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A novel approach for teaching IT tools within Learning Factories

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Abstract

Universities around the world are developing strategies to include into their curricula trend topics from Industry 4.0, such as Cyber Physical Systems, robotics, process virtualization and advanced IT tools. However, at the state of the art in literature there is few evidence for educational environments in which all these components are fully integrated. SMALL Factory, an ongoing project in Politecnico di Torino, aims to develop an integrated learning factory based on the technologies triggering the fourth industrial revolution. Beside the transfer of technological skills, the laboratory allows the on field training of students in the use of open source IT tools such as PLM and ERP systems. The present paper aims to present the teaching methodology proposed within the SMALL Factory framework. The ultimate aim of this project is to replace the traditional software teaching, based on tutorials and simple case studies, with a learning by doing, integrated approach, in order to provide students with a comprehensive perspective of a modern manufacturing environment and to train their mindset to be responsive.

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Keywords: Industry 4.0; CPS; IT tools; PLM; ERP

1. Introduction

The development of the Smart Factory (SF) is a critical concept in the reindustrialisation of Europe. The most industrialized countries are funding national and international programs to promote the integration of the Industry 4.0 enabling technologies within the manufacturing environments. In Fig. 1, a map highlighting the most active countries, around the world (a) and in Europe (b), and the relative programs is shown.

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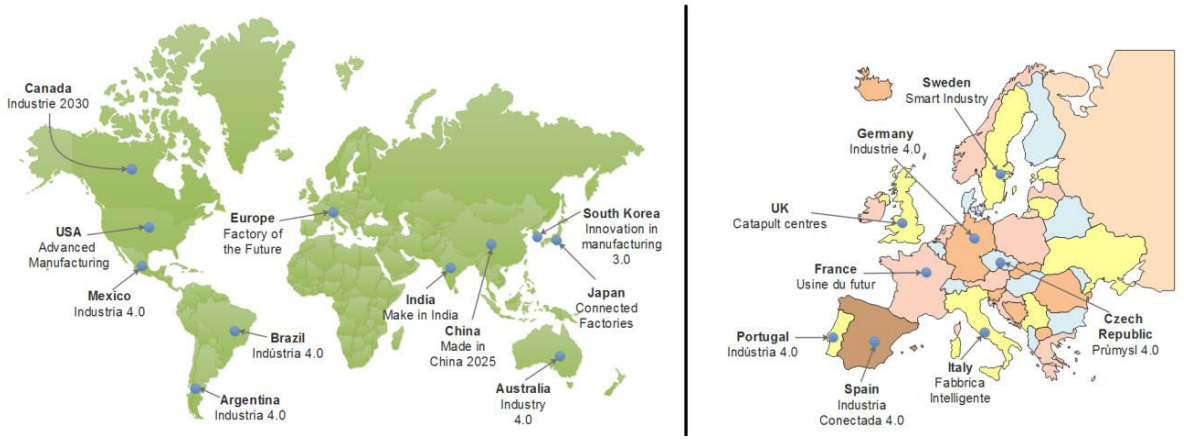

Fig. 1. a) SF around the world b) In Europe.

The SF spread will significantly affect job definition in industry. Today, the staff of a company can be classified in two categories: “white” and “blue” collars. Usually, engineers are asked to be proficient in one domain, and to have some basic knowledge in the other areas, due to the traditional organization culture with clear labor division. However, a new figure, commonly named “grey” collar, is arising: it consists in workers that combine practical skills with technical and intellectual capabilities [1]. Therefore, new engineers will be required to master several technologies to develop their job, including IT tools, manufacturing and automation.

To satisfy this industrial need, education programs must be updated. This need has also been highlighted in a European research [2], which states that the lack of skilled engineers is already restraining companies from generating more business. Recently, universities started to made huge investments to develop and deploy smart factory laboratories. Besides the technological aspects, IT tools play a critical role in the execution of processes and they are vital for any company. Among these tools, some of the most popular are: Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Computer Aided Engineering (CAE), Product Lifecycle Management (PLM), Enterprise Resource Planning (ERP), Manufacturing Execution Systems (MES) and Discrete Event Simulation (DES). However, at the state of the art in literature there is few evidence for educational environments in which these tools are fully integrated.

The present paper aims to extend the state of the art by describing the activities of the *SMALL Factory* laboratory, developed in Politecnico di Torino. Namely, the focus of this paper is the integrated approach used to teach IT tools, with particular concern for PLM and ERP systems.

The rest of the paper is organized as follows. The state of the art in training laboratories on Industry 4.0 is presented in section 2. In sections 3 and 4, the SMALL Factory project is introduced and one of the manufactured products is presented. In section 5, the approach to teach PLM is presented; the methodology used to train students to ERP systems is described in section 6. Finally, in section 7 conclusive remarks and future development plans are discussed.

2. State of the art

In the last years, several universities around the world implemented Learning Factories (LF). In Germany, a consortium led by the University of Kaiserslautern created the SmartFactory^{KL}: it is a hybrid production facility that has been built as a demonstration and development platform for the production of colored liquid soap [3]. Bochum University created a learning factory that comprises a holistic model of a producing company, from the ERP level – Top Floor – to the Field Level – Shop Floor [4]. Their main objective is the on-field training of students that are already working with SMEs. However, the kind of product is not specified. The Process Learning Factory CiP (Center for industrial Productivity) from Darmstadt University fabricates a pneumatic cylinder and a gear motor [5]; lean