Available online at www.sciencedirect.com

ScienceDirect

Procedia Manufacturing 23 (2018) 57–62

Procedia MANUFACTURING

www.elsevier.com/locate/procedia

8th Conference on Learning Factories 2018 - Advanced Engineering Education & Training for Manufacturing Innovation

Holistic approach for teaching IT skills in a production environment

Christian Block[a]*; Dieter Kreimeier[a]; Bernd Kuhlenkötter[a]

[a]*Ruhr-Universität Bochum, Chair of Production Systems (LPS), Universitätsstraße 150, 44801 Bochum, Germany.*

Abstract

Increasing digitalization of manufacturing leads to new competence requirements for mechanical engineers. In recent years, learning factories have proven to be the ideal learning concept for acquiring skills. However, the teaching of IT skills is missing in the current training courses. Therefore, this paper will present a holistic approach in form of a learning factory module, starting from the conception and development right up to the operation of a Cyber-Physical-Systems (CPS) in the production environment. Within the training module, the participants will have to develop a Cyber-Physical-Production-System (CPPS) for an assembly line. The participants are trained how to select the hardware and software components for a modular, decentralized and transferable solution in four consecutive learning units. In each unit, the selected technologies will be combined to a web-technology-based prototype, which is then tested in the real world environment of the LPS-learning factory.

Peer-review under responsibility of the scientific committee of the 8th Conference on Learning Factories 2018 - Advanced Engineering Education & Training for Manufacturing Innovation.

Keywords: Digital Competence; IT Skills; Cyber Physical Production System; Web Technology

1. Introduction

Digitization is the megatrend of recent years. In Germany the digitization efforts have been summarized under the term “Industrie 4.0”, which is strongly promoted by the Federal Government since 2013. Industrie 4.0 integrates many different perspectives in companies. [1] The product becomes a Cyber-Physical-System (CPS) and the production system becomes a Cyber-Physical-Production-System (CPPS). In addition, processes and workflows as well as the previous business models are changing. [2] Everything gets a computing unit and is networked to reach the traditional

* Corresponding author. Tel.: +49-(0)234-32-26298; fax: +49-(0)234-32-06298.
E-mail address: block@lps.rub.de

2351-9789
Peer-review under responsibility of the scientific committee of the 8th Conference on Learning Factories 2018 - Advanced Engineering Education & Training for Manufacturing Innovation.
10.1016/j.promfg.2018.03.161

aims. The goals of maximizing the transparency of processes, increasing flexibility and increasing productivity while reducing costs and resources shall be reached by using digital tools. The path to Industrie 4.0 is defined and many new concepts and technologies from research have already been put into operation, but employees with required skills are missing.

According to a study by the institute for SME (small and medium sized enterprises) in Bonn [3] SME represent 99.7% of all companies in Germany in 2009. However, SME are only rudimentarily prepared for the changing conditions. This is also proven by the study from [4]. The companies have historically grown expertise and the employees seldom have the necessary competences to implement digitization in their companies. There is a lack of digital skills, especially IT skills. Smaller companies are thus less prepared for the digital change process then the global player. In addition to all digitization efforts, the human being with its flexibility and decision-making ability remains in focus in Industrie 4.0 and keeps staying an important element in production systems. Therefore, employees have to be trained in the use of new technologies but also to be able to implement digitization projects as well as to carry out own implementations or customizations. For this purpose, the article shows a holistic approach from the pure digitization of data acquisition to visualization and data usage up to a full IT integration with simple and cheap hardware. In order to train new techniques with a direct relevance to reality, learning factories (LF) have proven to be an excellent training environment in recent years. Therefore, this new approach is bundled in a new module of the LF at the chair of production system (LPS) in Bochum.

The paper is structured as followed. Chapter two presents an overview of the current situation of LF. This leads to the motivation for the new approach and the specific aim of the new learning module, which is described in chapter four. Finally, the concept is summarized and an outlook for integration with other approaches is given.

2. Current state of learning factories

In preliminary work for the new learning module, a review of current LF was done. The currently available learning approaches were examined to see if these enable the learner to implement digitization concepts. As a differentiation to other LF the definition of [5] was used, which represents after [6] the complete consideration. According to [5] a LF must include manufacturing *processes* with technical and organizational aspects, the *setting* must present a physical value chain, which creates a physical *product***.** And all is capsuled in a *didactical concept*. Additionally, the *purpose* of a LF can be teaching, training or research. These are the main purposes so that a LF can be an experimental or validation environment. [6] The results from [7], [8] and [6] show the diversity of LF. Besides the LF at schools and universities, LF become very popular in the industry (e. g. LF at BMW or Chrysler; compare [6]). It was analyzed how digitization was integrated. As mentioned in [5] the review also results in a general clustering into two groups the teaching-oriented LF in contrast to installation or rather test environments. Like [6] mentions, the current teaching-oriented LF can be clustered in the following categories: LF for production process improvement; LF for reconfigurability, production and factory layout planning; LF for energy and resource efficiency; Applied teaching factory concept; LF for sustainability; LF for product emergence processes; LF for logistics optimization; LF for management and organization; LF for business administration; LF for automation technology. The research results show that digitization aspects are not focused on LF with teaching (excluding research) purpose in detail. In literature to LF e. g. in the proceedings to the "CIRP Conference on Learning Factories" Industrie 4.0 or digitization as a core technology are called for the first time in 2015 (e. g. [9] or [10]). In addition, LF concepts since then are pure research objects or showcases for digitization. New technologies are adopted for new learning scenarios, but only teaching the research results in use is focused and not the development of own creative solutions. The current purposes in digitization are the demonstration of new potentials (e. g. [11] or [12]) or the use of new information and communications technology (ICT) as delivery mechanisms (e. g. [13]).

3. Motivation and purpose of the new learning scenario

The review of the present status exposes that there is a lack of student and industrial training that focuses on base technologies, general concepts, development and implementation in the field of digitization. Teaching how CPS work in general or how they can be handled is not enough. Current LF trainings focus on the application of new concepts, technologies and solutions. Sensors, data-processing and visualization are assumed as given. The previous steps for