Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 32 (2015) 47 – 52

www.elsevier.com/locate/procedia

The 5th Conference on Learning Factories 2015

Learning factories and their enhancements - A comprehensive training concept to increase resource efficiency

Björn Krückhans*, Thom Wienbruch, Sebastian Freith, Henning Oberc, Dieter Kreimeier, Bernd Kuhlenkötter

Ruhr-University of Bochum, Chair of Production Systems, Universitätsstr. 150, 44801 Bochum, Germany

* Corresponding author. Tel.: +49-234-32-28713; fax: +49-234-32-08713. *E-mail address:* krueckhans@lps.ruhr-uni-bochum.de

Abstract

Learning factories have been developed to impart substantial knowledge about improvement processes and methods to students and especially industrial participants within a real-world manufacturing environment. Due to the rising significance of resource efficiency, this issue has become another main driver for learning factories. Therefore, a comprehensive training concept is necessary in order to build up a measurement system in order to determine key figures and derive optimization steps. A new material flow simulation approach, developed in the research project REBAS, is added to the training courses in order to extend optimizing possibilities.

Peer-review under responsibility of the organizing committee of 5th Conference on Learning Factories (CLF 2015)

Keywords: Learning Factory, resource efficieny, simulation

1. Introduction

In order to increase competition on a global scale, manufacturing companies depend on well trained and educated employees who are able to handle the increasing complexity of production systems. In order to reach this aim, new learning concepts are necessary [1].

Different concepts have been developed but learning factories are especially adequate in this context because the transfer of knowledge from the trainings to the participants' own companies is facilitated by real production conditions [2].

Learning factories consist of measures for process improvement and of the consolidation of theoretical knowledge in a practical manufacturing environment. As a result of this consolidation, it is possible to teach the participants in a very practical way. The practical manufacturing environment is used for educating academic students as well as to train industrial participants. For these it is possible to take over an active part in different scenarios, which have been specially designed for their remit in the company. Particular trainings have been designed for specialists from the shop floor up to the higher management level [3].

Process improvements can be practiced risk-free and without any additional pressure by the participants in the real learning factory. Additionally, the varied scenarios can also be tested in a virtual simulation environment.

The German manufacturing industry has to face different future challenges, e.g. resource depletion, which learning factories are also designed to meet. Therefore, training concepts have been enhanced to encounter recent conditions.

Learning factories in real production environments have been build up in Germany which offer conditions for problem and activity-oriented learning especially in this field of action [4].

The Learning Factory of the Chair of Production Systems covers three topic areas: lean management, resource efficiency as well as management and organization of work (Fig. 1) [5, 6]. In spite of the three very different areas, all of these areas are interlinked within the construct of the learning factory by the continuous use of real products, which are produced during a real production process [7].

Peer-review under responsibility of the organizing committee of 5th Conference on Learning Factories (CLF 2015)
doi:10.1016/j.procir.2015.02.224

It is remarkable that the implementation of learning factories in education is increasing. This trend is not only recognized at universities but also at industrial companies (e.g. [8, 9, 10]).

Fig. 1. Division of Learning Factories at the Chair of Production Systems

2. Challenges and Trends of the Future

In 2011, former export champion Germany generated a total revenue of 658 billion euros, just regarding its production output, which means 25.6% of the GDP [11]. Besides this high productivity, Germany is poor in essential resources at the same time. In 2011, for example, Germany was forced to import resources for more than 137.2 billion euros [12]. This fact as well as the cost structure of the German manufacturing industry illustrates the dependence of the German industry on resource imports.

3. Learning Factory for Resource Efficiency (LRE)

As described in section 2, it is becoming particularly important for the manufacturing industry to focus on resource efficiency. The main target of the Learning Factory for Resource Efficiency at the Ruhr-University of Bochum is the sensitization of the participants for the design and optimization of resource-efficient production processes.

In order to measure the consumption of the heterogenic machinery of the learning factory two real products are manufactured in the LRE (Fig. 5). The manufacturing processes of the products “UniLokk” and “LokkHolder” are designed so that the potential for improving the resource efficiency is especially high. Moreover, with these real products the chosen optimization tools are very easy to mediate and to use.

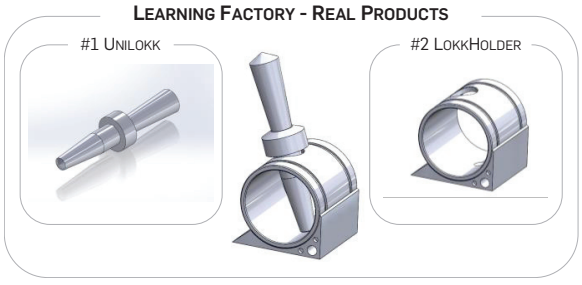

Fig. 5. Real products of the LPS Learning Factories

3.1. Training Concept

The goal of the LRE is to help the participants to understand the way of information from the sensor signal up to a final key performance indicator (KPI). With adequate KPIs they will be able to track and to optimize the focused production process using measured data. This approach is embedded in a superior training concept based on a PDCA cycle (Fig. 2) [13, 14] that requires knowledge of different competence areas which is imparted in a comprehensive didactical concept (Fig. 3).

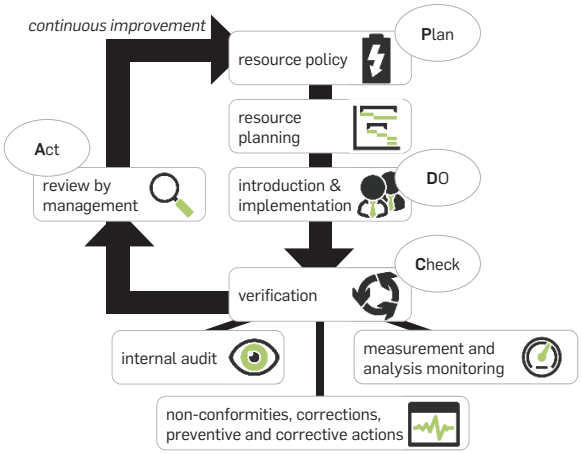

Fig. 2. Resource PDCA cycle according to ISO 50001 [15]

Within the training concept for resource efficiency, different trainings have been conceived for participants of all business levels. The theoretical and practical workshops are designed to suit to the PDCA cycle because it enables participants to transfer the experienced concepts and methods to their own company and processes. The global aim of reducing the resource consumption and not only the energy usage is achieved by the extension of the PDCA cycle according ISO 50001 [15] (Fig. 2).

Therefore, more input parameter are included in this approach according to the definition of resource efficiency. Referred to VDI 4800 [16], resource efficiency is defined as the ratio of a certain benefit or result to the necessary resource input. The resource input is defined as a natural resource and therefore it is an essential extension compared to the definition of energy efficiency.

$$resource\ efficiency = \frac{benefit\ \left(product, function, \frac{functional\ unit}{effort}\right)}{(input\ of\ natural\ resources)}$$

In order to pass through the focused PDCA cycle (Fig. 2), a fundamental knowledge of different fields of competence is necessary. Therefore, the LRE mediates knowledge in four competence areas (Fig. 3).