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Using a learning factory approach to transfer Industrie 4.0 approaches to small- and medium-sized enterprises

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Abstract

Digitalization and the informational interconnection of value-adding-processes promise a multitude of opportunities to increase the competitiveness of production companies. This article introduces a research project, which takes an already existent production setting of a learning factory as a starting point and aims to optimize it using Industrie 4.0 approaches. The given value chain and IT-infrastructure are thereby used as a foundation, which is not rebuild, but retrofitted for an increased efficiency and flexibility. Additionally, an outlook on a competence center will be given, which aims to holistically transfer the vision of digitalization into company practice.

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Keywords: Industrie 4.0, Effiziente Fabrik 4.0, Digitalization

1. Introduction

The ongoing developments in the field of information and communication technology constantly yield rising challenges for manufacturers. On the one hand, customers expect shorter response time. On the other hand, the requirements towards new functionalities and a high degree of individualization imply an increased product complexity.

New leaps of technology rise the capabilities of embedded systems, thus enabling the transformation of current manufacturing processes into best practice cases meeting customer expectations. Such innovations are seen as a 4th industrial revolution [1] and are therefore referred to as Industrie 4.0.

Regarding the current technological trends, the complexity and effort for developing, implementing and managing such production systems are expected to increase continuously [2]. This is one of the main reasons why many companies in the mechanical engineering and plant engineering field, small and medium-sized enterprises (SME) in particular, view Industrie 4.0 with caution and skepticism. Therefore, it is crucial that the benefits of these developments are demonstrated and evaluated. This situation causes an urgent demand for research and learning facilities to offer new workshops, trainings and other events to target the specific needs and production environments of SMEs, using a benefit oriented approach.

2. Research project “Effiziente Fabrik 4.0”

For the above mentioned reasons results of the research project “Effiziente Fabrik 4.0” (EFA) offer [3]

- a compilation of good-practice examples, previously successful realized in industry,
- a real experimental field making new attempts of Industrie 4.0 tangible and visible for universities, companies, as well as employees and company associations and
- successful methods, to involve efficiency-enhancing attempts effectively and sustainably into existing production systems.

Since Industrie 4.0 was presented at the “Hannover Messe” in 2011, several demonstration centers for Industrie 4.0 have been established [4]. However, most of them have a greenfield-

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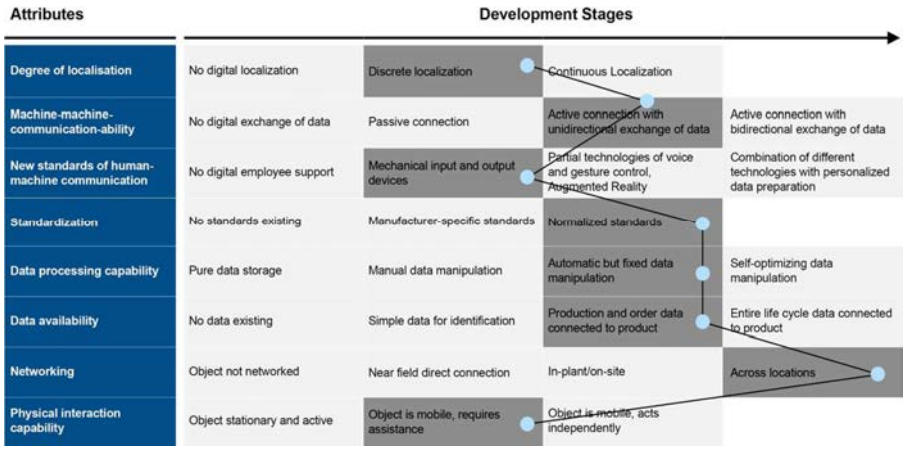

Fig. 1 EFA 4.0-stage model

approach in common. The unique feature of this project is its implementation of Industrie 4.0 concepts in an already existing company infrastructure including typical milling processes and a manual or rather half automated assembly line producing a pneumatic cylinder. This brownfield approach faces the same challenges as SMEs. Moreover, the existing performance measurement system of the learning factory can be used to evaluate the implementation. This project started in the middle of 2014 with a pre study, which identified and analyzed already existing Industrie 4.0 good practice examples. Based on this, together with a project consortium out of twelve company partners and two research institutes, Industrie 4.0 concepts were designed and implemented in the process-learning factory "CIP" at the TU Darmstadt. Finally, these implemented concepts are currently being validated successfully. The results are didactically prepared in form of application guidelines and made accessible to companies and students through workshops.

2.1. Preliminary good practice study

Within a preliminary study 15 already existing Industrie 4.0 good-practice solutions were examined through on-site interviews. The interview partners are suppliers, manufactures, as well as learning factories, which were chosen to identify the gap between company practice and research institutes. The focus of the study was the structural preparation of the identified solutions. The methodology consists of three parts [3].

The first part is the "EFA 4.0-stage model", which shows development stages towards a full Industrie 4.0 implementation in eight different attributes, see fig. 1. These aspects include CPS (cyber-physical-system) characteristics, which are derived from recent literature. The structure is based on a morphological box. Every attribute of the EFA 4.0-stage model starts at stage 0. At stage 1, the respective attribute is used in its simplest form. To achieve the highest evolutionary step in one aspect, a solution has to contain all required features of a perfectly implemented CPS. The connected line in fig. 1 illustrates the average of the examined good practice examples. Most of the examined solutions represent a high maturity level. The highest potential remains within the human-machine interface, especially in the fields of data preparation, data capturing, as well as data visualization. Most of the solutions are based on internet technologies, which enable a cross-linking

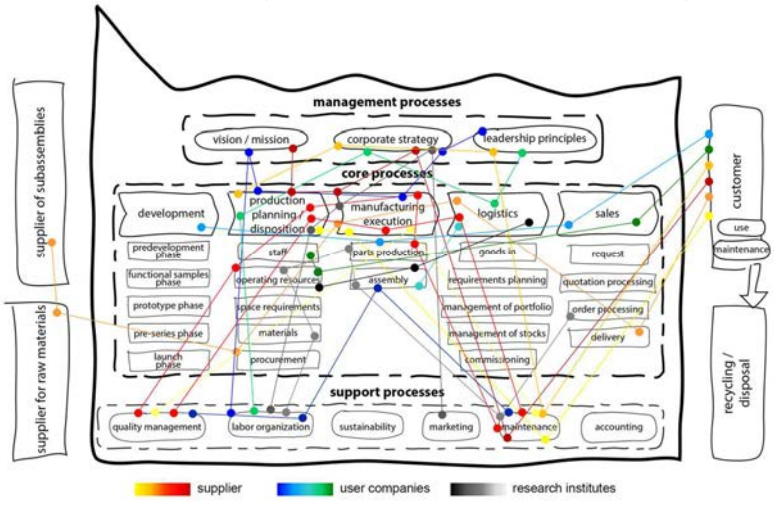

Fig. 2 EFA 4.0-business map