Available online at www.sciencedirect.com

ScienceDirect

Procedia Manufacturing 9 (2017) 17 – 24

Procedia MANUFACTURING

7th Conference on Learning Factories, CLF 2017

Classification of a Hybrid Production Infrastructure in a Learning Factory Morphology

Günther Schuh[a], Jan-Philipp Prote[a], Stefan Dany[a], Sven Cremer[a]*, Marco Molitor[a]

[a] *Laboratory for Machine Tools and Production Engineering WZL, RWTH Aachen University, Aachen, Germany*

Abstract

Current market trends confront industrial production with significant challenges: Volatility increases, uncertainty mounts, complexity grows and ambiguity escalates. While flexible and changeable organizational structures sufficed to combat present-time increasingly dynamic demands, modern disruptive times call for agility.
Agile learning will require expedited and well-structured training within industrial organizations: Learning factories enable new technologies to be put on trial, they capacitate integrated work and learning environments and they provide a valuable framework to instruct and educate new employees.
Numerous existing learning factories are geared towards education in engineering and didactics of industrial production. Defined distinctions are yet to be thoroughly discussed and will further the evolution of terminology and good learning factory practices.
This article portrays various use cases from real manufacturing operations and their accompanying indirect processes within the Demonstration Factory on the RWTH Aachen Campus. These cases shall be assorted to relevant characteristics of a morphologic description model for learning factories presented by Abele et al. and derive a critical reflection and enhancement of this framework. The applicability of said morphology shall be examined for the holistic Demonstration Factory approach with its aim to manufacture marketable goods in a genuine continuous industrial small batch production.

Peer review under responsibility of the scientific committee of the 7th Conference on Learning Factories

Keywords: Learning Factories; Learning Factory Morphology; Use Cases; Hybrid Production Infrastructure

* Corresponding author. Tel.: +49 241 80-26265; fax: +49 241 80-22293.
E-mail address: s.cremer@wzl.rwth-aachen.de

Peer review under responsibility of the scientific committee of the 7th Conference on Learning Factories
doi:10.1016/j.promfg.2017.04.007

1. Introduction and Motivation

Challenges in production processes and the preceding engineering tasks [1] rise as new production technologies become available, as highly individualized products are demanded in increasingly smaller quantities within shortened product life cycles in a more and more volatile production scenario with growing fluctuation in tasks and personnel – calling for new ways to build competencies and for lifelong learning to adapt to these ever new tasks [2, 3, 4]. The induction of such volatility in complex systems such as a production setting, urge these entities for a high degree of agility. With this in mind, learning factories provide an environment for agile learning and may thereby support a company's long-term success in the future [5]. Besides the provision of modern learning environments for education and vocational training, learning factories also arise for applications in research and provide an ideal setting to collect production based real-time data. Particularly with attention to the Industrie 4.0 paradigm [6, 7] learning factories serve as an advantageous surrounding for testing new work processes, new machinery and production of prototypes because there is limited risk of failure or major cost pressure [8].

In their article "Learning factories for research, education, and training", Abele et al. call for an interchange of ideas that constitutes the motivation for the following introduction to the Demonstration Factory in Aachen and four exemplary use cases. The Aachen Demonstration Factory will be classified in said learning factory morphology in order to delineate it and to ensure comparability to other learning factories worldwide [8].

2. State of Art Learning Factory Concepts

The idea of learning factories goes back to 1994, when the first learning factories were founded at Pennsylvania State University, the University of Washington and the University of Puerto Rico-Mayaguez [9, 10]. In the decades to follow, an increasing number of learning factories were established not only covering different fields and branches but also with widespread features and sizes [8, 11]. In current times learning factories are used in branches even outside universities or industry as for example in consultancy or in fields of medicine. Furthermore, the learning factories' scope is widening from not only education and vocational training to applications in fields of research and general competency training [12]. Approaches arise that aim to overcome such domain-gaps by implementing demonstrators and information-technology-based feedback loops between academia and industry. [13] Yet, the arising variety calls for a distinct way to classify learning factories and for a precise definition. For that purpose, the Initiative on European Learning factories, founded in 2011, initiated a CIRP Collaborative Working Group on learning factories in 2014 to establish a joint understanding of learning factories and related terms used in that context. The latest classification and description models for learning factories was published by Abele et. al. in order to deliver a morphology that allows for a distinction between learning factories [8]. In detail, this morphology classifies and categorizes a learning factory in seven dimensions according to its features. The dimensions consist of the purpose and targets, the process, the setting, the product, didactics, the operation model and lastly the metrics of the respective learning factory.

Following the determinations by the CIRP Collaborative Working Group on learning factories, a learning factory finds its definition in a narrow and a broader sense. In a strictly definitional contemplation, the composition of the words learning and factory suggest an agglomeration of both terms, combining the two fields: A factory in the narrow sense signifies a real production system and implies the manufacturing of a physical product while the aspect of learning highlights the – potentially simulative – gain of knowledge as a purpose. It makes use of a real value chain, authentic processes on several work stations and organizational aspects of production. [8] In contrast to that, broader sense learning factories for example address services instead of a physical product. [8]

An example for a learning factory in the narrow sense is the Center for Industrial Productivity located in Darmstadt, run by the Institute of Production Management, Technology and Machine Tools of TU Darmstadt [8] as opposed to the McKinsey Capability Center in Munich which also offers Lean IT classes as an example for a learning factory in the broader sense [14]. The Aachen Demonstration Factory will be allocated later in this paper. Figure 9 displays the classification of these and several other learning factories.

Regardless of this distinction the factories' main goals are either innovation in fields of technology and organization if used for research or an effective competency development if used in education and training. [8] Improving the learning factory and keeping it up to date is essential and requires a sustainable business model.