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How will change the future engineers' skills in the Industry 4.0 framework? A questionnaire survey

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Abstract

Industry 4.0 represents one of the most challenging themes for engineering design and also for engineering education. At this moment there are few studies in the field of engineering teaching that aim to investigate how the educational needs of students and of the industrial workforce are changing. On this basis, this research would like to investigate which are the necessary skills and expertise young engineers require to be ready for the Industry 4.0 framework. In particular, a questionnaire was developed to analyze this situation. It has been administered to students enrolled in the first and second year of the engineering undergraduate degrees held in three Italian universities: Brescia, Udine and Cassino. During two different academics years, a total of 463 students participated to the survey. The questions were aimed to investigate some key issues of Industry 4.0, and the students' digital belief and behaviors at their entrance in the university education system. The collected answers provided a picture of the actual situation in these three universities with some relevant considerations about engineering education. So, the fundamental question that authors want to answer is "Are the Italian engineering students effectively ready for Industry 4.0 or do we still work on it?"

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1. Introduction and background

The rise of new digital industrial technologies and the diffusion of the Industry 4.0 framework have also led academia to be interested in possible changes that could involve the academic education of young people in general and, the learning of technical and engineering topics in particular [1,2]. Today's students will work and will deal with an increasingly globalized, automatized, virtualized, networked and flexible world. They will compete for employment on a global market. This way, new competences and skills will become more important [1]. In fact, the adoption of Industry 4.0 technologies will allow manufacturers to create new jobs, to meet the needs introduced by the growth of the existing markets, and to introduce new products and services [3].

Given these premises, the goal of this work is twofold, first to investigate what effectively are the skills required by the digital transformation of Industry 4.0, and secondly, they want to know if a change of direction in the higher education is really needed. At this moment, the fundamental question is "Are our engineering students and educators effectively ready for the Industry 4.0 framework?". In the following paragraphs the result of an online questionnaire with engineering students are reported.

1.1. Industry 4.0 framework and the nine pillars

Industry 4.0 is formerly known as the fourth industrial revolution, a revolution based on the use of Cyber-Physical Systems - CPS [4]. In this framework several changes have to be expected for the industrial world such as the introduction of novel business opportunities and models, and novel service-based, real-time enabled CPS platforms with the arise of new social infrastructure for the workplaces. The shared vision about the Industry 4.0 framework considers the massive use of smart networked systems and IoT. This way, the focus of Industry 4.0 is to create smart products, procedures and processes. Thus, smart factories constitute the key feature of this framework. In particular, they are capable of managing complexity, are less prone to disruption and are able to manufacture goods more efficiently [4]. In the smart factory, human beings, machines and resources communicate with each other as naturally as in a social network. Smart products know the details of how they were manufactured and how they are intended to be used as they actively support the manufacturing process. Consequently, Industry 4.0 should be implemented in an interdisciplinary manner and in close cooperation with the other key areas and using different technologies drivers. These are formerly known as the nine pillars of the technological advancement, and they comprise the following technologies: Big Data; Autonomous Robots; Simulation; Universal System Integration; Industrial IoT; Cybersecurity; Cloud Computing; Additive Manufacturing and Augmented Reality [5]. On the other hand, training and continuing professional development represent other fundamental key factors for achieving the Industry 4.0 objectives as they will significantly transform job and skills profiles of the workers. As a consequence, the partnerships between businesses/factories and higher education institutions will be even more important in the future. It will be important to open up access to science and engineering studies and place greater emphasis on transferable skills and skill assessment. There are already several initiatives to bridge this gap of new knowledge and skills between the academic and industrial worlds. Two interesting examples are represented by the "Academy Cube" initiative [4,6] and the European Commission "eSkills for Jobs 2016" initiative [7].

At this point, it is also important to have a look at what kind of skills can be provided in an engineering academic context and those that will be most useful with the advent of Industry 4.0. Usually, the specific and teachable scientific and technical abilities, that can be defined and measured and, that are related to the specific education one has received, constituted the hard skills. For example, typical hard skills of a mechanical engineer are represented by numerical and higher mathematical knowledge; problem solving, creativity and design skills; investigative and experimental skills, information processing, computer programming, and knowledge of specific software tools [8]. Moreover, a mechanical engineer should have other particular hard skills, including a strong understanding of industry standards, and comfort working with computers, because much time is spent designing, simulating, and testing products and/or processes. By contrast, soft skills are less tangible but not less important. Again, with reference to mechanical engineering, important soft skills are represented by strong analytical thinking,