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Learning Factory for Industry 4.0 to provide future skills beyond technical training

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Abstract

The paper will describe the design of a learning factory for Industry 4.0 that addresses the growing demand for future skills of production staff. Existing learning factories often focus on the technical skills whereas this learning factory also trains decision making, group work and performance monitoring skills. The paper refers to the existing categorizes of learning factories and unveils its numerous features. The conceptual design includes theoretical and practical parts, which prove to be successful in a German learning factory that was realized by the authors. Especially, for the industry 4.0 environment, the layout consists of three stages of a production system, from manual to automatized manufacturing. The practical tasks cover the introduction of smart devices, connection of information flows as well as monitoring of performance. The didactical design of the training program provides a sustainable approach by not only realizing training courses but also includes preparation with management, mid-term coaching and success monitoring after the training. The learning factory is a part of a whole research institute for intelligent manufacturing in China including consultancy and application support. One of the underlying goals of the learning factory is to enable production staff for change management, decision making and innovation.

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1. Introduction

In the last 30 years, there are three fundamental phases from CIM via lean to industry 4.0 with different training needs in each phase. The first phase, CIM – computer integrated manufacturing, emphasizes automation and information flow. The focus was on the introduction of computers on shop floor level connected with CAD and ERP systems. The second phase, the “Lean wave”, brought organizational design and segmentation of factory structures into the focus. After Womack and Jones’ analytical book “The machine that changed the world” in 1990, they discovered “lean thinking” in 1996. This changed training contents from methods and tools to additionally mind set and behaviour [13], [14].

For the third phase, industry 4.0, the focus lies on the digitization in the industry [6]. The “Plattform Industrie 4.0” for example identified a lot of potentials and challenges which are all a part of the five fields of action: horizontal integration, digital end-to-end engineering, vertical integration, new social infrastructures and cyber-physical production systems. Additionally, they pointed out the following demands as the scope for qualification [8]:

- Digital learning techniques
- Job-related qualification
- Lead and operate production systems
- Interdisciplinary product and process development
- Specific industry 4.0 competencies
- Competency evaluation

These demands and challenges show the importance of qualification and human resource development in the near future. It makes clear that industry 4.0 is more than just technology. The human resource could be probably even more important in times of industry 4.0. These demands are transferred into the training scheme of the industry 4.0 learning factory of the authors. The learning factory should cover the following three categories of skills:

- Technical skills, e.g. install and operate IT devices: RFID-tags, tablets or automatic guided vehicle (AGV)
- Transformation skills (e.g. propose and realize changes in all three stages of the production system; learn to adapt transformation principles in their home plants)
- Social skills (e.g. team work, knowledge transfer, knowledge acquiring, collaboration for synchronization of processes and delivery dates and analyzing defects)

To enable the workforce and students as future workforce with the required qualification, there are different approaches. From classical seminars, over business games, to practical case studies, where students have a jour fixe with managers from companies to solve real existing problems [7], [10].

A very promising approach to assure these required capabilities by qualification of operators and management is the learning factory concept. Over the last 10 years more and more learning factories evolved over the whole world and especially in Europe. These existing learning factories have taken many different forms. They vary in size, topics, products and other factors [12], [2], [15]. A common aim of almost all of these facilities is the hands-on qualification of the participants. This is the case even if the trainees are not employees but students. Another function of learning factories especially in the academic environment is the usage as a test area for new technologies and processes. They vary from learning factories for production process improvement (e.g. lean management methods), over learning factories for production and factory planning to those for energy and resource efficiency [1]. Nowadays more and more learning factories and labs are concentrating on topics related to industry 4.0. A lot of them are focussing on research and technology transfer instead of training and education [1]. The learning concept which the authors have developed and will describe in this paper is a mixture of both, training and demonstration. On the one hand it is dedicated to train and qualify employees from several organizations. On the other hand, it should function as a demonstrator, where participants can get in touch with new approaches and technologies.

This paper will introduce a learning factory concept which integrates the three categories of skills and tries to address the identified research demands. Therefore, the didactical design is explained first to introduce the concrete training concept afterwards. Finally, an outlook is given to show the plans for future training and research.

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