World Academy of Science, Engineering and Technology
International Journal of Industrial and Systems Engineering
Vol:7, No:10, 2013

Changeability of Business Organizations

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***Abstract*—**Nowadays companies are facing an increasing turbulent environment. It is more and more important to react fast on changes to stay competitive. But not only the technology has to be adaptable; also the frame conditions for the production have to adapt as fast as the other elements of a manufacturing company. Therefore, the Institute of Production Systems and Logistics of the Leibniz University of Hanover has implemented a research project to describe and develop changeable organizational structures. The results of the analysis, which design principles can be used to evolve an organizational structure of a factory regarding their changeability will be presented in this paper.

***Keywords*—**Changeability, factory, organization.

I. Introduction

IN the last years, companies were more and more influenced by changes of their environment [1]. Turbulent markets that are characterized by an increasing individualization of products and customer specifications as well as shortening life cycles are challenging the companies to become more flexible [2], [3]. To meet the requirements of the market, many people within the company have to work together reacting fast on changes. Especially manufacturing companies are influenced by changes of the market and customer requirements.

For that to happen, the frame conditions, especially the work and business organization of the company, either need to support changes or provide changeable structures [4].

In the past research focused on design guidelines in various aspects for changeability in factories. The factory as a socio-technical system has to ensure the right frame conditions for both human and technology to adapt easily on changes and new challenges [5]. A research project with the focus on these topics was implemented at the Institute for Production Systems and Logistics of the Leibniz University of Hanover. The goal of this research project is to combine two different fields within the sociotechnical system: the employees and the organizational structures of a factory. This paper focuses on the development of changeability of a business organization within a factory.

In the first part of this article the basics of factories, changeability and the different types of business organization structures will be illustrated. In a second step, factors for a changeable organization will be illustrated and systematized. Following this, the requirements on a changeable organization will be identified and systematized. The derivation of design principles will be presented and summary and outlook will end the paper.

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This research was made possible through the generous funding by the German Research Foundation (DFG) in the context of the project “Planning process of the socio-technical changeability in factories”, which is funded under the sign NY 4/40-1.

II. Basics of Factory, Changeability and Business Organization

A. Factories

A factory is defined as the place where added value takes place by manufacturing industrial goods using production factors [6]. It is, as already mentioned above, a complex socio-technical system. A social-technical system combines technical (e.g. machine) and social subsystems (e.g. employee) and their correlations among each other. The primary task of a factory is the transformation of input goods to a determined output good [7]. To achieve this goal, the interactions of the subsystems need to be designed in line with the factory goals such as the economic efficiency. In the past, a lot of effort was spent in the systematic description of factories.

The factory can be described by so called factory fields, factory levels and factory objects. The factory can be structured horizontally by the factory fields Means, Organization and Space. Vertically, a factory can be subdivided into the levels Site, Factory, Cell and Workstation. A matrix is produced by linking the factory fields with the factory levels and provides the basis to define the factory objects [8]. These objects can be described and evaluated and result in a systematic overview of the factory.

B. Changeability

In many publications different key factors for a changeable factory are named [2], [9]. They can be clustered in technical, spatial and organizational changeability. The technical changeability describes the ability of manufacturing equipment, building and information technology to adapt fast on changes related to the products, processes or the quantities. The spatial changeability relates to the factory layout and the layout of the building site. The organizational changeability describes the ability to quickly adapt the business organization as well as the logistics within the field of sourcing, production and distribution [10].

Wiendahl defined five so called Changeability Enablers for the design of changeable factories (see Fig. 1): universality, compatibility, scalability, modularity and mobility [3], [10]. These enablers provide the ability of manufacturing companies to change respectively to adapt to changes.

Universality describes dimensioning and design for different requirements with regard to product or technology. Compatibility describes the interconnectivity of material, information or energy. Scalability refers to the spatial and technical changes as well as changes in the staff. Standardized units or elements are described by Modularity and Mobility refers to the unrestricted freedom of movement of objects [11].

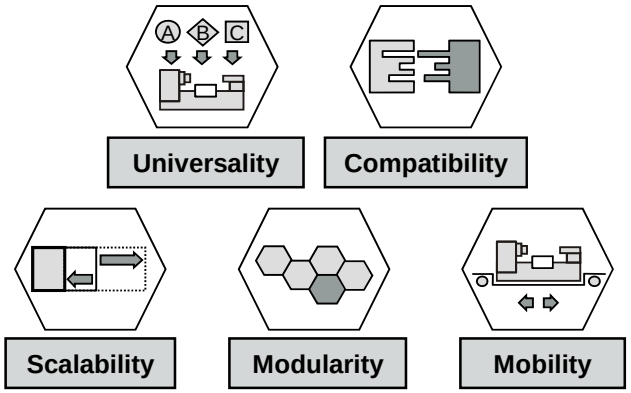


Fig. 1 Changeability Enablers of a Factory [11]

C. Business Organization

The term business organization covers various topics. The main challenge in designing a new business organization is the appropriate division of tasks as well as the definition of hierarchical levels [7]. Different levels of detail need to be planned, such as the organizational structures or the work organization.

Different concepts for work organization are shown in the literature: job design principles (e. g. job rotation, job enrichment, job enlargement), remuneration and shift models, responsibilities and different levels of autonomy [12], [13].

The organizational structure of a factory describes the organizational assignment of the employees and with that the hierarchy within the factory. There are three structures that are common in factories: functional, divisional and matrix organization.

Two general design principles can be identified within the different organizational structures: the single-line system and the multiple line system [14]. The single-line system describes a hierarchy from top to bottom. It is characterized by the managing entities that are responsible for a certain functional area. Each entity is assigned to exactly one managing entity, which has the right to take decisions for this functional area. The second principle is the multiple-line system. It is characterized by the assignment of several managing entities per functional area.

The functional organization distinguishes between resource-related function areas and performance-related function areas. The resource-related function areas are responsible for the procurement of required resources. This includes human resource management, financial management, materials management as well as asset management. The performance-related functional areas are in charge of the operational output of the factory. The department's research and development, production and sales can be allocated to this category [14].

From its construction the divisional organization is very similar to the functional organization. The main difference is the way of subdividing. The so called divisions can be based on objects, products or a region, which means that they are independent from the other divisions and supposed to be more effective. The disadvantage of this organizational structure is the risk of creation of redundancies, because some functional areas may be necessary in each division.

The matrix organization combines the two different design dimensions: different management levels are responsible for the same functional areas but with a different focus [10]. There is a management level specialized for the function-related tasks as production, sales or human resources and a management level for the object-oriented tasks, for example the specialization on a particular product or a particular market.

While planning the production, different manufacturing principles can be used as a reference. Fig. 2 shows the five manufacturing principles that can be found in the literature [7], [11].

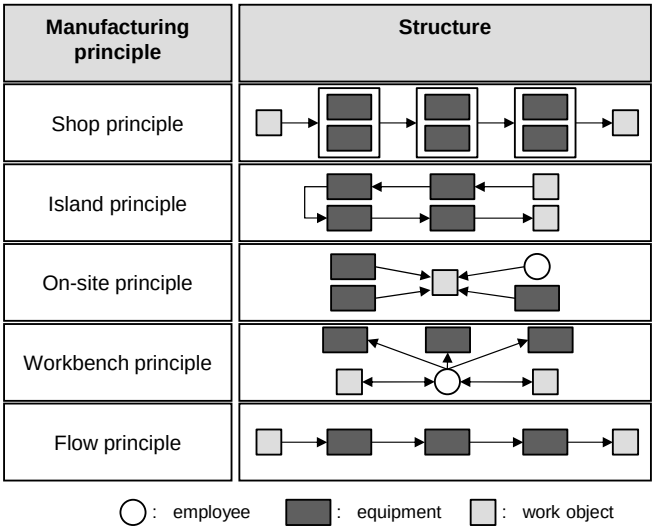


Fig. 2 Manufacturing principles [7]

The shop principle is characterized by a spatial proximity of similar equipment (e. g. milling machines). The parts to be processed are passed through the different shops. Thus, this principle can be used preferably for products with a high number of variants. The island principle combines different equipment, which is used in a particular order to produce similar products, with the goal to create a 'flow' of parts through this group of equipment. The on-site production is used for heavy or huge products and is characterized by the transport of equipment to the part to be processed. The implementation of the workbench principle means, that the employee is aware of the different operations and is allowed to choose the necessary equipment. This principle is common

with a high proportion of manual production processes. The flow principle is used for products with a high production volume and is based on the division of labor [7], [11].

III. Changeability of a Business Organization

In the literature seven factors that are beneficial for changeable organizations were identified: goal orientation, transparency, congruency, scope for development, change competence, performance orientation and basic flexibility [4].

The communication and the agreement on corporate goals as well as the orientation of goals of individual functions on the corporate goals can be summarized as the goal orientation.

The transparency of an organization is characterized by simplified processes, information and procedures, that are visualized and easily comprehensible. Another factor is called congruency and is described as the assignment of both competence and responsibility for a specific task to only one person. High autonomy, freedom of decision and the overall responsibility for a certain task need to be embedded into the functionalities of the organization and determine the factor scope for development. The ability as well as the willingness and the authority to identify and influence changes are summarized in the change competence. This includes the motivation to initiate and promote changes. The performance orientation implies that all employees are prepared to work on maximum performance to enhance the corporate success. The basic flexibility of the company was defined as the support of dynamic organization forms by technical equipment and suitable employees [4].

IV. Requirements on a Changeable Organization

To develop design principles for a changeable organization it is necessary to identify the requirements on such an organization. Using the seven factors described above a literature review was executed. Subsequent, the changeability enablers as well as the factors by Bullinger [4] were used to systematize the requirements. Examples for these requirements are listed in Fig. 3.

Employees with know-how in many different functions are able to rotate between these functions and their work force or rather their capacity can be used more effectively regarding their utilization. For the same reasons highly skilled employees are also beneficial for the basic flexibility of the company. Possible further requirements are a high level of standardization in terms of forms and processes as well as working times and places. The standardization across business functions will result in shorter familiarization periods and enables the company to adapt to changes very fast. Standardization can also be beneficial for the goal orientation due to shorter familiarization processes. This also applies to the performance orientation.

If the company implements a flexible remuneration system as well as a flexible shift model, it is much more likely to adapt to changes. Compared to the changeability enablers, the enabler scalability requires both the increase as well as the decrease of capacities in a determined way which can be done by implementing these flexible systems. Compared to the seven factors it becomes clear, that basic flexibility of the whole system becomes more flexible because of the implemented systems. Subsequently the performance orientation of the organization is probably higher, because it is easier to adapt to changing conditions (e.g. seasonal fluctuations in demand).

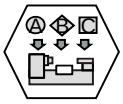
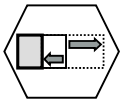
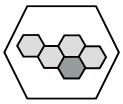
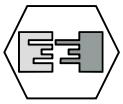
		Goal orientation	Transparency	Congruency	Scope for development	Change competence	Peformance orientation	Basic flexibility
Universality	 ▪ Highly skilled employees ▪ Standardization (processes, forms, etc.) ▪ …	✓ ✓	✓ ✓	✓ ✓		✓	✓ ✓	✓
Scalability	 ▪ Flexible remuneration systems ▪ Fast adaptable shift models ▪ …	✓ ✓				✓ ✓	✓ ✓	✓ ✓
Modularity	 ▪ Short familiarization periods by clear job descriptions ▪ Definition of interfaces ▪ …		✓ ✓				✓	 ✓
Compatibility	 ▪ Similar departmental structures ▪ Systematic and standardized exchange of information and expertise ▪ …	 ✓	✓ ✓	 ✓			 ✓	✓ ✓

Fig. 3 Systematization of organizational requirements

The requirement of a fast familiarization period and the new composition of teams will be supported by a clear

description of the tasks and duties as well as the job description. This also applies for the – in this context more relevant – enlargement of teams by the addition of new team members. All these requirements can be assigned to the changeability enabler modularity, because the ability to subdivide extensive tasks is one part of this enabler. A further requirement is the definition of interfaces between the employees. Every employee needs to know, which information in what quality is required by the (downstream) process partners.

The changeability enabler compatibility requires per definition the interconnectivity of material, information or energy. In reference to the organizational view, similar structures within teams or departments have a positive impact. Another aspect is the competence profile of the employees. The wider the knowledge of the individual employee, the better will be the adaptability on changes. This will be even more supported by a systematic and standardized exchange of information and expertise.

The changeability enabler mobility could not be assigned to any requirement concerning the organization. For further considerations this enabler is excluded.

V. Design Principles

After systematizing the requirements it is possible to derive design principles. As mentioned above, three different types of changeability were defined: spatial, organizational and technical changeability. In the following, some of the derived design principles will be specified.

One major factor is the implementation respectively the realization of (partial) autonomy within processes while defining clear job and task descriptions at the same time. For that, the relevant foundations need to be laid. Some examples are a high level of standardization, high qualified employees and cohesive teams. This can be realized through organizational changeability, e. g. definition of processes, but also through technical support: the relevant information is available for the teams at all times.

According to Rudow [15], different conditions need to be realized to implement team work successfully. It is promising to implement teams in a manageable area. This means, teams can work together in a specific and designated area to fulfill the task and support each other. This can be supported by spatial changeability, for example the installation of lightweight walls. For the team dynamic it is necessary to implement regular team meetings and CIP workshops. This could also be supported by considering meeting and CIP areas by planning the factory layout. It is also beneficial for a team to introduce a coordinator, who is responsible for the critical reflection concerning productivity goals and the task assignment based on the individual competences. Rudow also points out the importance of organizational changes to implement team work successfully [15].

A similar, i. e. a standardized structure for job descriptions can support the interchange of persons and functionalities between different business units, because every supervisor can get a quick overview of responsibilities. Combined with standardized competence profiles, the supervisor can select the persons, who are qualified the most for the new tasks. This describes the target of the changeability enablers' universality and compatibility.

Another example is an organizational structure which is scalable: The addition of new products can easily be managed, because in every function or department only few new employees need to be hired and integrated. This is also beneficial with regard to the familiarization process and the duration, because the effort for the individual incorporation will be spread out among several managers and departments. Standard processes and procedures can be applied and adjusted as required.

Taking all these information into account, it can be assumed that a functional structure of a factory organization is the most appropriate basic organizational structure, because it follows the production steps of the products and subdivides the organization into resource and performance related areas. This enables to optimize the different areas individually.

The resource related areas can be structured as very specialized teams with highly specialized employees for certain tasks. Examples are employees for purchasing and sales for individual product groups or similar specialized tasks. On the contrary, the performance related areas should be organized more autonomous. They also should have wide diversified teams, that work well together. If this can be realized, it is very likely to design a changeable organization that can adapt fast on changes.

VI. Summary and Outlook

Different design principles for factory organizations were illustrated in this paper. It became clear, that there are various aspects, which require the analysis of competencies that are beneficial for the adaptability of the employees, because a lot of the organizational design principles require highly skilled employees. For that, the Institute of Production Systems and Logistics will develop a methodology that supports the design of changeable organization structures within factories by taking into account the competence-related aspects of the employees. It will be shown, if and in what way the developed design principles can be included into the factory planning process.

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