

Workshop



Collaboration in Industry 4.0: Human, Robot and Flexible Processes

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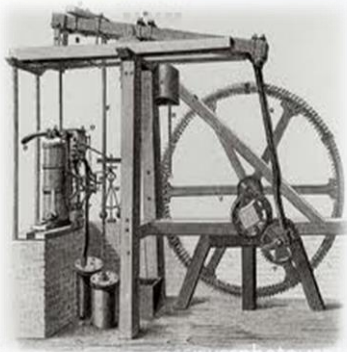
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The Long Path of Industry

From Industry 1.0 to Industry 4.0

First Industrial Revolution

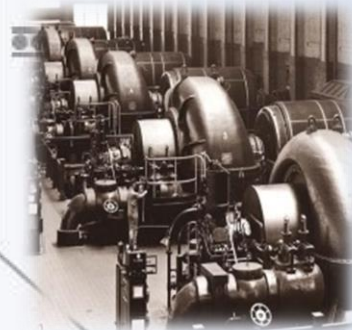
based on the introduction of mechanical production equipment driven by water and steam power



First mechanical loom, 1784

Second Industrial Revolution

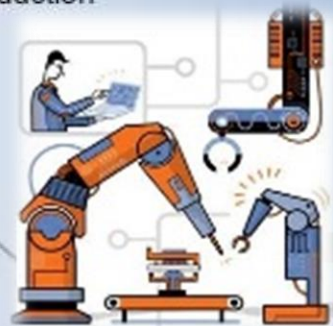
based on mass production achieved by division of labor concept and the use of electrical energy



First conveyor belt, Cincinnati slaughterhouse, 1870

Third Industrial Revolution

based on the use of electronics and IT to further automate production



First programmable logic controller (PLC) Modicon 084, 1969

Fourth Industrial Revolution

based on the use of cyber-physical systems



Degree of complexity



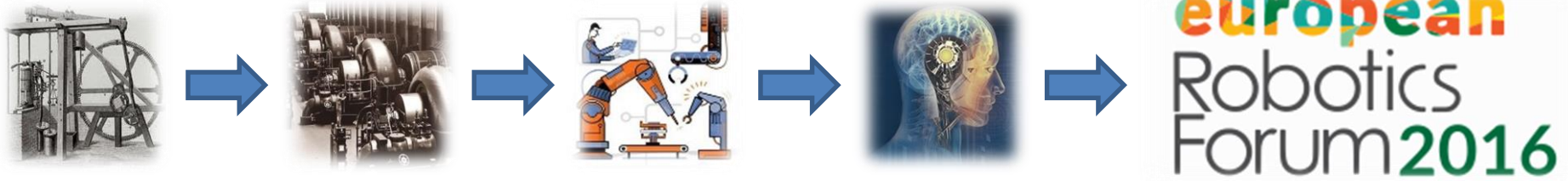
1800

1900

2000

Today

Time

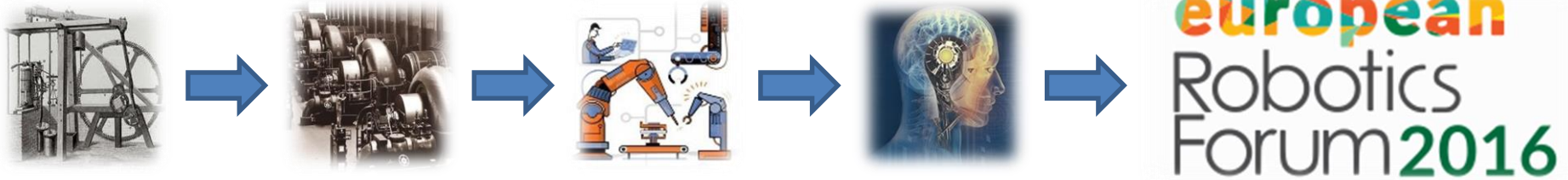


Introductory remarks...

- **Robotic technology** develops for better performance, richer interaction with the environment, precision and accuracy in human-like tasks too
- This process goes on regardless the use of these robots in an Industry 4.0 environment, but **Industry 4.0 has an influence and shall be taken into account by developers and designers** (it comes naturally for an overlap of means toward objectives)
- **I4.0 is built above these functions in the physical equipment.**

Kindly invited to fill in the session questionnaire:

<https://it.surveymonkey.com/r/JQCLMQZ>

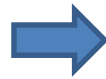
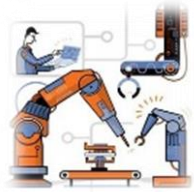
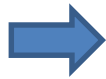
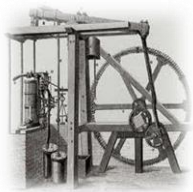


...some examples...

- 1. How an Industry 4.0-compliant approach influences the definition of the architecture and design and sensing and operation of:**
 - a. Manipulation means?
 - b. Arms and process robots?
 - c. Cells?
- 2. How information-flows may be extended and cover the humans involved:**
 - a. sensorize humans?
 - b. agents watching human doing and performance?
 - c. furthermore, not all info is accessible by external monitoring (mood, fatigue): use cognitive layers predicting human status?

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...discussion points!

Expectations of Industry 4.0:

- Robustness
- Autonomous
- Real time control
- Networked
- Safety
- Autonomous manufacturing and logistics
- New business models

Research issues

- Big data
- Cooperative control
- Ontologies
- Privacy protection
- Interoperability
- Emergency
- Recognition and interpretation of human behavior

System functions:

- Coordinated
- Monitored
- Integrated

Coupling of resources

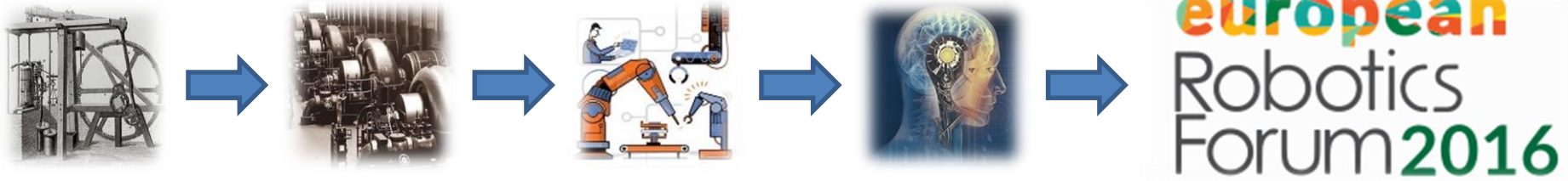
- Computational
- Physical

Robot system Architectural aspects affected

- Sensor units
- Actuator units
- Higher level control unit

Sensors do

- Collect data from physical processes
- Analyze and store data
- Network among themselves
- Connect to the other resources sensors



WorkShop Work Flow

Robots 4.0

Adaptive Grippers

Matteo Palpacelli, [UnivPM](#), (IT)

Dexterous Manipulators and Human Manipulation

Carlo Canali, [IIT](#), Genoa (IT)

Multi-Modal/Arms Cooperation

Dragoljub Surdilovic, [Fraunhofer IPK](#), (D)

Flexibility 4.0

Service Oriented Approach in Flexible Manufacturing

George Papanikolopoulos, [CASP](#), (EL)

Task Planning in Flexible Manufacturing

Sotiris Makris, [LMS-Uni Patras](#), (EL)

Open Dynamic Manufacturing Operating System in Flexible Manufacturing

Amit Eytan, [WePlus](#), (I)

Manufacturing 4.0

Cognitive Manufacturing

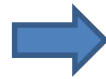
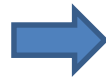
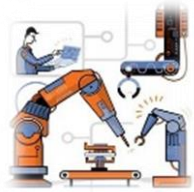
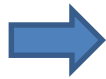
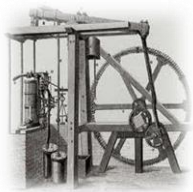
Vaclav Hlavac, [CVUT](#), (CHK)

Cooperative Manufacturing

Matteo Zoppi, [UNIGE](#) (I)

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- Industry 1.0 was the use of steam and electricity to replace human or animal power**
- Industry 2.0 was mass production as a means of exploiting economies of scale**
- Industry 3.0 was the use of computers to control individual machines & processes**
- Industry 4.0 is the ability to benefit from real-time connectivity via the internet**