I4.0LAB @IMIM - The teaching factory lab for the new manufacturing

Candidates:

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Teaching initiative description:

1. Description and objectives

Context

Since 2016, the Industry4.0Lab at the School of Management of Politecnico di Milano is an initiative promoted and developed by the Manufacturing Group in the Department of Economics, Management and Industrial Engineering of the School of Management of Politecnico di Milano. The main objective is to promote a multidisciplinary vision of production environments through the realization of a "teaching factory" for educational and research purposes. MSc students from Management Engineering, Mechanical Engineering and Automation Engineering are working in the Lab for their Master thesis definition andl PhD students use it for their research activities. Also, the Lab is used for research purposes within EU funded projects like PERFORM; MAYA; PSYMBIOSYS; BEinCPPS; L4MS; MIDIH; Fenix; and other national and regional projects.

The core of the Lab is constituted by the fully automated assembly and manufacturing line with a robotic cell with a high precision 7 axis articulated robot. The high flexibility of the system and the modularity of the configuration allows to test and replicate virtually any variety of manufacturing/assembly system for discrete manufacturing. The configuration of the system can be quickly and reshaped with ad hoc modelling and simulation tools. Each work station is controlled by an individual logic and services can be instantiated on each component/phase both for operational and for energy (electricity and air) consumption. An RFID and QRCode infrastructure allow to track and trace the production (single component or pallet).

As far as the use of the Lab for teaching purposes, this document describes the first initiative that was actually developed. In particular, the Lab was used for delivering three modules within the course on Integrated Operations & Supply Chain Planning for the International Master in Industrial Management (www.imimprogramme.org) (Edition 14, 2017-2019).

The International Master in Industrial Management (IMIM) is a multi-site Master Programme, designed to provide students with primarily scientific or engineering based educational backgrounds with essential business and managerial skills, relevant to pursuing careers in internationally orientated manufacturing and servicing industries. The IMIM Programme is offered by five leading Universities in Europe, among which Politecnico di Milano (POLIMI).

The purpose of the course on Integrated Operations & Supply Chain Planning is to provide the students the basic knowledge to manufacturing systems and to the production management principles. The main addressed topics are: manufacturing systems configuration, production planning and control process, medium and short-term production planning, inventory management, operations scheduling.

Objectives and description of the initiative

The initiative herein described aimed at using the Industry 4.0 Lab as a teaching environment to enable students to understand and connect the theory they learnt during the course with the potentialities given by the new technologies under the Industry 4.0 paradigm.

In detail, as a first step, a frontal lecture was given to complement the course content with topics connected with Industry 4.0 including Smart Manufacturing Technology Enablers, Interoperability, Innovative Control Architectures and smart technologies. The objective of the lecture was to make the students aware of the Industry 4.0 trend and what it does entail for manufacturing systems management.

Secondly, two parallel modules were delivered to the students (divided into two smaller groups of 15-20 people each). In this case, the lecture was held at the Laboratory premise. After a brief presentation of the Lab and of its components and installed technologies, the main type of data that can be collected thanks to the existing I4.0 technologies in the Lab were enlisted. Based on that, the students were called to group in small teams (5-6 people each). Each group was asked to discuss together and prepare a short presentation in which they should discuss how the data that are collected through the I4.0 technologies installed in the Lab could be used to improve traditional Production planning and control processes that they studied during the course. In particular, each group work on one specific process, i.e. scheduling, inventory management, aggregated planning.

Finally, each group was asked to present to the rest of the class their work. Comments from the audience as well as feedback from the professor were collected stimulating further discussion on the potentialities of the new industrial revolution for production management.

2. Excellence

The main innovative and significant issues of the initiative were about the use of a tangible physical entity, the I4.0 lab, where the teaching activity on innovative manufacturing management and planning approaches can be carried out in conjunction with a practical implementation in a "real-like" environment. The initiative allowed the students to get in contact with a real manufacturing system (at a small scale) and actually understand the new technologies such as sensors by visualizing them and looking them working.

3. Effectiveness

The students welcomed the initiative with lot of enthusiasm since it fitted very well with the program topics by providing a real-like environment that allowed them to really understand topics that are usually delivered through theoretical frontal lectures. Comments collected by MIP as evaluation of the teaching by the students reveal that the students appreciated the activity done in the Lab and this led to consider this activity to have priority on the traditional class about Industry 4.0 topics.

4. Results

Overall, 50 students were taught through the initiatives and the reaching of the learning objectives could be assessed thanks to the presentations that each group did at the end of the class. Collected students' evaluations (44 out of 50) give the modules an average mark of 4,1 out of 5.

5. Materials

Find attached the following material at this link:
https://www.dropbox.com/sh/bwe02y5fhta8dua/AADpHmQ3aX_cpbmpUo8hNm1Ta?dl=0

1. Lectures slides
2. Students evaluation report
3. Curriculum vitae of candidates