Proceedings CLME2017/VCEM
8º Congresso Luso-Moçambicano de Engenharia / V Congresso de Engenharia de Moçambique
Maputo, 4-8 Setembro 2017; Ed: J.F. Silva Gomes *et al*.; Publ: INEGI/FEUP (2017)

ARTIGO REF: 6728

ENGINEERING EDUCATION EFFORTS TO SUPPORT INDUSTRY 4.0

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ABSTRACT

Industry 4.0 [Kagermann et al., 2013] is a German initiative aiming to promote the digitization of manufacturing towards the smart factories of the future, and seen worldwide as the fourth industrial revolution. The first industrial revolution was related to the introduction of mechanical production equipment driven by water and steam power, the second one based on industrial organization (i.e. mass production) and the use of electrical energy, and the third one based on the introduction of electronics and IT to automate the production and machinery. Similarly to the third industrial revolution, the fourth one relates mainly to apply ICT technologies, essentially based on the use of Cyber-Physical Systems (CPS).

CPS [Leitão et al., 2016] are distributed smart systems, with cyber and physical counterparts networked to form a large system. These distributed and intelligent entities are able to sense, reason and act, being the overall system behaviour emerged from the interaction among them. CPS involve a multidisciplinary area with electronics, mechanics, computer science and networks playing an important role. Indeed, as stated by the McKinsey report [Bauer, 2015], the complete digitization of the manufacturing sector will require the use of several disruptive technologies, namely Big data, Internet of things (IoT) and cloud computing to support the data computational power and connectivity, advanced data analysis algorithms for the analytics and intelligence, augmented reality for the human-machine interfaces, and additive manufacturing and advanced robotics for the digital-to-physical conversion.

The success of Industry 4.0 strongly depends on the skills and competences that engineers can have in the different dimensions of this multidisciplinary vision. Note that many jobs that are now crucial to implement this vision, such as Big data analyst and cloud services specialist, didn't exist 10 years ago. This leads to several pertinent questions, namely, are they prepared with the required knowledge and skills to respond to challenges and expectations of industry when implementing the Industry 4.0 vision, how do they acquire their multidisciplinary knowledge and skills, and lastly, can the current education system, e.g. universities and vocational training centres, meet this challenge.

Having this in mind, the new generation of engineers in this area needs to integrate multidisciplinary and cross-domain knowledge, focusing more on understanding the system of systems perspective than being an expert on a deeply topic domain of knowledge. In particular, and as previously referred, new engineers, working in Industry 4.0 field, have to cope with new paradigms and concepts (e.g., modelling, simulation, semantics, interoperability and self-organization) and emergent technologies (e.g., IoT, Big data and advanced data analytics). Additionally, in the CPS context, the engineers are not anymore dealing only with the physical counterpart (i.e. hardware), but instead and predominantly with the cyber counterpart of complex engineering systems, which requires an integrative learning process and a continuous learning update since the acquired knowledge quickly becomes obsolete.

Thus, the challenge is to develop and design new vocational and academic training programs that focuses this multidisciplinary specialization, which apparently is contradictory: on one hand to have understanding over a wide plethora of topics and technologies, which can be provided by Bachelor and Master programs, and on the other hand to have short term learning and training programs on specific topics that provide specialization.

Examples of these innovative short-term academic learning programs are the Erasmus Intensive programme on Robotic Systems and the Summer School on Industrial Agents in Automation. The major innovation of the first project is the establishment of a learning course, with the duration of 60 presential hours, that provides global insight knowledge on robotic systems, and particularly significant hands-on experience in this field. This is accomplished in an international framework where the complementary and multidisciplinary knowledge and expertise from six European High-level Education Institutions from five countries are possible. Furthermore, the inter-disciplinary nature leads to an innovative environment that allows the exchange of different expertise and learning practices aligned with the Bologna process. The second example focuses a more specialized topic, aiming to enhance the participants' knowledge in the field of Multi-Agent Systems applied to industrial environments, being able to gain a range of theoretical and practical skills necessary to develop real industrial agent based applications [Leitão et al., 2016]. The topics were lectured by well-known international researchers, with a duration of 28 hours. In both cases, the feedback from the participants related to the overall evaluation of the courses was very positive, and particularly they were very much satisfied with the duration of the courses, which reinforces the benefits of having this kind of learning programs concentrated in a short period.

At another level, the on-going Erasmus+ DA.RE (Data Science Pathways to Re-imagine Education) project aims the pioneer development of a new blend mixed education program, actuating as catalyser for the design and deployment of new educational programs, at national, European and international levels, in the data science field. The project aims to contribute in reforming of teaching, bridging the usual gap between Higher-Education Institutions and the business and industrial sectors. The widespread involvement and deep commitment of small, medium and large companies, along with tech-intensive companies in designing educational paths and creating standards for the assessment of their quality will have a great impact on the alignment between said paths and market requirements, generating highly qualified Data Scientists professionals.

REFERENCES

[1]-Kagermann, H., Wahlster, W., Helbig, J. Securing the Future of German Manufacturing Industry: Recommendations for Implementing the Strategic Initiative INDUSTRIE 4.0, ACATECH - German National Academy of Science and Engineering (2013).

[2]-Leitão, P., Colombo, A.W., Karnouskos, S., Industrial Automation based on Cyber-Physical Systems Technologies: Prototype Implementations and Challenges, Computers in Industry, 81 (2016), 11-25.

[4]-Bauer, H., Baur, C., Camplone, G., et. al., Industry 4.0: How to Navigate Digitization of the Manufacturing Sector, McKinsey Digital (2015).

[5]-Leitão, P., *et al*., Summer School on Intelligent Agents in Automation: a Hands-on Educational Experience on Deploying Industrial Agents, Proc. of the 42nd Annual Conference of the IEEE Industrial Electronics Society, (2016) 6602-6607.