Integration of Employee Skills into the Planning Process of Factory Transformability

Tobias Heinen[a] and Peter Nyhuis[b]

[a / b] heinen@ifa.uni-hannover.de, nyhuis@ifa.uni-hannover.de
Institute of Production Systems and Logistics, Leibniz Universität Hannover
An der Universität 2, 30823 Garbsen/Germany
Phone: +49 (0) 511 / 762-2440, http://www.ifa.uni-hannover.de

Abstract

Enterprises face a plethora of outside influences. Examples include shortening product life cycles, rising cost pressure or increasing number of product variants. In order to make arrangements for their factories to remain future-robust, many companies strive for a transformable factory. In order to fully use the change-potential installed, a methodology that allows integrating an employee-oriented view, is indispensable. This paper presents – after covering the fundamentals of factory transformability – an approach which renders possible the coordination of employee skills and factory transformability.

Introduction

Nowadays, a multitude of changes occur in the environment of companies. These will accelerate and, thus, result in a so-called turbulent environment (Nyhuis et al., 2008). In order to cope with the pressure caused, factories are often planned considering the basic principles of factory transformability. In so doing a “decoupling” of factory planning and factory operations can be noticed: Universal technologies, scalable factory buildings or modular factory layouts determine the technological potential of a change. At the same time, it is not possible to use this technical change-potential without considering the employees who need to be qualified accordingly. Therefore, it is important to anticipate the planning of employee skills and integrate it in the early phases of factory planning instead of considering it reactively in the stage of operations.

In the following part, the systematic of changeability is described.

Systematic of Changeability

Many different terms or definitions have been used to describe the ability of a production facility to change, e.g. flexibility (ElMaraghy, 2005; and De Toni and Tonchia, 1998), reconfigurability (Koren et al., 1999; and Cisek, 2005) or transformability (Wiendahl et al., 2007; and Nyhuis et al., 2006). Changeability can therefore be regarded as an umbrella term for different types of change in a factory or a part thereof. Wiendahl et al. (2007) have introduced a taxonomy to distinguish these terms.

The differentiation is based on the so-called specification or production levels of a factory. These production levels also relate to a certain product level (cp. Fig. 1).

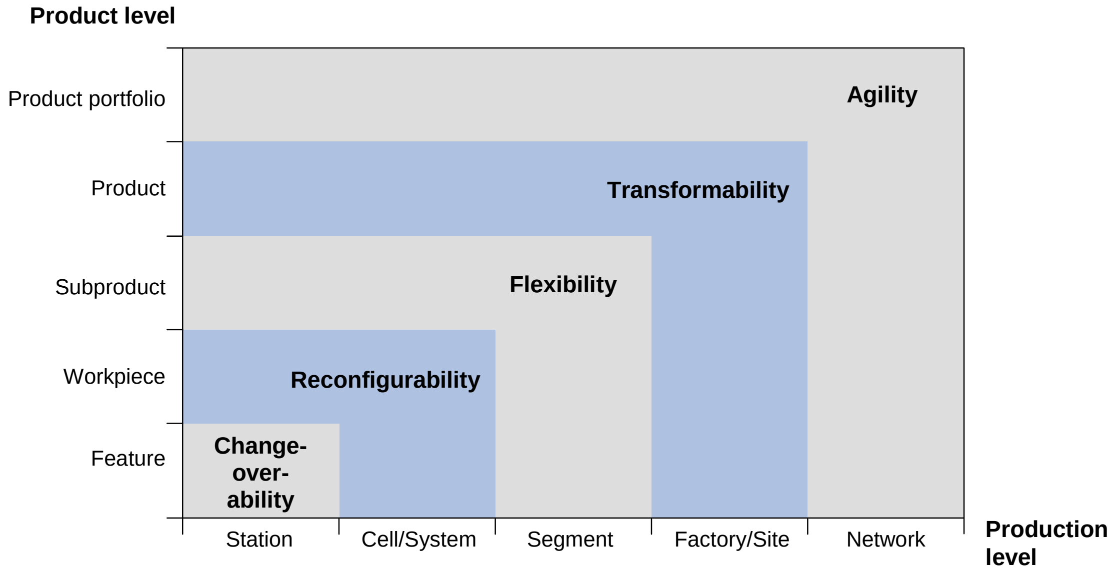

Fig. 1: Types of Changeability (Wiendahl et al., 2007)

On the highest level, a production network is responsible for the entire product portfolio of a company. The ability to alter the portfolio as a whole or to redesign the entire supply chain of which the company is a part is called agility. On the next level down, a single production site or a factory usually produces a product. Transformability describes the ability of a factory to change, e.g. to a new product, by repositioning production areas in the factory. A segment within the factory is responsible for the manufacturing or assembly of a so-called subproduct (e.g. assembly group). Flexibility enables segments to change to new subproducts. Diverse kinds of flexibility have been mentioned such as product, variant, quantity or materials-flow flexibility (Abdel-Malek et al., 2000; Haller, 1999; and Kaluza and Blecker, 2005). Within a segment, there are usually several manufacturing or assembly systems or so-called cells. These perform several operations on a workpiece, e.g. a turning operation or a surface treatment. The ability to adjust to different workpieces, e.g. by adding or omitting certain operations, is called reconfigurability. Finally, on the lowest level, change-over ability describes the ability of a single station within a cell to perform a different, predefined manufacturing or assembly feature on a workpiece.

The types of changeability of a factory cannot be looked at separately because the higher levels include the lower ones. A factory needs to possess flexible or reconfigurable elements in order to be transformed.

The focus of this paper, however, does not exceed the level of factory transformability. Agility is dealt with on a strategic corporate level and thus surpasses the focus of factory planning. It is not considered further here.

Transformability Enablers

Certain characteristics allow the factory to perform a transformation. These so-called change enablers can be defined for the different production levels (Wiendahl et al., 2007) and have been intensively discussed (Hu et al., 2006; Koren, 2006; and ElMaraghy, 2006).

For the factory level, five attributes have been found that enable a transformation (Wiendahl et al., 2007; and Heger, 2007). These transformability enablers can be described as follows: universality refers to the dimensioning and designing of an object for various requirements regarding product, function or technology, e.g. variants flexibility. The unrestrained mobility of transformation objects, e.g. machines on rollers, is described by mobility. Scalability denotes the scope for the ability to be able to expand and contract technically, spatially, and in terms of personnel, e.g. flexible labor time. So-called plug&produce modules are just one example of standardized, technically pretested functional units or elements which work due to their modularity characteristic. Finally, compatibility describes the internal and external networkability regarding materials, information, media, and energy, e.g. standardized software interfaces.

Normally, factory planning concerns the quality of transformation objects and tries to arrange these optimally with a view to future needs while taking into account cost factors. However, in the interests of transformability, it is not sufficient to limit an assessment to technological objects. It is much more important to include the subjects in the assessment, i.e. the persons who have to sustain the change. This aspect is discussed below.

Deficiencies Concerning the Systematic of Changeability

Change is initially planned by the management and then implemented by the employees. The latter must subsequently work in altered structures and come to terms with these. In the light of this, a process of change judged as sensible can be limited in terms of its implementation and potential. Two of the primary reasons for this can be found in the need to improve the competencies of the personnel and in the psychological resistance to change. This applies to managers just as much as it does to production personnel.

The need for a broader view is also shown in a current study of “transformable production systems”, which the Institute of Production Systems and Logistics has carried out in cooperation with other partners (Nyhuis et al., 2008). The study assessed the requirements, prerequisites, potential, and deficits of transformability in 30 qualitative case studies. The study comes to the conclusion that the potential for change increases when it is possible to train personnel and managers at an early date for the tasks in a production system due to be changed. The success factors mentioned by the interviewees from the companies were professional and procedural skills, and also the motivation to contribute actively to change. Businesses see the greatest challenges in the production of new or modified products and in managing changing product portfolios. Whereas fluctuations in demand can still be dealt with relatively easily through flexible working hours and employment models plus corporate cooperation, the majority of the companies interviewed see an urgent need for action and research in order to adapt their production structures, operational resources, and competencies to new product features. According to the companies interviewed, this urgent need primarily takes the shape of developing human skills for change.

In the light of this, the challenge for the company is to analyze the personnel with respect to its significance for the transformability, and to integrate workforce competencies into a model of the planning and realization of the transformability. What has to be taken into account here are, above all, human skills in the sense of specific professional and procedural capabilities plus the readiness to support transformation processes. Furthermore, it will also be necessary to integrate the work and plant organization into the planning of the transformability because these allocate functions in operational procedures to the personnel and in this way decide on the responsibility and organizational integration of the personnel. This aspect is important because research into innovation processes has shown that the organizational integration or responsibility of personnel is, in addition to professional competence and motivation, the deciding factor for an individual’s competence to take action (Staudt and Kriegesmann, 2002; and Staudt, 1999). Consequently, work and plant organization that gives individuals and teams freedoms and resources for taking responsibility for the control of production subprocesses serves the interests of a broader transformation competence. If the demands placed on a business increase due to an increasingly turbulent environment, we can no longer assume that central planning and control is able to guarantee adequate transformability on its own. Instead, it becomes necessary to increase the complexity of the work organization in order to match the increased complexity of the problem (Baecker, 1999). A complex organization in this sense is based on self-controlling competent subareas focusing on operational targets.

The aforementioned themes form the basic framework for being able to carry out a technological transformation of the factory objects. If the personnel and the work and plant organization are not considered, they can appear as hindrances to transformation; although the technological options for transforming factory objects are in place, they will probably not be achieved in the desired form or within the necessary time-frame. Additional aspects must therefore be integrated into the transformability systematic.

Socio-technical Planning of Factory Transformability

Against this background it becomes obvious that an approach which considers factories sole technical systems is not sufficient. In fact, it is necessary to integrate a socio-technical point of view which focusses on the employees with their skills and characteristics into the planning process of technical systems. As factories are complex systems (Westkämper, 2008), their full potential can only be used by considering both technology and employees. Existing approaches on factory transformability such as (Hernandez, 2003) or (Nofen, 2006) leave this aspect aside. Here an approach is presented that can be used in order to match employee skills with the planning of factory transformability.

Therefore, a methodology is derived. The content of the first step is to derive so-called transformation clusters. These embody means of adjustment that can be used within the scope of factory planning to realize changes in the system factory. The content of step two is to derive a taxonomy of employee skills. By comparing transformation clusters with employee skills, it becomes obvious what kind of skills employees need to possess in order to react accordingly. Finally, it is important to implement employee skill planning into the processes of factory planning in order to make them utilizable for users. This is content of a fourth step. These particular steps are described below.

Derivation of transformation clusters and -determinantes

A system model of the factory can be used to understand the effects of external transformation drivers. Therein, a factory is considered as a system in which an input is transformed to an output by adding value (Nyhuis et al., 2008). In addition, external factors of the environment impact on the system. These external disturbances can be intercepted by changing the so-called transformation clusters.

Transformation clusters are bundlings of factory elements which canalize the external transformation pressure and adapt to it as a response. The following transformation clusters can be identified referring to (Fiebig, 2004; Heger, 2007; and Wirth, 2000): Elements which focus on the factory organization, the structure and the workflow in a factory are combined in the cluster “Organization”. Those factory elements which include logistical concepts such as the logistics and production concept are aggregated in the cluster “Logistics”. Furthermore, all spatial arrangements, their placement as well as the layout of the factory are combined in the cluster „Space”. Finally, all technological production facilities, handling tools, transportation and storage means are aggregated in the transformation cluster “Technology”.

Objective of the factory transformation processes is the fabrication of a product. As research has shown, it is essential to integrate prospective trends affecting the product to the scope of factory planning (Nyhuis et al., 2008b). The reason is that the product heavily affects the planning and design of the factory (e.g. through hygiene requirements). Additionally, the product can make demands on the skill level of the employees (e.g. through new work contents that need to be learned and trained). Thus, a fifth transformation cluster “Product” is introduced for future analysis.

In accordance to (Steinle, 2008) so-called transformation determinantes can be named. These describe the kind of a change. Examples of transformation determinantes include intensity and extent of a change (e.g. considered levels of the production system), required resources of a change, strategic importance or duration of a change. Based on that, a differentiation between fundamental and incremental change becomes possible. All change processes can be classified accordingly. For example, the introduction of an all-new product can be considered a fundamental change, whereas the redesign of an existing product can be described as an incremental change.

Systematic of employee skills

After the determination of transformation clusters within the system factory, this chapter will present typical employee skills. This can be considered a prerequisite of the next step in which employee skills and transformation clusters are contrasted. Based on literature certain characteristics that have an impact on the change behaviour of employees can be found. Examples include the age (Furnham, 2005), the system of norms and values (Robbins, 2005), or the social rank (Maslow, 1987). Employee skills, however, can be considered most important with regards to the will and ability to initialize and accept a change, or to work in an altered environment. Employee skills are described as a disposition to act in a self-organized way (Bergmann, 1999; and Erpenbeck, 1997). Typical kinds of employee skills are (in accordance to (Kauffeld, 2006; Grote et al., 2006; and von Rosenstiel, 2007) professional competences (i.e. skills and abilities to cope with work tasks as well as job-related skills and abilities), general problem-solving skills (i.e. skills related to structuring problems and decision-making), social competences (i.e. ability to act communicatively and cooperatively) and personal competence (i.e. ability to assess oneself as well as to develop one’s skills independently). Different classifications of employee skills can be found (Winterton et al., 2005)

Identification of change-induced requirements concerning employee skills

Content of this chapter is the definition of requirements related to employee skills through the transformation clusters. The objective is to determine for each transformation cluster what level of employee skills is required in order to react to changes in these clusters (cp. Fig. 2). These requirements will be shown in a so-called cluster-specific skill profile.

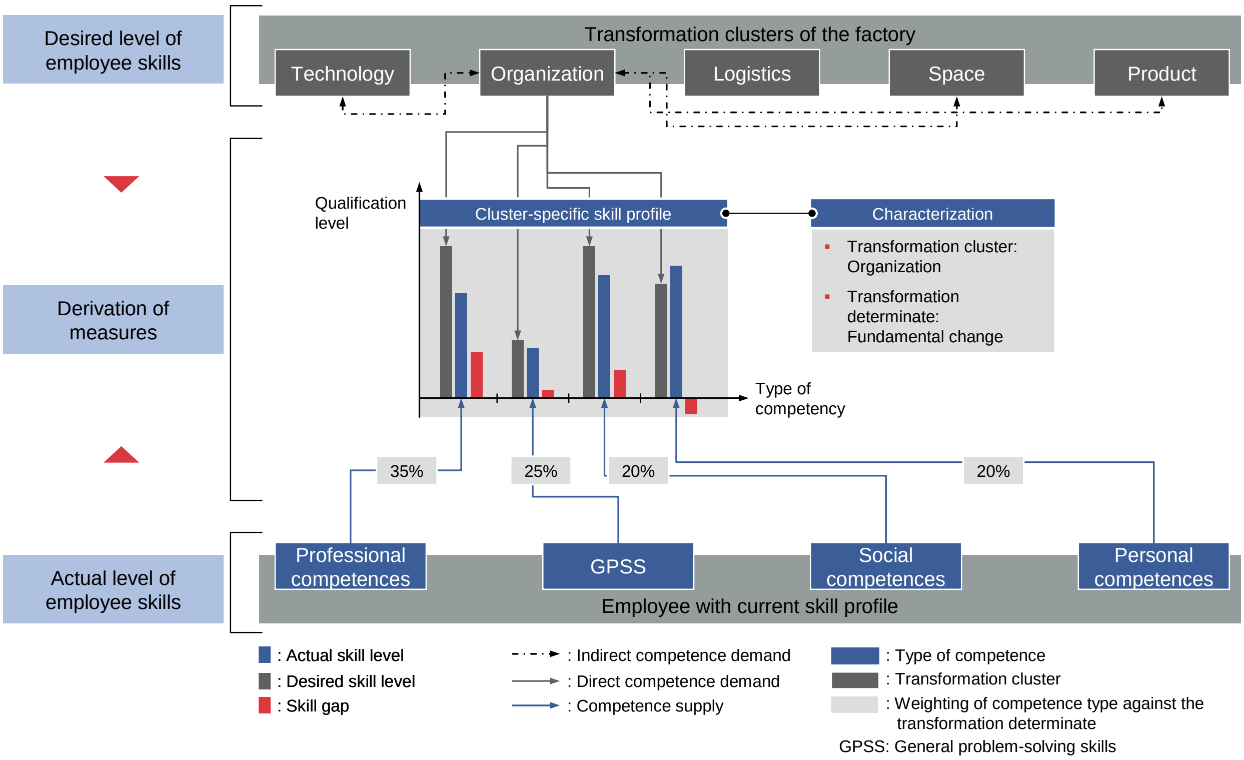

Fig. 2: Requirements concerning employee skills (example Organization)

As an example, the requirements that result from a fundamental organizational change as well as the necessary employee skills needed to react appropriately are described. If it becomes obvious that a centralized, strongly hierarchical organization needs to be transformed into one that is characterized by small, decentralized, self-organizing units, it can be stated that a fundamental change is necessary. It is then inevitable to determine what level of employee skills is required in this case. At first, a higher level of professional competences will become necessary in order for the employees to be able to carry out indirect operations independently. What is more, social competences must not be disregarded as an increased percentage of coordination processes is likely to occur. Finally, a higher level of personal competence is necessary in order to independently implement continuous improvement processes. It must be determined whether employees possess the required skill level. If applicable, measures of skill development should be introduced if required levels of employee skills cannot be achieved.

Transformation clusters can have interdependencies so that indirect requirements on employee skills can occur through different clusters: An example is the building of an additional factory building-module which can results in a different organization of the factory. As shown above, this can results in different skill requirements. Thus, indirect requirements and interdependencies of transformation clusters must be considered, too.

The transformation determinantes also have an impact on the systematics. It can be assumed that different skill levels are required for a fundamental change from the level needed to cope with an incremental change. In the case that only a single machine will be changed professional competences which ensure the correct use of the machine are more important than social competences. These, however, become more important, should an entire site be restructed. In this case, coordination process will be more important and, consequently, skills to handle this situation. Therefore, the employee skills can be weighted against the transformation determinantes.

Integration into the Factory Planning Process

The last step is to integrate the findings into the factory planning process (e.g. Nyhuis et al., 2004) (cp.

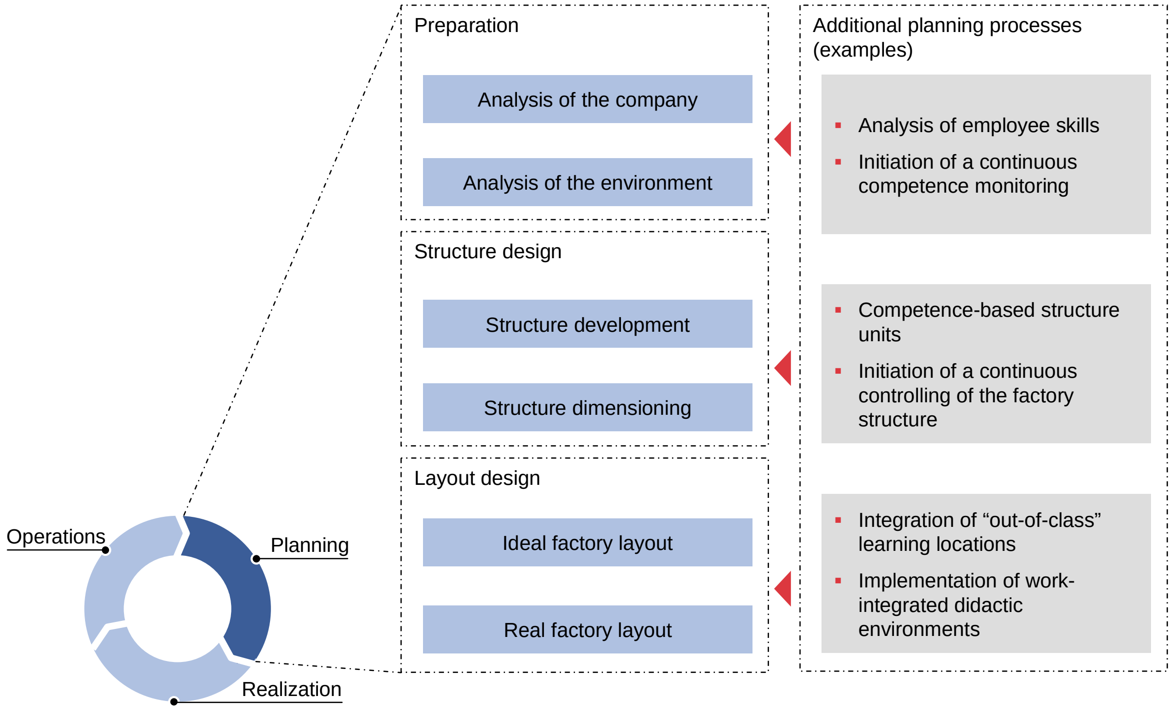

Fig. 3). In the first step of preparation a comprehensive skill analysis should be conducted. Furthermore, first approaches exist that allow the definition of competency-based structure units in a factory (Strunz, 2008). Finally, a continuous skill development can be supported by an adequate factory layout. Existing concepts comprise the integration of "out-of-class" learning locations into the factory or work-integrated didactic environments (Sonntag et al., 2000). In addition, an employee skill controlling is to be established in the stage of factory operations as described in (Nedeß, 2008). This can form the basis of a permanent controlling of the factory's structure.

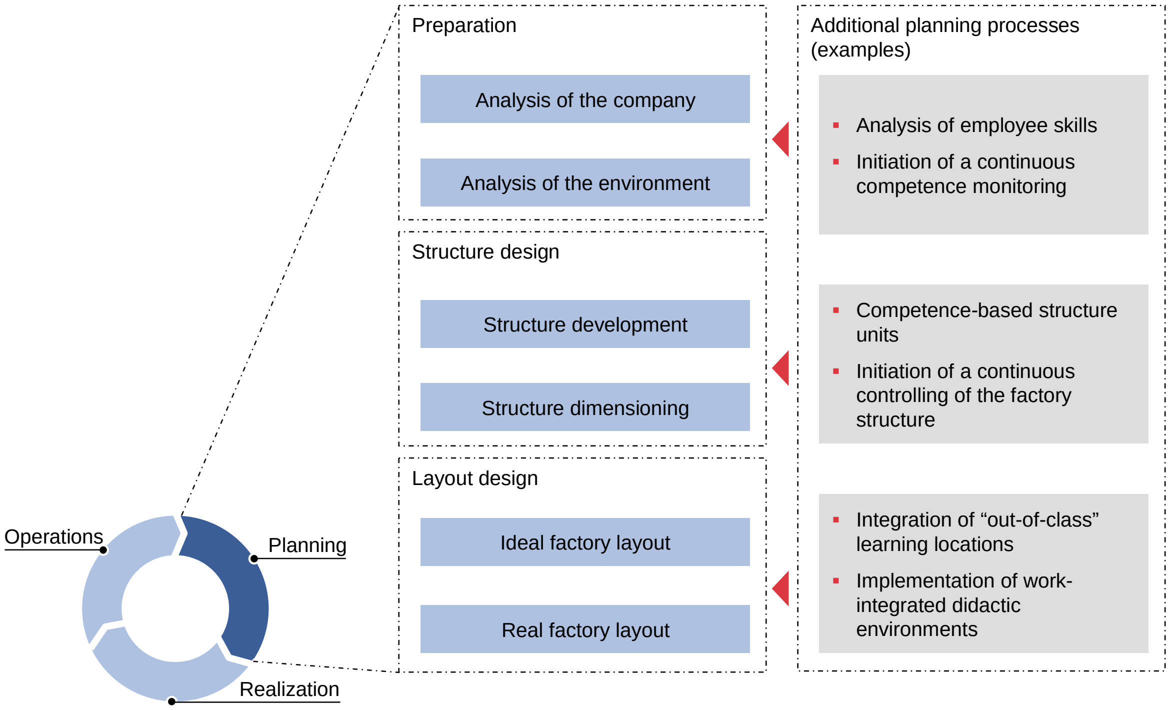

Fig. 3: Expansion of the factory planning process

Conclusion

Employees’ importance for an adequate and economic factory transformability can be considered high. However, existing planning procedures do not deal with employee skills sufficiently. This paper presents a first approach on how to close this gap.

Future research should – amongst others – be directed towards the assessment of the transformability of human ressources.

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