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COMPETENCY MANAGEMENT APPROACH FOR CROSS ENTERPRISE PRODUCT DESIGN

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1. Introduction

Due not only to the increasing use of information technologies and the globalization the importance of and the demand for virtual and distributed collaboration across corporate boundaries for the engineering is rising, too. This also applies to the development of new and innovative products, which takes place more and more across organizations boundaries, the so-called cross enterprise engineering. In this dynamic environment the importance of human resources and the related challenges for employees working in this field also increases. [Picot 2003, Eigner Stelzer 2009]
These trends and developments have massive impact on activities and tasks of engineers as figure 1 shows. Comparing an average workday of 2000 with on of 2006, it reveals a clear shift of the main tasks from ordinary professional duties toward (project) management tasks, coordination, consultation activities, information and documentation tasks. [Schleidt 2009]

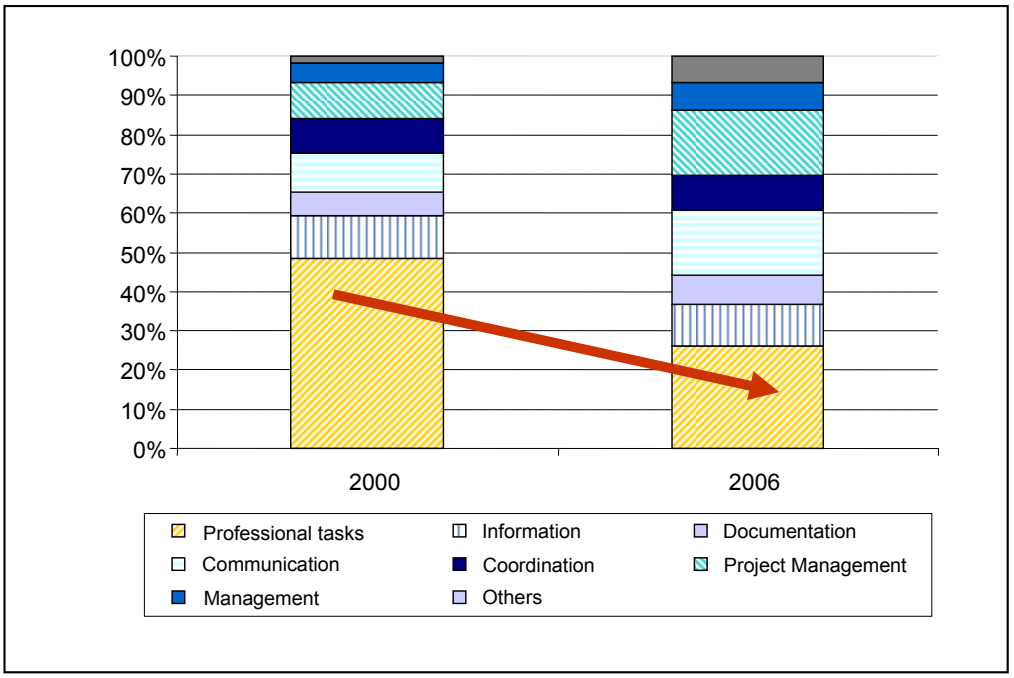

Figure 1. Change of tasks of an engineer – a comparison between 2000 and 2006

This shift of tasks on the individual level and work place seems to be related to the changing working conditions that happen over the last years. Individuals are - among other factors - asked to make use of other or adapted skills to successfully fullfill given tasks. The broad concept of the "human factor" in this case is restricted to competencies that employees require to work under the mentioned conditions. There are many more factors that contribute to the often complex situation of individuals, for instance the high speed of change, cost pressure, simultaneous activities in different projects or dealing with teammates from other cultures and resulting problems. [Schleidt 2009]
In the following paper we shall present an approach, that considers working conditions prevail in Cross Enterprise Product Design on the one hand and on the other hand the competencies needed on the individual level to successfully work under these working conditions. It is based on the idea of Quality Function Deployment and was developed as part of a dissertation project at the University of Kaiserslautern. The aims of the project were to develop criteria for the description of working conditions in Cross Enterprise cooperation, to identify relevant personal and social competencies and to investigate relationships of both areas. The main research question to be answered was: How can working conditions and competencies be matched with each other to increase the overall efficiency of cooperation?
The theoretical foundation of the approach is the so called theory of person environment fit. According to [Kristof-Brown et al 2005] person-environment fit can be seen as a general kind of compatibility between an individual and his working environment. This compatibility is often referred to as congruence, similarity, or convergence. It occurs, when certain characteristics of a person fit to the characteristics of the work environment in which it finds itself.

2. Working conditions in Cross Enterprise Engineering

Cross Enterprise Engineering encompasses the totality of all human activities to be provided throughout the product lifecycle across corporate boundaries for the development, operation and disposal of products. Product Design is part of this definition. These activities are supported by modern information technology, appropriate organizational forms of cooperation and working conditions-oriented approaches for human resource development. Cross Enterprise Product Design is included in this definition. [Eigner Stelzer 2009, Schleidt 2009]
Virtual and distributed teams in Cross Enterprise Engeneering and Product Design are defined as groups of employees that are located geographically, organisationally and/or timely shifted and mostly interact and communicate on the basis of information and telecommunication technologies to solve one or more common work tasks. Based on this definition and on the assumption that working conditions in Cross Enterprise Engeneering and Product Design are closely related to those of virtually working teams, the following criteria can be used to distinguish between cooperations and to describe existing working conditions:

- Location: Identifies the locations of the participating partners.These can be distinguished for example in: International, meaning cross country borders / national, within a country / regional, in close proximity to each other
- Time zones: Denotes the number of time zones, in which the project participants are located, can be distinguished for example in: one and the same zone / two different time zones / three or more time zones.
- Disciplines: Describes the different disciplines that are involved in the design process, for instance one discipline, two different disciplines (e.g. mechantronic and pneumatic), three and more different disciplines. [Schleidt 2009]

These criteria are mainly based on the research of [Chudoba et al 2005] and [Vartiainen 2006], who have dealt in their work with virtual teamwork and the measurement of virtuality and virtual working conditions over several years. Based on their results, in the next step the selected criteria were empirically and statistically evaluated in two studies. The result is an index, which can describe working conditions for Cross Enterprise Product Design. It is composed of the following criteria:

- Time zones: different time zones affected,
- Interaction and communication: media that are used to interact and communicate,
- Local distribution: distribution of the different project partner

- Diversity: intercultural, interdisciplinary and / or interfunctional composition of the project team,
- Project organisation: project management and structure.

Based on the calculation of reliability coefficients for each dimension could be demonstrated that these criteria are suitable to be included in an index. The calculation of product moment correlations of individual items of the dimensions was used to determine the strength of connections between the items. The actual index was then created, using a simple averaging of individual values of the dimensions. [Schleidt 2009]

3. The human factor: Social and personal competencies

[Vartiainen 2006] developed a model of human beings in virtual environments that shows that the properties and actions of individuals or groups modify the influence of tasks and environmental complexity on performance and the results of a working system.

An individual may - while running internal processes - regulate and manage external influences. In this approach, a human being is understood as an open system, that exists and also is able to exist because it is able to interact with its environment. Competencies of an individual can be seen as part of cognitive functions.

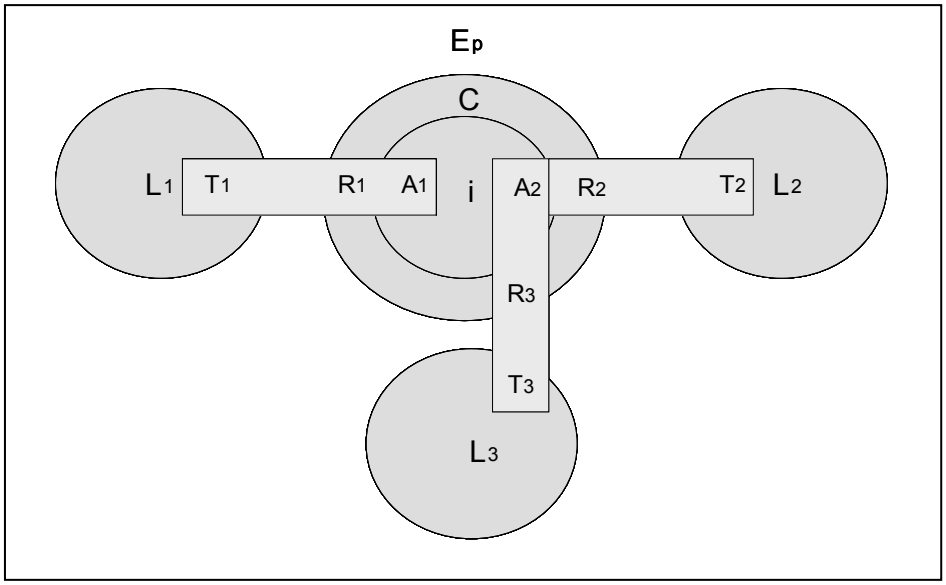

Figure 2. Individuals in distributed working environments [Vartiainen 2006]

Explanation of figure 2: Ep = external environment of a person, L1 to L3 = different locations of work, C = cognitive functions of a person, i = internal world of a person, T1 to T3 = different tasks, R1 to R3 = different roles, A1 and A2 = attitudes. This model reflects the complexity of the situation, which employees have to deal with under working conditions like they are increasingly existing in Cross Enterprise Engeneering and Product Design.

As mentioned, the "human factor" concept is liable to a very broad range of interpretations, so that we restrict it in this work to personal and social competencies that employees require for working under the conditions described in chapter 2. One main argument for this limitation is also, that competencies represent a modern and widely accepted approach to the planning and implementation of staff development activities in companies. For us, the competency concept builds a sense making and innovative interface between engineering sciences and economic psychology.

In this project the research on competencies and connections between working conditions and competencies required have been significantly influenced by the findings of [Konradt Hertel 2007], because they like [Shin 2004] clearly pointed out that research is needed regarding the relationship between existing working conditions and required competencies. [Shin 2004] assumes that work environments that are characterized by virtuality are not suitable for all people equally and that people

need a combination of certain attributes to work effectively in virtual environments. She sees among others the following attributes as the most important ones: Valuing autonomy, flexibility and diversity, trustworthiness, lateral skills or domain knowledge. Although Shin emphasized that these attributes are likely to need, not only in virtual environments, she assumes that these are most important to achieve a fit in virtual environments. Simultaneously, she expects that the extent to which those mentioned attributes are required, depends on the degree of virtuality of a work environment. Therefore she embeds these considerations in an approach of the fit between person and environment.
Based on the literature research and on the results of the first study of the project in the second study 12 "soft" competencies were derivated and evaluated. To achieve a reduction of the number of items and competencies a principal component analysis was performed. Based on the results the following competency dimensions were formed:

- Entrepreneurial acting competency,
- Communication competency,
- Self-management competency and
- Work-life-balance competency.

The original questionnaire was reduced to 25 competency variables. For these four competencies satisfactory Cronbach's alpha values could be reported. An analysis of the intercorrelations revealed, as in the original 12 competencies significant relationships between the single items. [Schleidt 2009]

4. Competency Management Approach

As mentioned above, the theory of person-environment fit builds the foundation for the approach described in the next paragraph. It is based on the assumption, that employees need - in addition to other psychological requirements like for example motivation - a special set of competencies to be able to deal with varying working conditions in Cross Enterprise Engineering and Product Design. If competencies match (or "fit") to the existing working conditions, an important prerequisite is met to work more efficiently together. Figure 3 shows the theory and the linkage to the competency development approach. [Schleidt 2009]

When transfering the approach into practice and drawing up the so-called "House of Engineering Competencies", the aim is to match and harmonize on the one side working conditions and on the other side employee competencies, that are required for these conditions. The approach is based on the Quality Function Deployment (QFD) method, that has been used successfully for many years as a quality assurance methodology, for instance in the area of product development. According to [Akao 1992], who introduced this method in the shipbuilding industry in 1972, Quality Function Deployment is understood as a planning tool to develop a product quality function in line with the quality characteristics required by the customer.
In the approach we describe, the underlying QFD system is adopted and applied to the harmonization and interrelationships between existing working conditions in Cross Enterprise Engineering and Product Design and the corresponding competencies required by employee working in these conditions.
The individual steps for the development of the House of Engineering Competencies are as follows:
First, the working conditions that exist for employees will be analysed. These conditions are listed horizontally in rows and will be prioritised if necessary. Next, staff competencies are identified that contribute to the successful handling of the working conditions that have been identified in the first step. Therefore, technical, methodological, social and personal competencies can be distinguished. They will be entered into the vertical columns of the table. Thereafter, the interaction between skills and working conditions are evaluated. The relation may either have qualitative character, for example for the purposes of identification of general connections or can have concrete numerical values to develop figure based competency profiles. [Schleidt 2009].
Based on the results of this process it is possible to adopt active, targeted employee development measures to carry out a comparison between the competencies that are actually present (= as-is competency profile) and any competencies that are additionally required or are required in a different form (= to-be competency profile). Any skill gap that may exist, can then be addressed by means of

employee development measures. In this context, the House of Engineering Competencies can be understood as an instrument for analysis, communication and planning, based on a tabular structure.

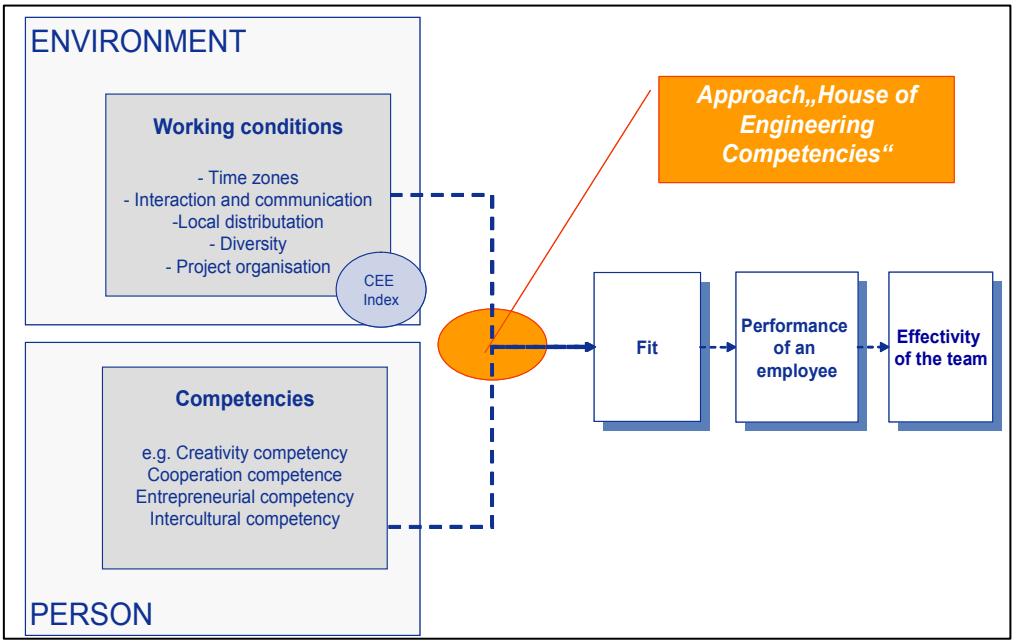

Figure 3. Theoretical approach

The content that finally fills the column and rows can be worked out in group discussions in one or more workshops. Another option is to use the index for working conditions that have been described in chapter 2 and the competency model introduced in chapter 3 as input. As the development of the House of Engineering Competencies is actually a theoretical approach its evaluation in practise should be the next step. [Schleidt 2009]

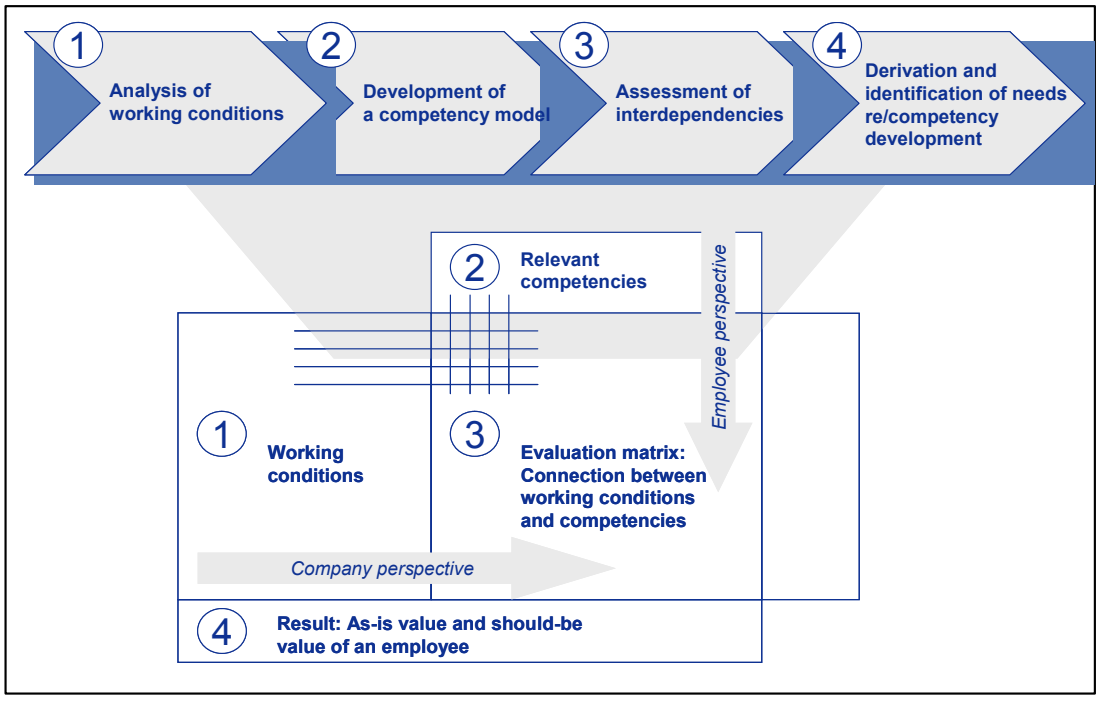

Figure 4. Steps to build the “House of Engineering Competencies”

5. Summary

The described competency management approach can make a significant contribution to increase the efficiency of cooperation in Cross Enterprise Engineering and Product Design projects. On the one hand the importance is the fact, that there has been just few approaches to combine and systematically bring together working conditions and competencies needed for these conditions. On the other hand, it makes the often "fuzzy" term "human factor" more tangible. Last but not least, the concept of competencies is a modern and meaningful starting point for multiple people development initiatives.

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