The Teaching Factory Paradigm

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Introduction

Investment in education and training is essential to boost growth and competitiveness [1]

Skills development can

- determine the capacity to increase productivity
- trigger innovation
- move production up the value chain
- shape the future labor market

[1] European Commission, 2012, Rethinking Education: Investing in skills for better socio-economic outcomes, COM(2012) 669 final

Introduction

Talent-driven innovation is key for industry

- Talent-driven innovation is the major enabler of transforming research efforts into successful products and services
- Manufacturers worldwide keep ranking the quality and availability of highly skilled workers, as the most critical driver of global manufacturing competitiveness [2]

[2] Deloitte Touche Tohmatsu Limited and US Council on Competitiveness, 2016 Global Manufacturing Competitiveness Index

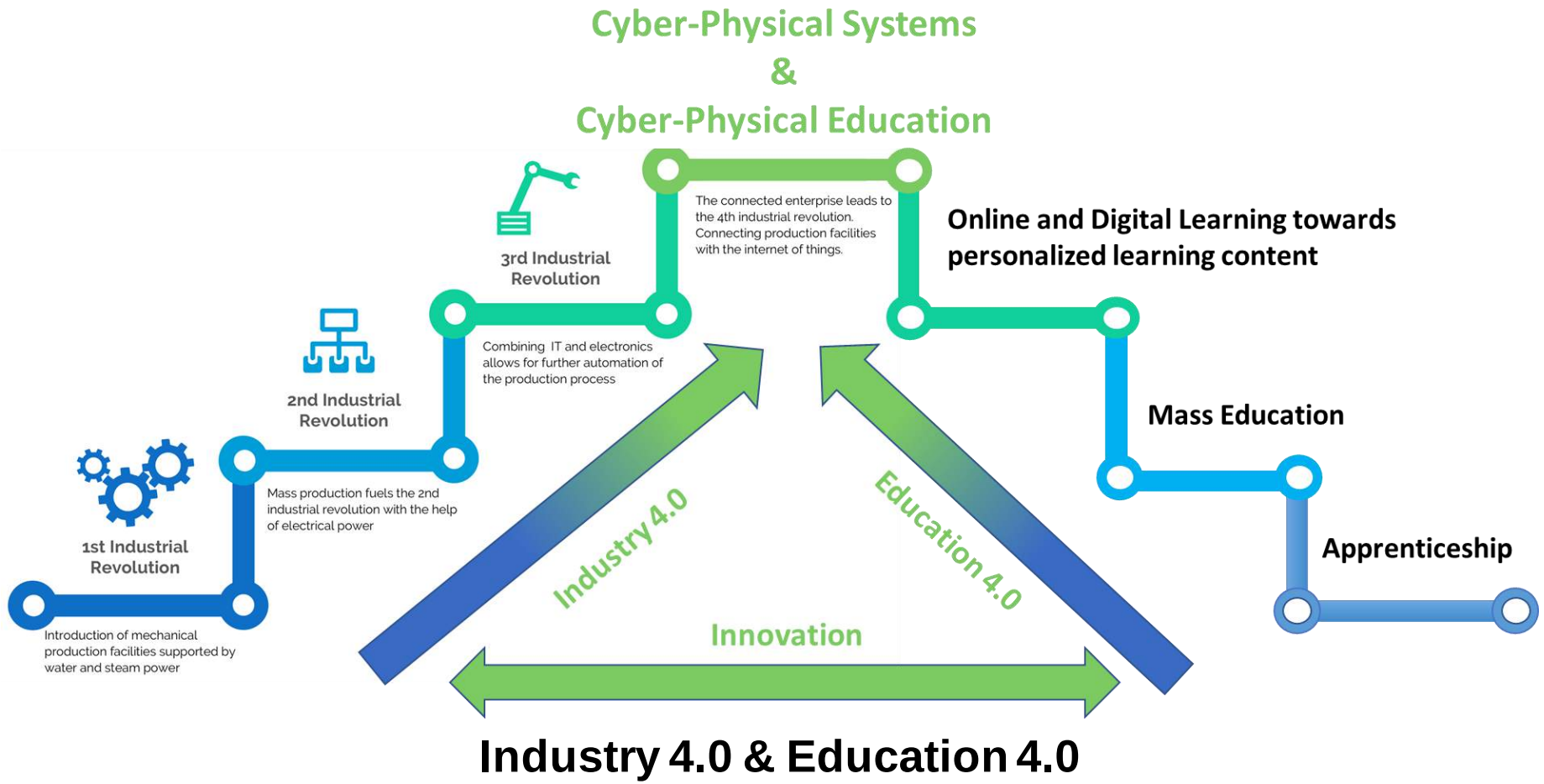
Introduction

Skill gaps and shortages hinder industry's innovation performance world-wide

- 38% (global average) of employers are nowadays facing difficulties in filling jobs [3].
- In the US, two million positions in the US manufacturing industry will likely go unfilled due to a lack of skilled workers over the next decade [4].
- Chief executives of some of Europe's largest manufacturers predicted a possible gap of 500,000 engineers by 2025 [5].

[3] ManpowerGroup Talent Shortage Survey 2015
[4] 2014 Skills Gap Study, Deloitte and The Manufacturing Institute
[5] Financial Times, 2013, Alarm over skills shortage in Europe

Introduction



Approach

Medical profession

connecting
education/training
with *real life*

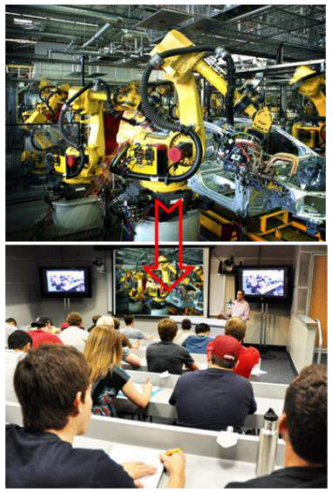
Manufacturing

Teaching Hospital ≈ **Teaching Factory**

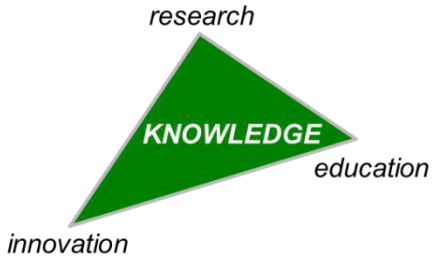
The concept of the **Teaching Factory** has its origins in the medical sciences discipline and specifically in the paradigm of the **Teaching Hospital**.

Approach

… integrating the real factory environment with the classroom …



… industrial practices to the classroom



The **Teaching Factory** as a 2-ways "learning channel" communicating

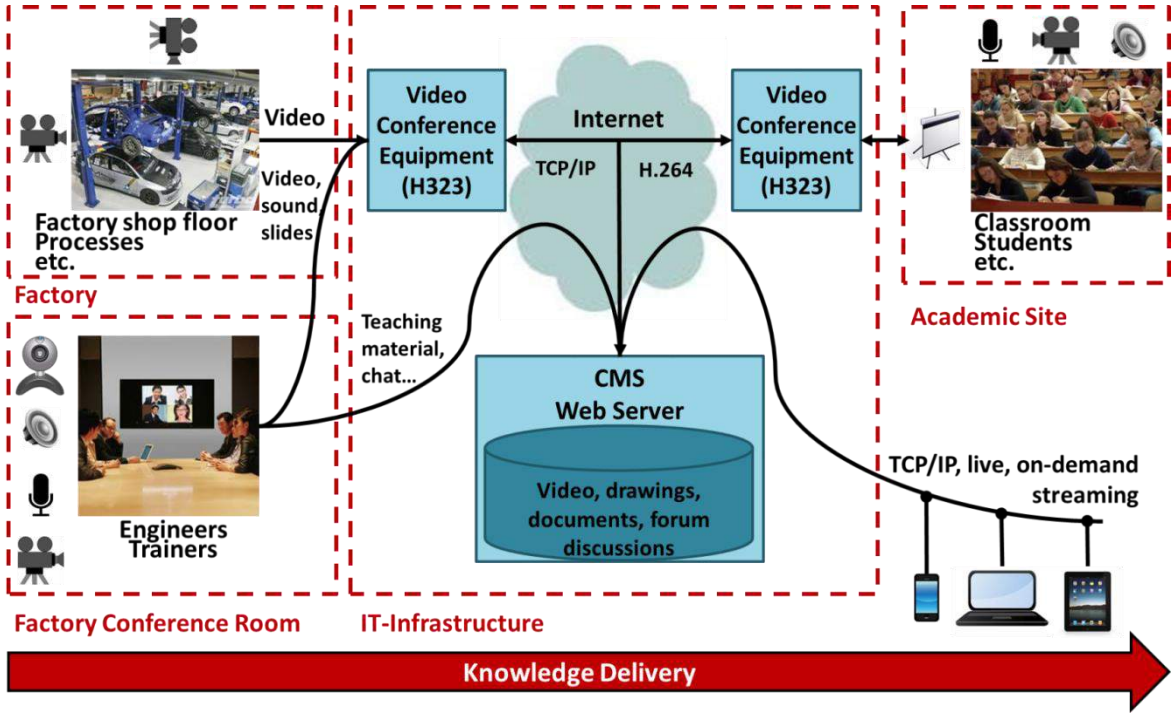
… "new" knowledge to the factory

Real life changes rapidly and so does industrial practice, i.e. manufacturing technology, industrial settings, engineering problems etc.

The **Teaching Factory** paradigm follows the developments by "bringing" the **real factory** to the **classroom** and the classroom to the real factory

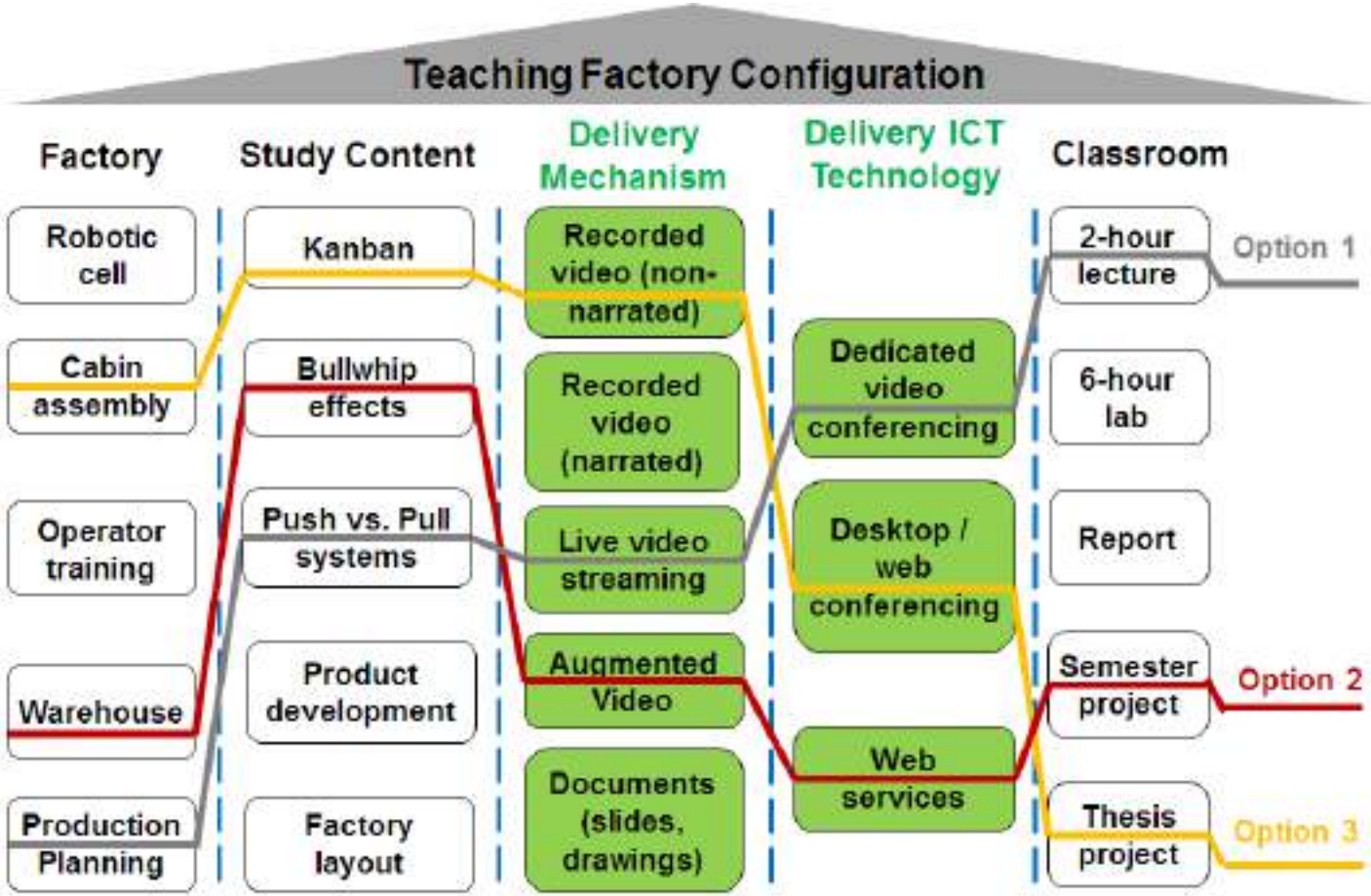
Approach

… using modern ICTs …



The Teaching Factory paradigm uses **advanced ICTs** and **high-grade industrial didactic equipment** to operate as a **non-geographically anchored learning "space"**

Approach



Configuration of a TF training scenario

Approach

Students watch an augmented video from a warehouse about how raw materials are handled

Engineers present, in a conference room, a welding operation, performed in real time at a robotic cell. Students are able to interact with the engineers from the classroom.

Asynchronous 1-to-1 session

Synchronous 1-to-many sessions

TF Pilot: Construction Equipment

Industry → *knowledge transfer* → **Academia**

Industrial problem:

- line balancing of a new production area
- planning of material kitting area

4 engineers of the industrial partner
20 LMS students
6 weeks (2h session per week)

TF Pilot: Construction Equipment

- ✓ In the framework of the course: **“Introduction to Manufacturing Technology”**
- ✓ **20** Mechanical Engineering Students (4 groups of 5 persons)
- ✓ **2nd** Year of their studies
- ✓ With the assistance of **4-5 Research Engineers** (e.g. provide details and the problem’s background, supporting the students)
- ✓ They provided an **understanding of the optimal configuration for the material feeding process** to be carried out.
- ✓ The students **identified bottlenecks and provided suggestions** to prevent such phenomena.

TF Pilot: Industrial Automation

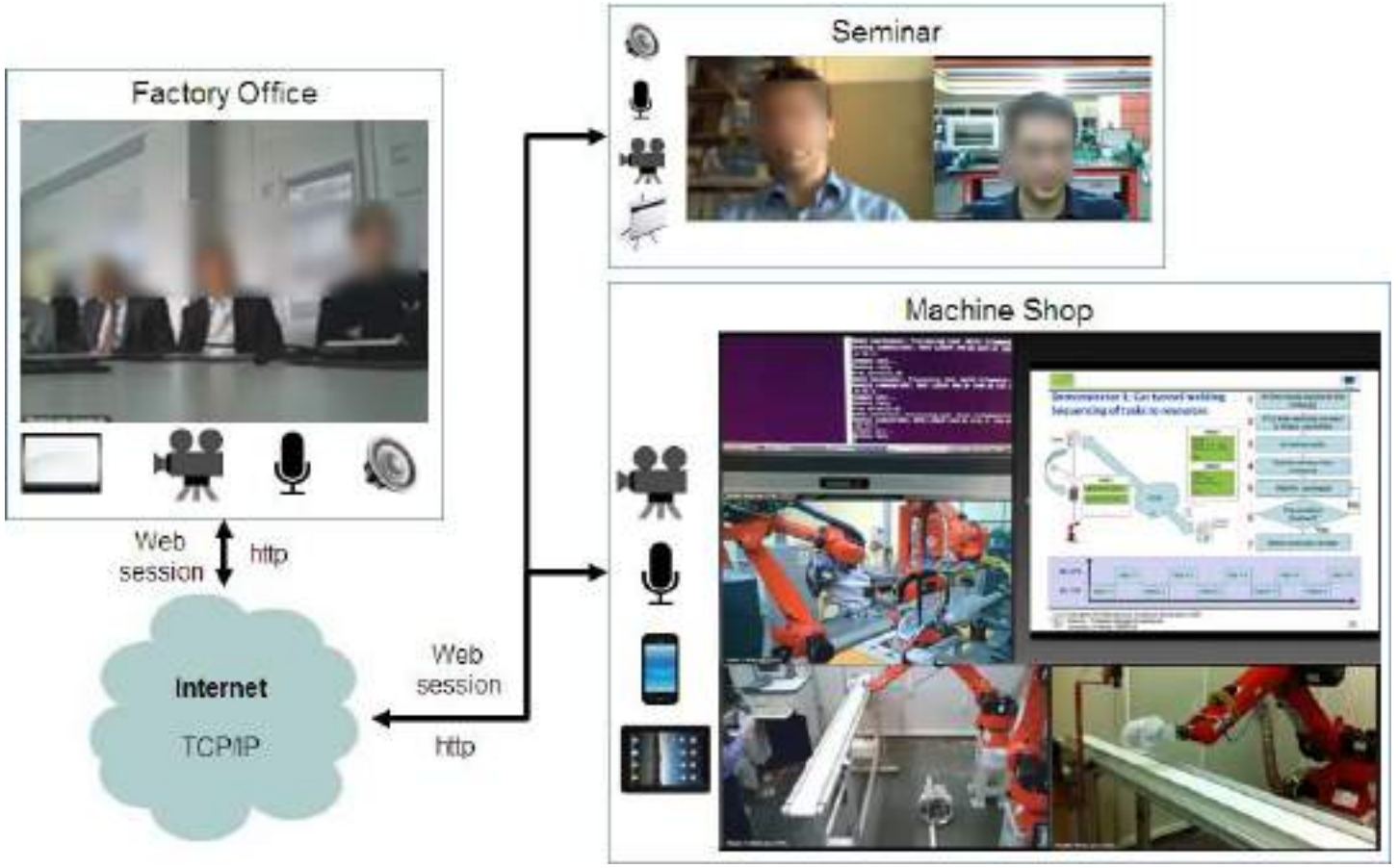
Industry ← *knowledge transfer* → Academia

Industrial problem:

- new integration and control architecture for industrial robots

5 engineers of the industrial partner
7 LMS research engineers
3 weeks (1h session per week)

TF Pilot: Industrial Automation

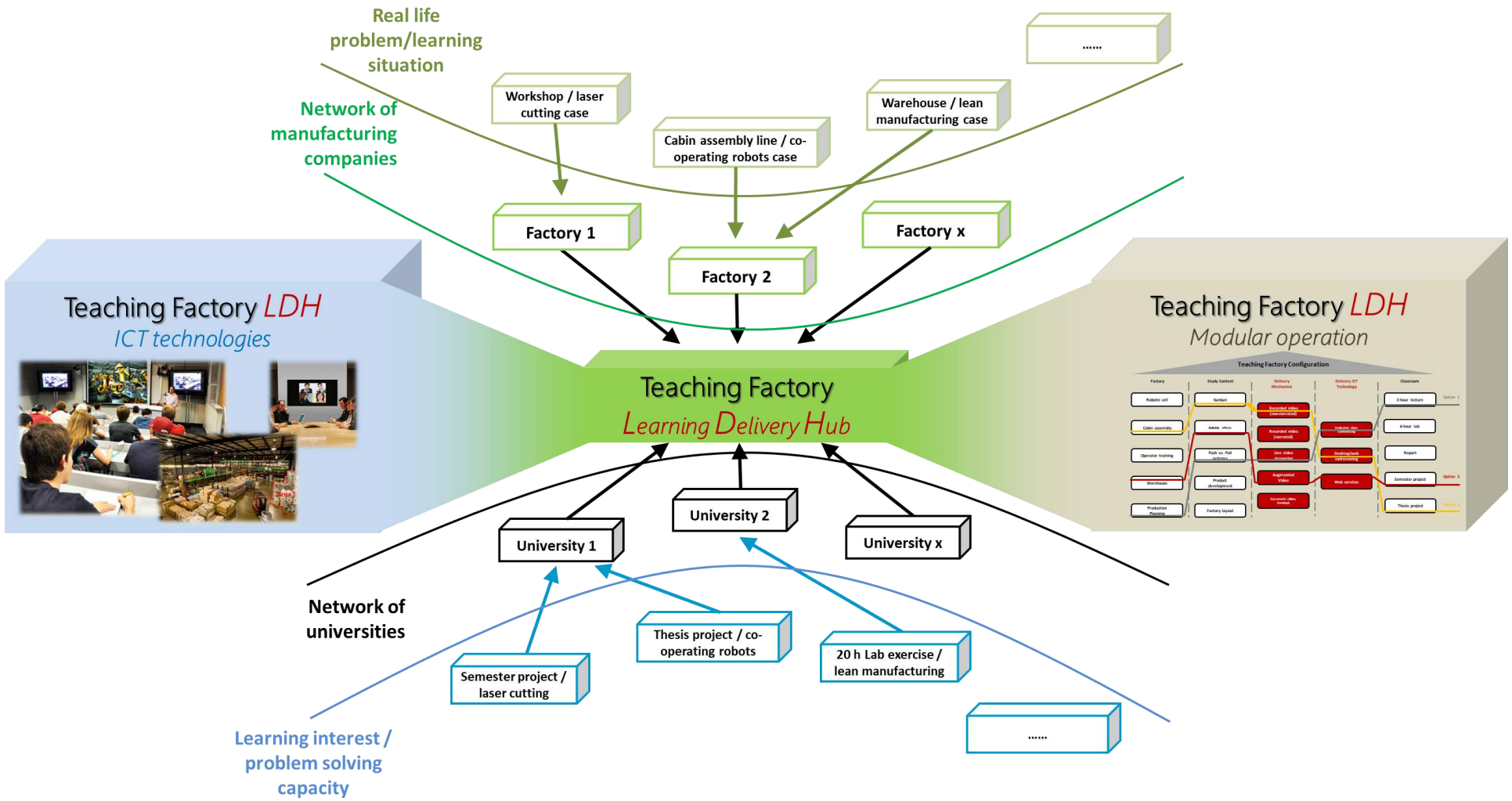


Engineers from industry watch the tasks carried out by the cooperating robotic cells, taking place at academia, through a simultaneous presentation of the services controlling the operation

Conclusions

- Skills have a **major impact on the economic growth of a society**, on the innovation process as well as on industry's competitiveness.
- The **Teaching Factory demonstrates high-degree of modularity** and can therefore be adapted to the needs of both the academia and industry.
- **Multiple, remotely located "factories" and "classrooms"** are envisioned.
- New technologies and manufacturing concepts can be **exchanged**.
- Use of the Teaching Factory concept can encourage **entrepreneurship** in universities and **innovation** within companies, through **shared projects** between academia and industry.
- The Teaching Factory can also be used to **train suppliers/subcontractors** of OEMs, in cooperation with academia.

Outlook: The Teaching Factory Network



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References

- Chryssolouris, G. (2006): Education for next generation manufacturing, Keynote Paper, IMS Vision Forum, 12-13 April 2006, Seoul, Korea.
- D. Mavrikios, K. Georgoulias, G. Chryssolouris, "The Teaching Factory Paradigm: Developments and Outlook", KEYNOTE, 8th Conference on Learning Factories, (CLF2018), 12-13 April, Patras, Greece, pp. 1-6, (2018)
- Chryssolouris, G., Mavrikios, D., Rentzos, L. (2016): The Teaching Factory: A Manufacturing Education Paradigm. In: Procedia CIRP Keynote paper of the 49th CIRP Conference on Manufacturing Systems (CIRP-CMS 2016).
- Chryssolouris, G.; Mavrikios, D.; Papakostas, N.; Mourtzis, D.; Michalos, M.; Georgoulias, K. (2008): Digital manufacturing: history, perspectives, and outlook. Proceedings of the Insitution of Mechanical Engineers Part B. In Journal of Engineering Manufacture 222 (5), pp. 451–462.
- Chryssolouris, G., Mourtzis, D. (2008): Challenges for Manufacturing Education. Proceedings of CIMEC 2008, CIRP International Manufacturing Engineering Education Conference, Nantes, France, October 2008.
- Chryssolouris, G.; Mavrikios, D.; Papakostas, N.; Mourtzis D. (2006): Education in Manufacturing Technology & Science. A view on Future Challenges & Goals. Inaugural Keynote. In Proceedings of the International Conference on Manufacturing Science and Technology (ICOMAST 2006), Melaka, Malaysia.
- Chryssolouris, George; Mavrikios, D.; Mourtzis, D. (2013): Manufacturing Systems - Skills & Competencies for the Future. In 46th CIRP Conference on Manufacturing Systems. Procedia CIRP 7, pp. 17–24.
- Mavrikios, D.; Papakostas, N.; Mourtzis, D.; Chryssolouris, G. (2013): On industrial learning and training for the factories of the future: a conceptual, cognitive and technology framework. In: J Intell Manuf 24 (3), pp. 473–485. DOI: 10.1007/s10845-011-0590-9.
- Rentzos, L.; Doukas, M.; Mavrikios, D.; Mourtzis, D.; Chryssolouris, G. (2014): Integrating Manufacturing Education with Industrial Practice using Teaching Factory Paradigm: A Construction Equipment Application. In: Open-Access Journal Procedia CIRP, 47th CIRP Conference on Manufacturing Systems, Volume 17, pp. 189-194.
- Rentzos, L.; Mavrikios, D.; Chryssolouris, G. (2015): A Two-way Knowledge Interaction in Manufacturing Education: The Teaching Factory. In: 5th Conference on Learning Factories, Procedia CIRP 32, pp. 31–35. DOI: 10.1016/j.procir.2015.02.082.

- AUTORECON Project, Funded by the EU under the FoF.NMP.2011-2 theme, http://www.autorecon.eu
- Know4Car Project, Funded by EU under the FoF-ICT-2011.7.4 theme, http://www.know4car.eu
- KNOWFACT Project, Funded by EU under the EAC-19-2011-067, , http://www.knowfact-project.eu
- ROBO-PARTNER Project, Funded by the EU under the FoF.NMP.2013-7 theme, http://www.robo-partner.eu