Chapter 1

New Perspectives on Industrial Engineering Education

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ABSTRACT

The widespread deployment of inexpensive sensors, processors, embedded systems, etc., as well as the latest advances in data storage, analytics, cloud, etc. triggered significant changes in industrial engineering. This chapter aims to examine the adoption of the internet of things (IoT) in industry and the challenges for higher education. In this respect, the authors tried to explain the relationship between major concepts: IoT and industrial internet of things (IIoT). At the same time, they focused on the presentation of some IIoT enablers that could be viewed as building blocks for IIoT higher education curricula. In order to ensure the required qualifications and to develop the necessary skills for current employees, management staff, and students, academic engineering programs must undergo important changes. Some of these changes are also discussed in this chapter. Nevertheless, since there are so many uncertainties that lie between today and the future, higher education programs need to keep up with the latest technological tendencies.

INTRODUCTION

In recent years, the rapid evolution of information and communications technologies involved many changes in various fields, including industrial engineering. Thus, the widespread deployment of inexpensive processors, embedded systems, smart sensors, wireless sensor networks, but also the advances in data storage, analytics, cloud infrastructure, etc., enabled the rise of a new digital industrial wave, referred as the fourth industrial revolution (IR 4.0). And the biggest technological initiative for implementing this revolution is the Industrial Internet of Things (IIoT), considered at the heart of the 4th industrial revolution, according to various worldwide surveys. The adoption of IIoT could have a huge impact. Thus, Accenture estimates the Industrial Internet of Things (IIoT) could add $14.2 trillion to the

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global economy by 2030 (Daugherty & Berthon, 2015). According to a McKinsey report (Manyika et al., 2015), this revolution is well under way, anticipating that by 2025, the percentage of factories adopting IIoT will reach 65%-90% in advanced economies and 50%-70% in developing economies. Several scientific papers and studies have focused their attention on this new paradigm, examining, among others, the multiple promised benefits, but also the demands and challenges encountered in developing it. In addition to the technological barriers, the uptake of the Internet of Things paradigm in industrial field is delayed by the so-called skills gap. Thus, one key to success would be the qualification and human resource development in the near future. Researchers estimate that, as former industrial revolutions, IR 4.0 will not only influence the industry itself, but also the labor market, by creating new jobs, and also causing the displacement of some existing ones. For example, the World Economic Forum, considering 15 important developed and emerging economies, anticipated the production of 2.1 million new jobs, offset by the elimination of 7.1 million jobs (WEF, 2016). According to an analysis from Deloitte (Giffi et al., 2015), over the next decade, there will be 3.5 million job openings in manufacturing, but only enough skilled labor to fill less than half of them. In order to reduce the skills gap, education is essential. Over the years, throughout the world, education in engineering has undergone important changes. But, in order to ensure the required qualifications and to develop the necessary skills for workforce, management and students as future workforce in the fourth industrial revolution, the education system must also evolve from Education 3.0 to Education 4.0. Also, in the future, companies will have to pay more attention to developing the skills of their employees, by re-training or further training on new technologies.

This chapter aims to examine the adoption of the Internet of Things in industry and the requirements for higher education. Currently, the pictures of the Internet of Things, Industrial Internet of Things and Industry 4.0 are still quite blurry. Although IoT, IIoT and Industry 4.0 are closely related concepts, they cannot be used interchangeably. In an attempt to understand these concepts, this chapter tries to clarify them. These concepts do not have precise and widely accepted definitions. The literature in the field proposes several definitions, some of them presented in this chapter. We also consider the related fields, such as big data, artificial intelligence, security technology, etc. Standardization plays an important role for the further development and spread of IIoT and we can assert that various standards regarding security communication, identification and others are used in IIoT. An IIoT platform is a future looking framework that offers various capabilities, essential to enabling the successful adoption of the Industrial Internet of Things. Some of the most important platforms are presented in this chapter. IIoT applications are being developed and/or deployed in various industries, including manufacturing, logistics, energy production, construction, mining, supply, transportation, etc., to name just a few. In fact, all enabling technologies and related fields could be viewed as building blocks for IIoT education, that have to be included in the higher education curricula. Traditional industrial engineering models are changing, as traditional industrial processes are being supplemented and optimized by the digital world. Higher education must adapt to the new ways in which people, machines, services and data can interact. Based on the trends so far, experts predict that in the context of IR 4.0, profound changes are needed in the major aspects of education, from content to delivery. To this extent, this chapter examines some problems and possible solutions. Thus, for example, in order to meet the changing requirements and to respond to the increased demand for a highly skilled workforce, in the future, new effective educational programmes will have to be developed and/or the existing academic programmes will have to be re-structured.

In this chapter, we use IIoT-HE as a shorthand to refer to a transformation journey that higher education institutions have to make in order to meet the needs of the IIoT.
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