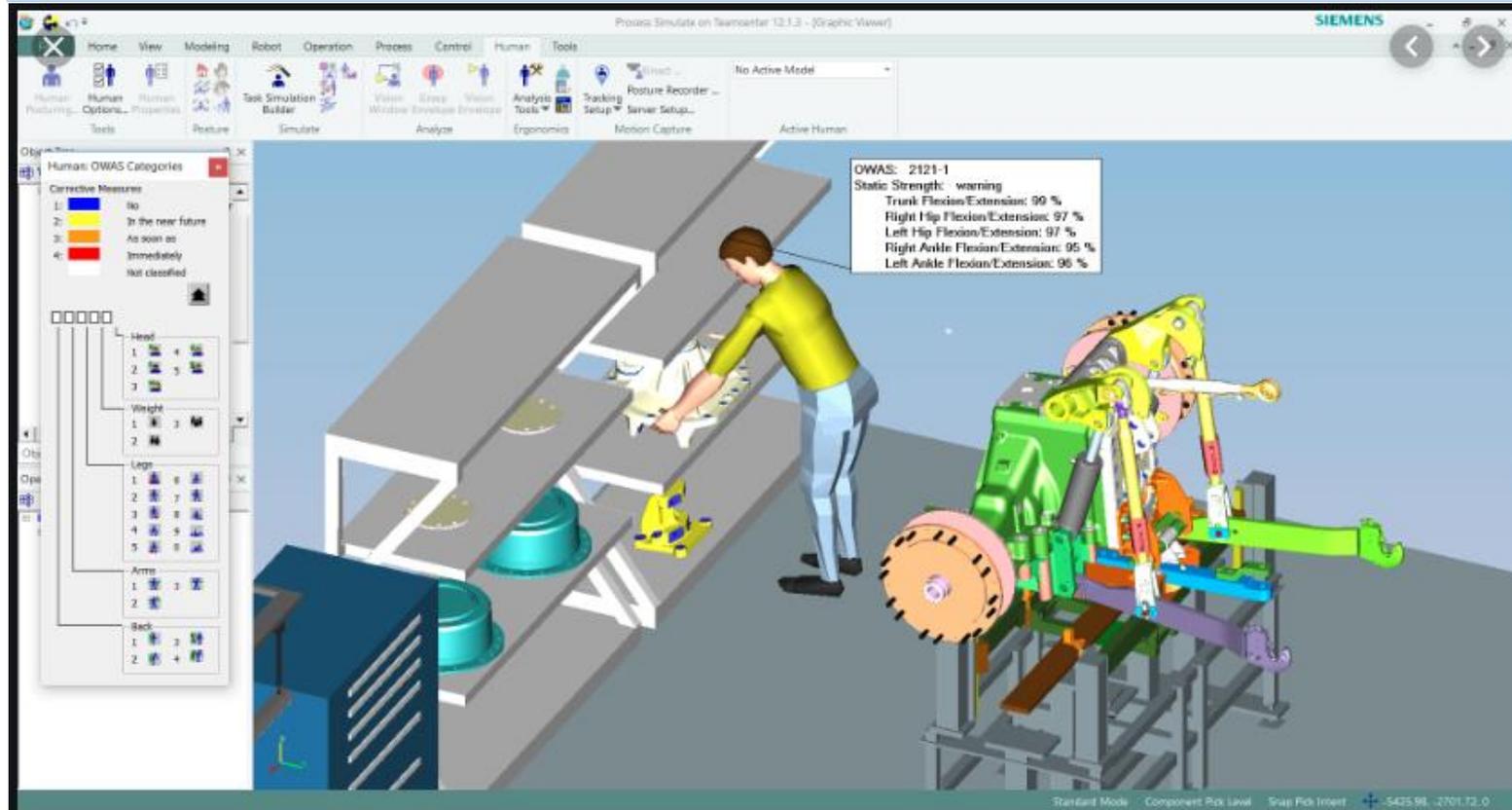


Credit: Network Encyclopedia

Blockchain



Credit: Alina Grubnyak on Unsplash, World Forum Economic





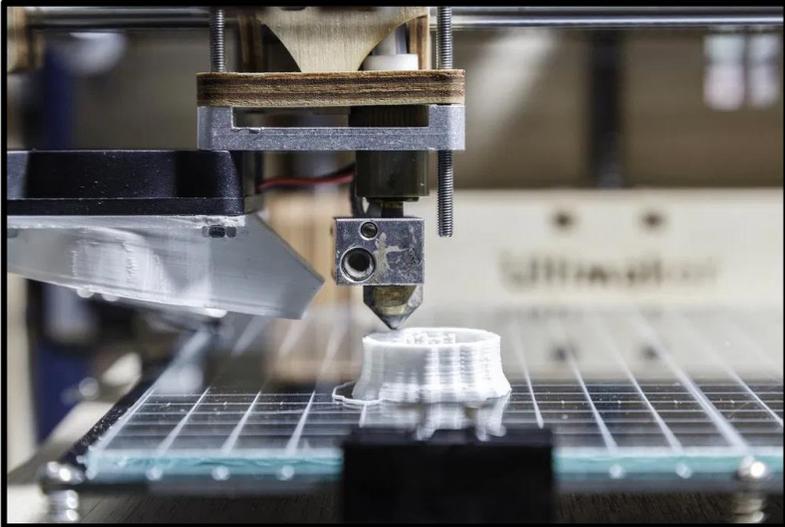
Credit: Adobe Stock

Co-funded by the
Erasmus+ Programme
of the European Union

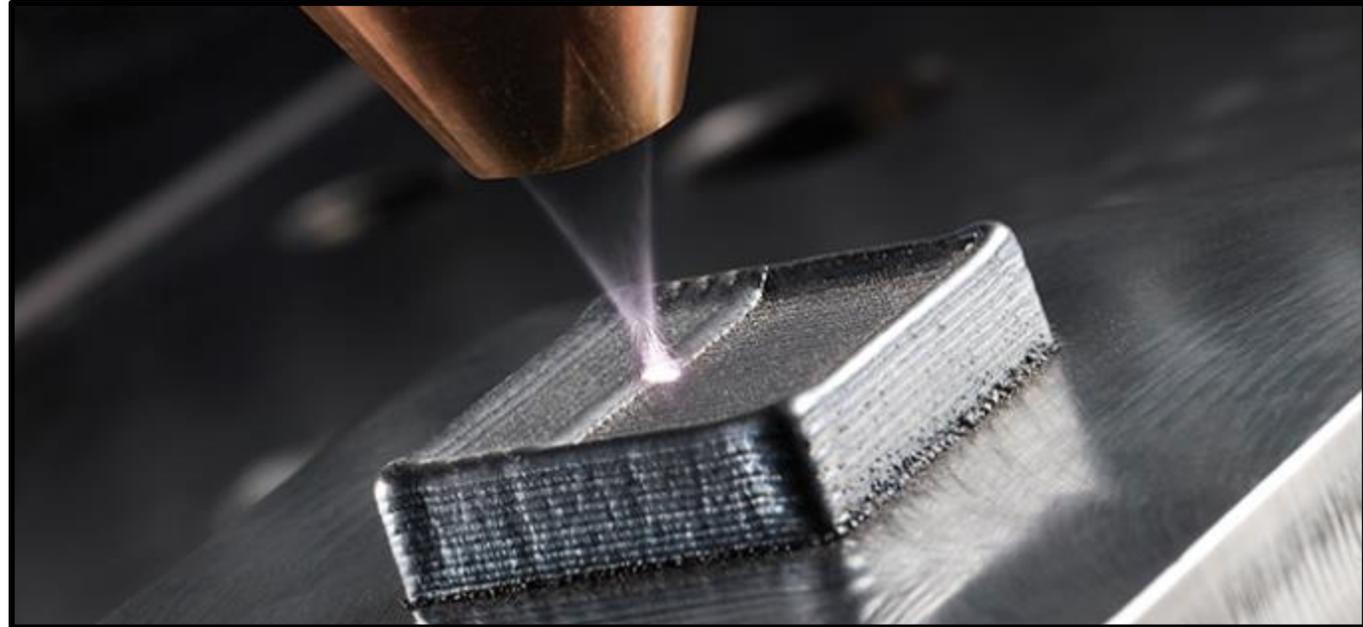




3D Printer (additive manufacturing)



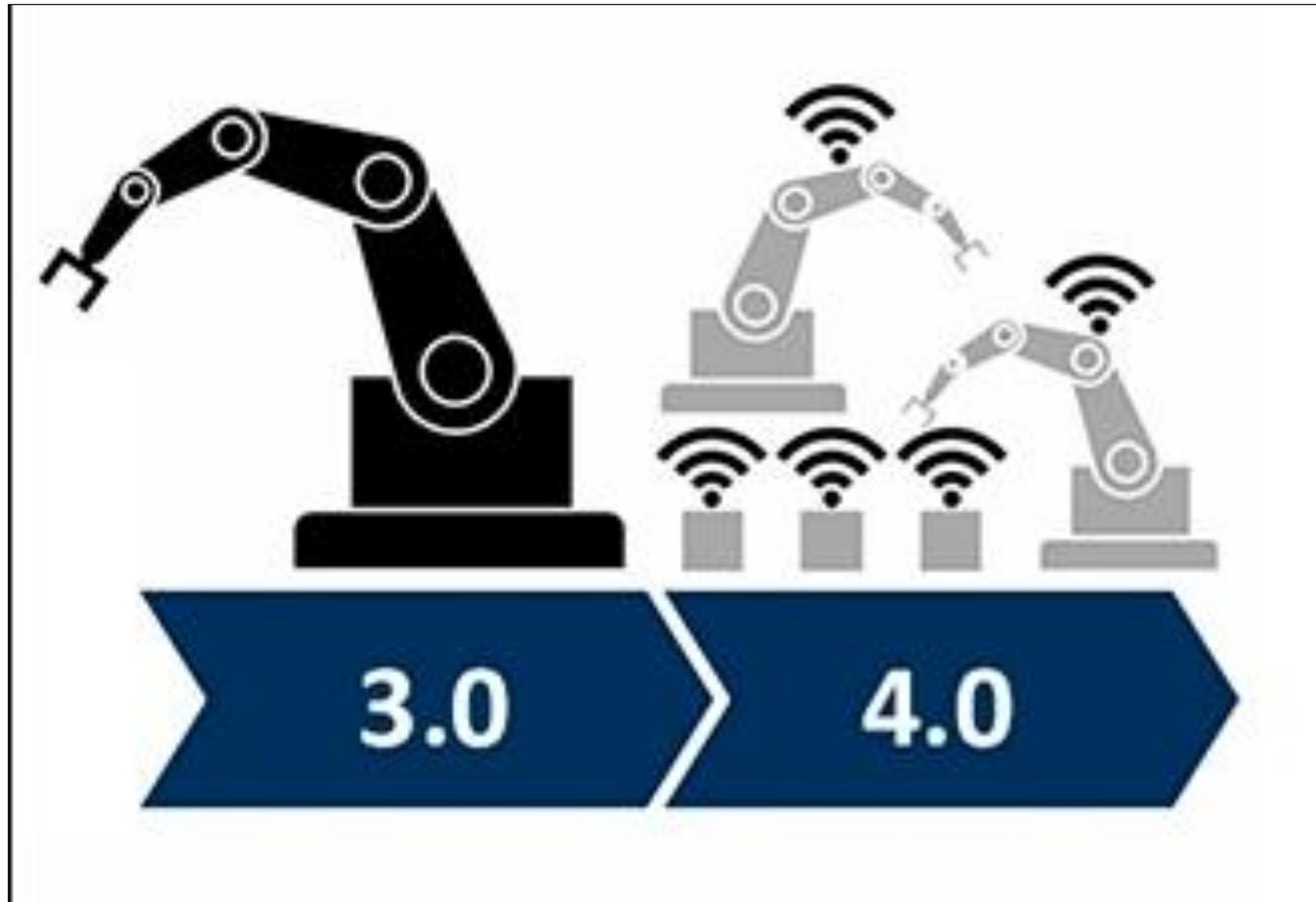
Credit: A Voz da Indústria



Credit: Manufatura em Foco

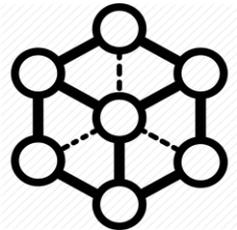


Autonomous systems

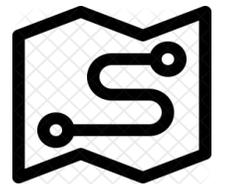




- **Readiness assessments** are evaluation and analysis tools that aim to determine the level of preparedness of an organization in terms of conditions, attitudes and resources.



- **Frameworks** are collections of procedures, methods and tools focused on the design of an organizational architecture or a system.

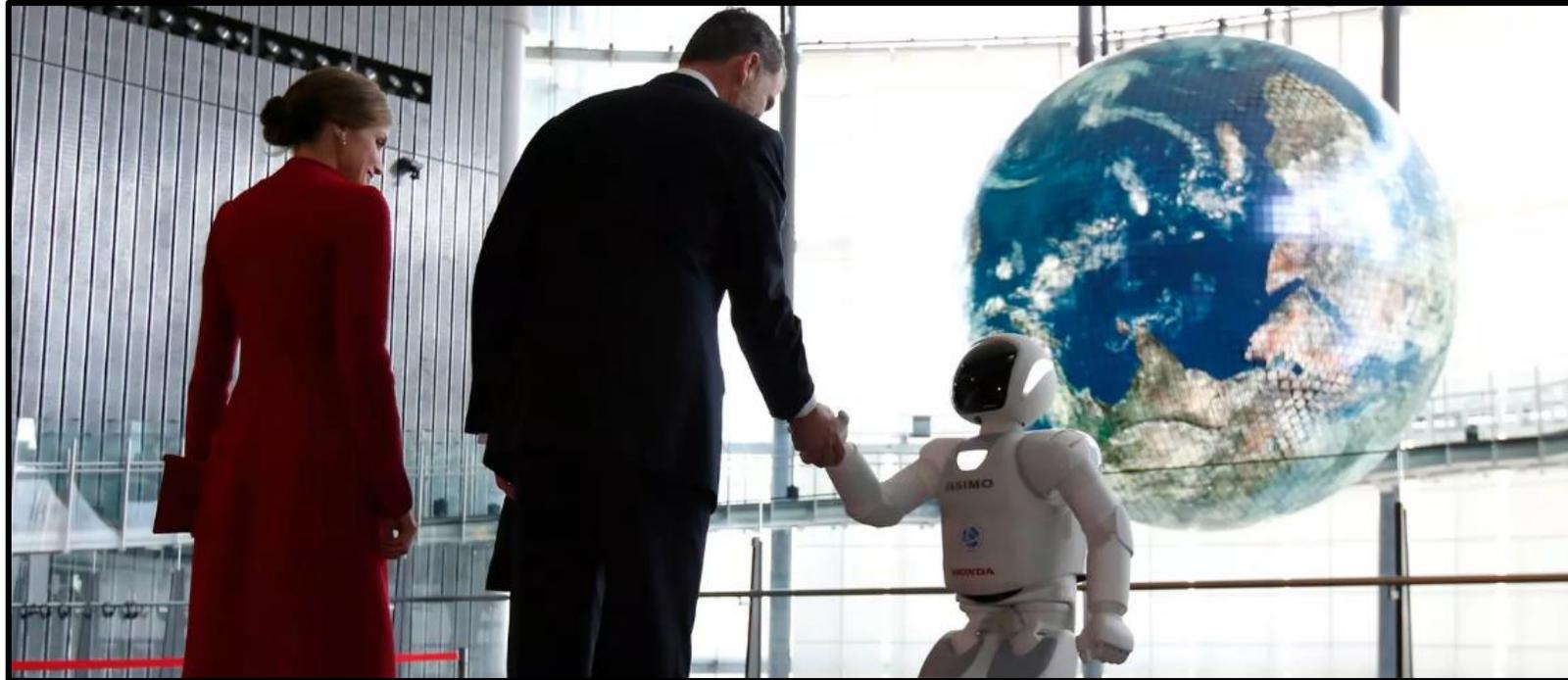


- **Roadmaps** are "plans that match short-term and long-term goals with specific technology solutions to help to meet those goals".

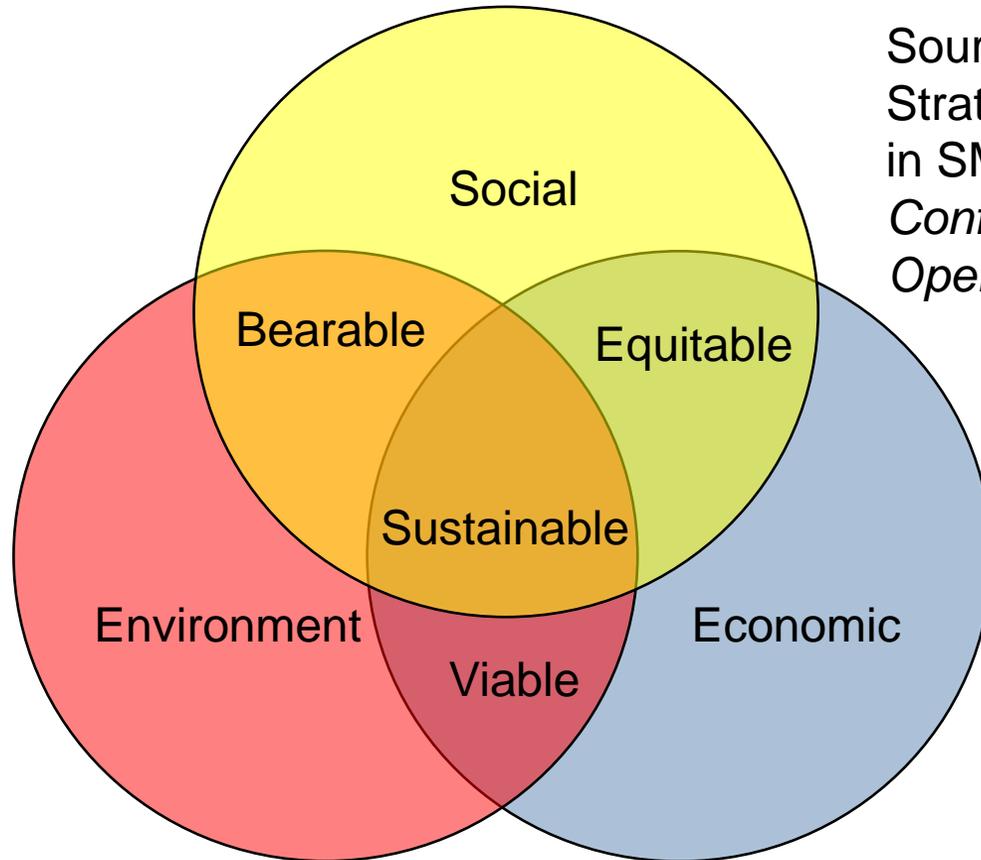


- **Maturity models** are models that help organizations achieve expected skills in specific dimensions such as culture, processes, resources, etc., through continuous improvement processes.

New Competences



Credit: REUTERS/Issei Kato, World Economic Forum



Source: Bakkari, M., & Khatory, A. (2017). Industry 4.0: Strategy for More Sustainable Industrial Development in SMEs. *Proceedings of the IEOM 7th International Conference on Industrial Engineering and Operations Management*, (Rabat, Morocco), 11–13.



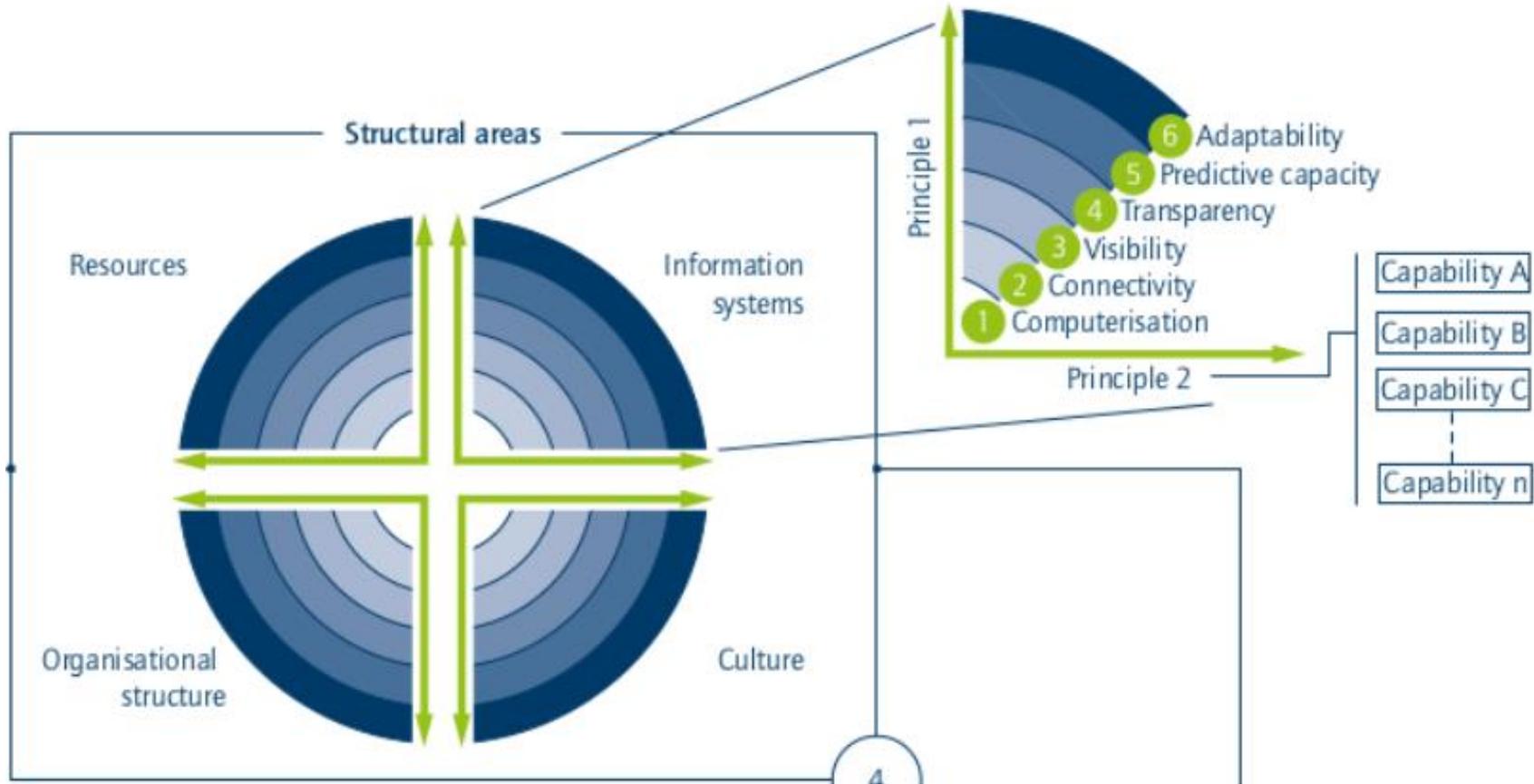
Industry 4.0 Attributes



- **Interoperability** or the ability to achieve results by different means, to perform the same functions, despite possible exchange of equipment and manufacturers.
- **Decentralization**, which corresponds to the ability to make decisions without dependence on a data processing center or a decision-making body of human resources.
- **Virtualization**, reproduction resource or simulation of the real world in virtual mode.
- **Modularity**, capacity for change, to make processes more comfortable and adherent depending on environmental configurations and the need for variations in product design.
- **Real-time** reaction through analysis of large volumes of data that allow the identification of profiles and even subtle changes in scenarios.
- **Orientation to services** made possible by the integration of processes, since they present themselves as adequate means to mediate the relationship of the consumer market with the companies, as an opportunity for improvements in the final use of the product.



Maturity index (Acatech)



Maturity levels (Acatech)

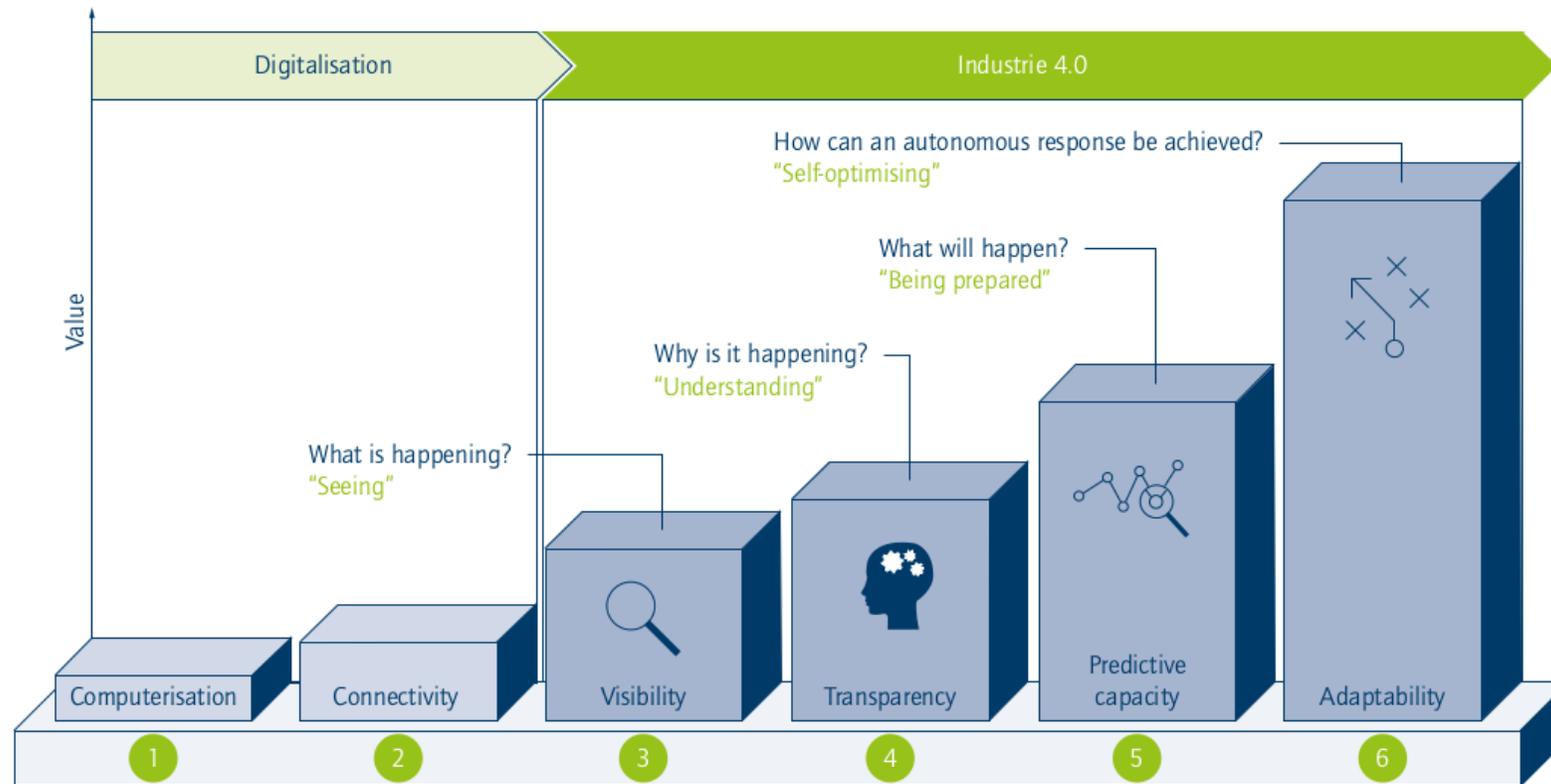


Figure 5: Stages in the Industrie 4.0 development path (source: FIR e. V. at RWTH Aachen University)



Maturity levels (Acatech)



- **Computerization** - use of information technology;
- **Connectivity** - integration of IT tools;
- **Visibility** - sensors allow processes to be monitored from end to end;
- **Transparency** - digital shadow indicates the current situation;
- **Predictive capacity** - ability to simulate scenarios;
- **Adaptability** - ability to adapt continuously.



- **Digital capability** - (1) digital skills (human resources), (2) automated data acquisition through sensors and actuators, (3) decentralized pre-processing of data collected in an automated way.
- **Structured communication** - (1) efficient communication, (2) design of (3) task-based interfaces.

- **Information processing** - (1) data analysis, (2) contextualised data delivery, (3) application-specific user interfaces, (4) resilient IT infrastructure.
- **Integration** - (1) horizontal and vertical integration, (2) governance, (3) data interface standards, (4) security.

- **Internal organization** - (1) flexible communities, (2) decision rights management, (3) motivational goal systems, (4) agile management.
- **Dynamic collaboration and value networking** - (1) focus on customer benefits, (2) network cooperation.

- **Social collaboration** - (1) democratic leadership style, (2) open communication, (3) confidentiality process and information systems.
- **Willingness to change** - (1) recognition of the value of errors, (2) openness to innovation, (3) knowledge database and decision-making, (4) continuous professional development, (5) change modelling.

- 1) Development of critical knowledge (Acatech model...)
- 2) Planning, project management - Canvas, Scrum, etc.
- 3) Development of items (questions) by dimensions foreseen in the Acatech model (each team is responsible for one dimension)
- 4) Application and validation t-test
- 5) Tabulation and diagnosis
- 6) Final presentation

- Identify theoretical milestones (critical knowledge)
- The constructs form the items (questions) and the items form the instrument (questionnaire)
- Example of construction: Business excellence
 - It is possible to develop a conceptual description of this expression, however, from this theoretical basis it is necessary to extract variables to measure it, for example, business excellence should be calculated by weighting the following indicators: market leadership (weight 10), growth (25), profitability (30), liquidity (15), indebtedness (10).

- Items should be structured (do not use images, projective techniques or creativity tests)
- Take care with divergent interpretations between the author of the test and the subject evaluated (validate by means of the "think aloud" technique)
- Ensuring matching one item - one task, and one task - one idea.
- Use a likert scale with 4 or 5 posts: I totally disagree, more I disagree than I agree, more I agree than disagree, I totally agree.

- Application in at least one company (ideally more than one)
- Public - directors, managers or supervisors
- Acatech model: 4 dimensions with 2 themes in each dimension and 2 to 6 sub-themes in each theme.
- Develop from one to two items for each sub-theme so that they total 10 items for each dimension.
- The composition of the questionnaire with 40 questions will be carried out by teachers Rui and Cristiano
- Each team must apply the full questionnaire.

MSE40

Co-funded by the
Erasmus+ Programme
of the European Union



Thank You



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