Capturing Knowledge Within A Competence

Anders Paarup Nielsen
Department of Production,
Aalborg University,
Fibigerstraede 16, DK-9220 Aalborg O,
Denmark
Phone: (+45) 96 35 89 64;
Fax: (+45) 98 15 30 30;
E-mail: apn@iprod.auc.dk

Abstract

Departing from a knowledge-based model of a competence this paper will address how the different types of knowledge within a competence can be captured and analyzed. The paper adopts a knowledge-based view of competencies and a competence is perceived as composed of three different types of knowledge. The paper then progress by describing a number of problems that emerged from using the knowledge-based view in connection with competence analysis. These problems are primarily related to the tacitness of the knowledge making verbal descriptions insufficient. To address these problems a model is developed that can capture the relations between the different types of knowledge and the need the competence is fulfilling. The final parts of the paper discuss the use of the model in connection with the company's competence development activities. The paper progress by outlining a number of different situations in a company's competence development – each situation departing from the relation between changes in the different types of knowledge.

Keywords:

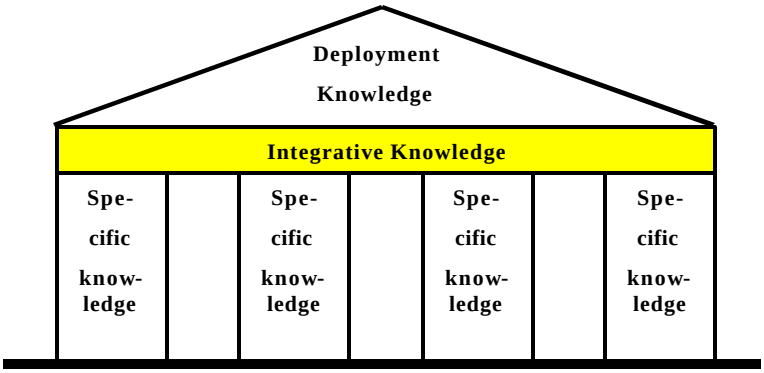
Competence analysis and development, Knowledge Management, Technology Management

Introduction

A major problem facing many companies is that just acquiring new areas of knowledge (and technologies) does not lead to the creation of new competencies. Competencies will only emerge after the different areas of knowledge within the competence have been integrated into a "functioning system" capable of fulfilling a need – this requires the development of what is termed "integrative and deployment knowledge" in the company.

This paper departs from the model of a competence developed by /Nielsen 1997, 1998/. Nielsen conceives a competence as consisting of three different types of knowledge – specific, integrative (or integration), and deployment knowledge. The first type of knowledge is knowledge about specific areas or knowledge domains, such as a technology or a scientific discipline. However, a competence will (in most cases) be dependent on the integration or combination of several (many) areas of specific knowledge. Integrative knowledge can be seen

as a representation of the knowledge underlying the ability to integrate the different domains of specific knowledge. Specific and integrative knowledge is, however, of little value if this



knowledge is not used to create economic or commercial value for the company. A company needs to have knowledge about how to derive value from its technology and knowledge bases in order to survive in the market place. This leads to the third type of knowledge that focuses on how to exploit and use the preceding two types of knowledge in the creation of competitive advantage (see, e.g., /Nevis *et al*. 1995). This type of knowledge can be seen as an expression of the abilities in the company to derive value from its stock of knowledge through effective commercialization. The model from /Nielsen 1997; 1998/ is illustrated in figure 1 below.

Figure 1. Model of a competence /Nielsen 1997; 1998/

It should be emphasized that a competence is dependent on the existence of all three types of knowledge and the development of competence will require that all three types of knowledge is developed in conjunction.

The major characteristics of the different types of knowledge can be seen table 1 below. The table is based on the findings from a number of case studies as well as theoretical predictions. The first dimension is the content of each type of knowledge, e.g., what is the knowledge about. The second dimension is concerned with the location of the type of knowledge – internal or external to the company. The third dimension is concerned with the level of articulation – is the knowledge tacit or explicit. Finally, the fourth dimension is concerned with the expected level of diffusion of the type of knowledge, e.g., is the knowledge shared among many members of the organization or is the knowledge only diffused among a few members in the organization, e.g. a small team of experts

Dimension Type of knowledge	**Content**	**Location**	**Articulation**	**Level of diffusion**
Specific Knowledge	For example: Technologies and scientific disciplines	Internal as well as external to the company	Often documented and explicit	Diffused as well as un-diffused
Integration Knowledge	Combinations, relations, and	Typically internal	Will often have tacit elements	Often shared and diffused in the

	systemic effects	to the company		organization
Deployment Knowledge	Exploitation and use	Internal to the company	Will often have tacit elements	Often shared and diffused in the organization

Table 1. Characteristics of the different types of knowledge.

Table 1 illustrates that integrative and deployment knowledge often will be complex especially because of the lack of articulation and the high level of diffusion. Using the model suggested in figure 1 for competence analysis often proved to be difficult and it was necessary to impose some sort of structure on the analysis. One way of achieving this is to use hierarchical analysis. In the following sections a way of describing competencies based on the principles from hierarchical analysis will be developed.

Analyzing competencies using hierarchical analyses

The idea of hierarchical competence analysis has been suggested by /Grant 1996/ who have discussed the possibility of establishing a hierarchy of competencies -- ranging from the competencies of the company to the competencies of the individual. A simple form of hierarchical analysis is the well known "Bonsai Tree" model suggested by Giget – see, e.g., /Purcell et al 1997; Coombs 1996/. The "Bonsai Tree" model attempts to illustrate the connection between the company's products (the branches and leaves of the tree) the company's competencies (the trunk of the tree) and the technologies and skills constituting the competencies (the roots of the tree). The key activity in connection with the transition from a lower level competence to a higher level competence is the integration of a number of lower level competencies /Grant 1996/. An activity related competence would thus be characterized by the integration of several specialized competencies. It is believed that the idea of using a hierarchical decomposition of a competence could add to the clarity of the analysis by enabling the researcher to identify competencies at different levels and also the relations between these competencies.

The principle underlying the hierarchical decomposition resembles the principles deployed in Quality Function Deployment (QFD) (see, for example, /Hauser & Clausing 1998/). QFD is a method whereby the customer's requirements and preferences with respect to a product can be decomposed into a number of product characteristics. The product characteristics can in turn be decomposed into engineering characteristics, and the decomposition will continue until a number of requirements for the production processes needed to produce the desired product have been established.

However, hierarchical analysis can not be expected to provide means for the identification of the different areas of knowledge which contribute to a competence -- they can only serve as a tool for the structuring and classification of the different competencies once they have been identified. It is therefore necessary to supplement the hierarchical analysis with tools that can facilitate the identification of the individual areas of knowledge constituting the competence. Resource analysis is believed to provide such tools – see, e.g., /Grant 1995 Table 5.1/ or /Leonard-Barton 1995 Figure 1-3/. Resource analysis (as described by Grant and Leonard-Barton) is perceived to be best suited for the identification of specific knowledge.

However, using resource analysis will often merely provide long lists of different resources with little or no emphasis on the integration between these resources. Thus resource analysis on its own is apparently insufficient to capture the complexity involved in a competence.

Capturing integrative knowledge

Using a method for hierarchical decomposition of a competence inspired by the focus on relations found in QFD would enable the company to gain deeper insight into the configuration of the competence. It is therefore suggested to use a number of tables resembling the different "houses" from QFD. The principle in this type of analysis is illustrated in Figure 2 below. It should be emphasized that this method resembles the well-known technique of the "influence matrix" (see, e.g., /Brynjolfsson 1997 Figure 2/ for a discussion of a similar technique that is used to identify system interactions between different elements of a system). Figure 2 uses the competence in new product development from a case company as an example.

The limitation of this method is that it can only be used to describe and analyze one competence level at a time, so it can be necessary to open up the individual competencies in a new matrix for the next hierarchical level. The advantage is that the method facilitates the analysis of integrative knowledge. This is done in the triangular part of the figure. The triangular matrix can be used to identify the relations between the areas of specific knowledge contributing to the competence. The triangular matrix can thus be seen as an instrument to capture the integrative knowledge contributing to the competence. Using the matrix provides greater insight into the "content" of the integrative knowledge because the matrix permits a concrete description of the relations between the different types of specific knowledge. The individual fields (or cells) in the triangular matrix are used to describe the direction (positive or negative) and strength of the relation between the two areas of specific knowledge. The rectangular fields connected to the triangular matrix contain the different areas of specific knowledge constituting the competence.

The following Figure 2 illustrates the use of the influence matrix to describe the aspects of integrative knowledge in the new product development competence of a Danish producer of medical measurement equipment for human blood.

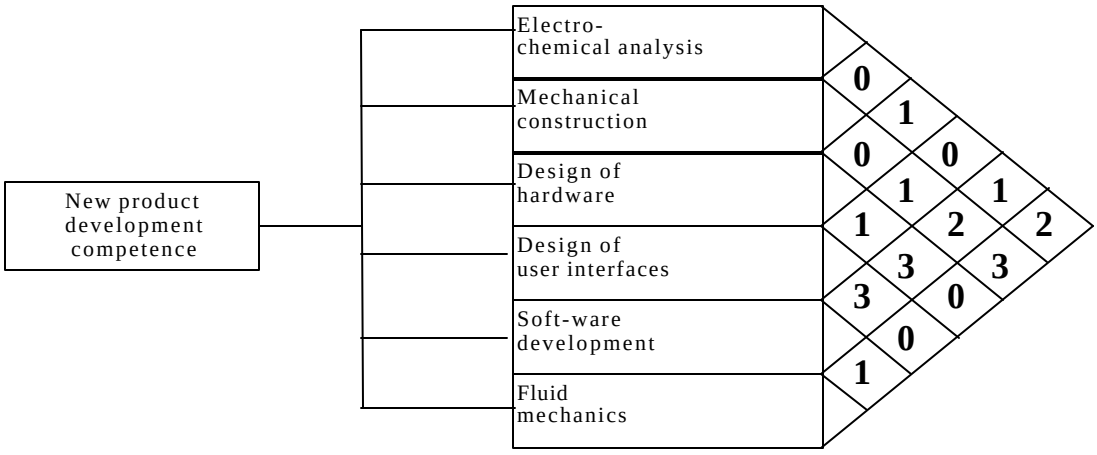


Figure 2 The new product development competence of the case company.

The integrative knowledge in the figure is described using an integer to indicate the strength of the relationships between the different areas of specific knowledge -- the higher the integer the stronger the relation. The analysis in the figure demonstrates that software development is a key area of specific knowledge in the new product development competence of the case company. Using integers (or other symbols) to describe the strength of the relationships can also be used in connection with the analysis of the effort required to change or add an area of specific knowledge to the competence, thus determining the required change in integrative knowledge. This aspect of competence development will be discussed in the concluding sections of this paper.

Capturing deployment knowledge

The final problem encountered in the case studies is concerned with the identification of deployment knowledge. Deployment knowledge is perceived to be an expression of the knowledge needed in order to use specific and integrative knowledge in a purposeful manner. It is believed that the key to the identification of deployment knowledge lies in this purposefulness. The starting point for the identification of deployment knowledge should therefore be the ways in which specific and integrative knowledge is used in the company. This analysis should be carried out using as a starting point the need which the competence is going to fill -- for competencies at the highest level the need should be related to the demands of the customers, while for lower level competencies the need should reflect the desired "role" of the competence in relation to value creation in the company.

However, it is difficult to find ways whereby the deployment knowledge can be visualized in connection with the identification and analysis of the competence. The use of a method inspired by the first house in QFD, where customer needs are being translated into product requirements, has, however, been considered. This makes it possible to gain insight into the aspects of deployment knowledge, which are concerned with the purposeful use of the different areas of specific knowledge contributing to the competence.

Describing a competence

The considerations in the sections above make it possible to develop a description of a competence, which takes both the individual elements and their relations into account. The use of a figure resembling the first house in QFD, as illustrated in Figure 3 below, is suggested. Using this way of describing a competence makes it possible to capture important elements of a competence by providing the means for articulating integrative and deployment knowledge within the competence. Figure 3 is based on the same case as figure 2.

It is believed that this model permits a clearer separation between the different types of knowledge in the competence than it is possible by relying on a verbal description in isolation. Furthermore, it is believed that this way of describing a competence will facilitate the visualization of its elements as well as the relation between the different elements. It is also believed that this model will be applicable to competencies at different hierarchical levels. However, it should be emphasized that the matrix needs to be supplemented by a verbal description of the integrative and deployment knowledge within the competence. Having

discussed both the problems in identifying the constituents of a competence and their possible solutions, the chapter will now go on to discuss a number of problems related to the description of the development of a competence.

Implications for competence development

The paper will now proceed by elaborated the possibilities for describing a competence using the tools in Figure 2 and 3. Special attention will be given to the possibilities for analyzing the interrelations between the development of the different types of knowledge. This section will address this matter by describing the relations between changes in the different types of knowledge and using this to describe the magnitude of the competence development activities. It is believed that the models in figure 2 and 3 make it possible to analyze the relations between changes in the different types of knowledge constituting the competence.

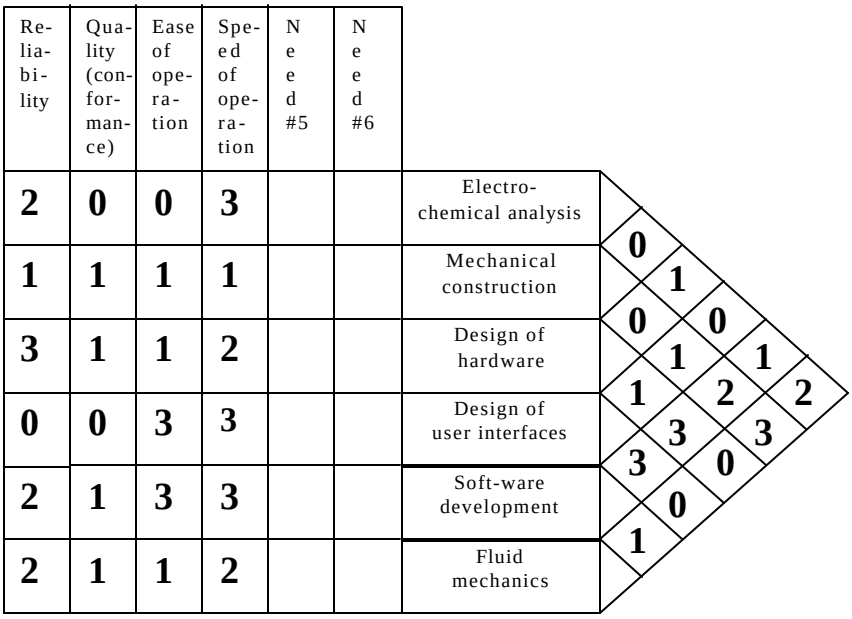


Figure 3: Describing a competence.

One of the major ways to influence the competence development process is to influence the selection of areas of specific knowledge that are to be changed or new areas of specific knowledge that are to be integrated into the competence. This is because the different areas of specific knowledge will typically be the easiest to identify, demarcate, articulate and, thus, transfer. New areas of specific knowledge can often be acquired from external sources without a major effort. However, the problem is not the acquisition (or even the development) of specific knowledge -- the real problem and challenge for a company is the integration of the new areas of specific knowledge into the pre-existing competence. Furthermore, the most appropriate (and often the only possible) way to influence the emergence of a competence is to work with the acquisition or development of areas of specific knowledge. However, it should also be emphasized that a competence can in some cases also be developed through reconfiguring – changing the integrative knowledge of the competence without making major changes in the

contributing areas of specific knowledge (this has been termed “Architectural Innovation” by /Henderson & Clark 1990/).

This section will discuss a number of models that can aid the company in assessing the magnitude of the competence development activities and in visualizing the relationships between changes in the individual areas of knowledge in the competence. The section will use two approaches to discuss changes in a competence. Firstly, the relation between changes in specific knowledge and changes in integrative knowledge – this type of change can be seen as dealing with changing (and hopefully improving) the "productive capacity" or the "efficiency" of the competence. Secondly, the relation between changes in deployment knowledge and changes in integrative and/or specific knowledge – changes in deployment knowledge can be seen as dealing with changing (and hopefully improving) the way in which the competence is used to create value for the customers or the company itself.

Changes in specific and/or integrative knowledge

The problem of integrating specific knowledge into a pre-existing competence is observed in the case company in connection with the change from analogue to digital processing, which involves the inclusion of knowledge related to software development into the new product development competence. It is expected that this "technology fusion" will require a substantial amount of time and resources before it is completed. The case study also illustrate that changing a competence often requires the integration of specific areas of knowledge into the existing competence and this will typically trigger some kind of reconfiguration of integrative knowledge. However, this reconfiguration can also be triggered without changes in specific knowledge, for example by the discovery of hitherto unknown relationships between areas of specific knowledge or by the desire to strengthen the competence by reinforcing the relations between areas of specific knowledge.

At this point it is necessary to return to the model presented in Figure 2. This model can also be used to identify the need for the development of integrative knowledge in connection with the absorption of new areas of specific knowledge into the competence. The model in Figure 2 can be used as a starting point for the identification of the need for development of integrative knowledge by identifying and describing the relations between the different areas of specific knowledge – the need emerges as the difference in integrative knowledge in the present situation (without the new area of specific knowledge) and in the future situation (with the new area of specific knowledge). It is believed that the need for development of integrative knowledge can be described in a three-by-three matrix, as shown in Figure 4 below.

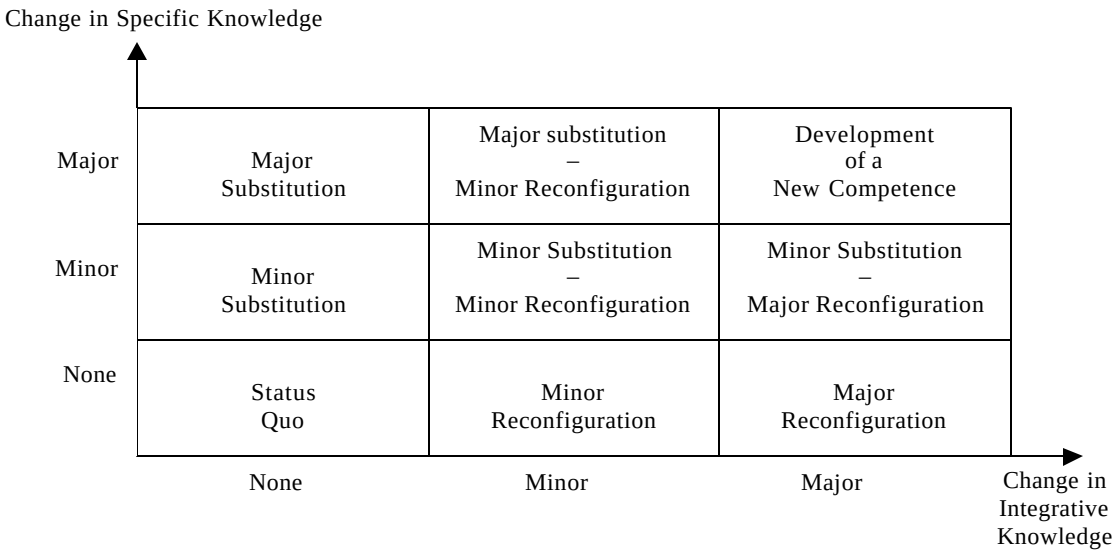


Figure 4: Identifying the ease of changing specific and integrative knowledge within a competence.

The matrix has two dimensions. The first dimension is the expected size of the change in the specific knowledge, for example expressed by the proximity of the new knowledge to the pre-existing areas of knowledge in the competence. The greater the change, the more complex the task of integrating this knowledge with the pre-existing knowledge bases. The second dimension is the need to change the integrative knowledge within the competence – either as a consequence of the adoption of new areas of specific knowledge or as a consequence of an attempt to "reconfigure" the competence. The matrix is illustrated in Figure 4 and is inspired by the work of /Henderson & Clark 1990/ on architectural innovation. The cells in the matrix identify nine different situations in connection with the development of the "productive capacity" (or efficiency) of the competence.

Using the matrix makes it possible to identify the magnitude and direction of the knowledge (and thus competence) development activities. Minor changes in a competence will be located in the lower left corner of the matrix and can be seen as an incremental improvement of the competence that only will require limited resources; it can be expected that a change of this type will be unproblematic and fairly straightforward. At the other extreme is the "development of a new competence" (the upper right corner of the matrix). It can be expected that such an activity will be challenging and require a substantial amount of time and resources. However, the matrix outlined in Figure 4 does not take changes in deployment knowledge into account – this will be the focus of the following brief section.

Changes in deployment knowledge

Deployment knowledge is concerned with the purposeful use of the competence in connection with value creation in the company. Changes in deployment knowledge will therefore typically be triggered by changes in the need, which the competence is currently fulfilling, for example by the emergence of new customer requirements. It is believed that it is possible to describe the challenges faced by a company as in Figure 5 below. Figure 5 has two dimensions:

"change in deployment knowledge" and "change specific and/or deployment knowledge" and describes nine different situations associated with changes in the competence.

The situations involving no change in specific and/or integrative knowledge, but a change in deployment knowledge, represent situations where the competence is being used in novel ways. The situations involving changes in specific and/or integrative knowledge, but no change in deployment knowledge, represent situations where the "productive capacity" or "efficiency" of the competence is improved (this situation is described in Figure 4).

The four situations involving changes in both deployment and specific and/or integrative knowledge are described below. The situation called "adjustment" represents a minor (routine) change, typically in connection with the continual improvement of the competence. "Efficiency seeking" represents the situation where the competence is changed dramatically, but continues to fulfil an existing need -- an example of this is found in case company A in connection with the inclusion of software development into the new product development competence. The need that the competence is filling remained the same, but new technologies and knowledge areas were used. "Expand use" represents a situation where the use of an existing competence is expanded to cover new needs, for example by using the existing competence in a new line of products. Finally, "new game" represents a situation where the company attempts to develop an entirely new competence, for example to enter new markets. "New game" is believed to be the most complex situation while "adjustment" is believed to be the least complex.

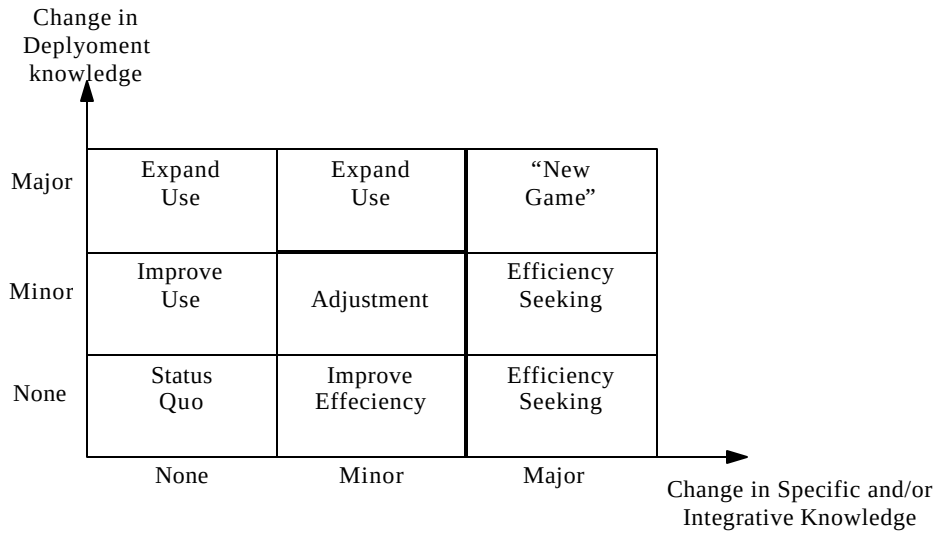


Figure 5: Matrix describing possible situations in changing the deployment knowledge within a competence.

The discussions above of the magnitude of the competence development activities and the two matrices describing the possible situations can be used to describe the challenges involved in competence building (or changing) from a managerial point of view. It should be emphasized that competence building can be triggered by many different factors, such as managerial decisions in a company to strengthen a competence, the emergence of new

technological possibilities, or the emergence of new uses of the competence in the market. Thus competence building can be triggered by "technology push" as well as "market (or need) pull."

If technology push is triggering the competence building activities, the starting point will typically involve analyzing the change in specific knowledge and thereafter the effects on the integrative knowledge of the competence. The magnitude of the competence development task can then be determined using the matrix from Figure 4 and thereby also using the "influence matrix" suggested in Figure 2. In connection with "technology push" it should also be emphasized that reconfiguring a competence by changing integrative knowledge can be seen as an example of technology push. Technology push was observed in one of the case companies where the emergence of software controlled equipment was perceived increase functionality -- this then led to the adoption of knowledge areas related to software development

If market pull is triggering the competence building activities, the starting point will involve analyzing the required change in deployment knowledge. The matrix in Figure 5 can then be used to identify the magnitude of the competence development activities. However, it should be emphasized that this matrix should be supplemented by an analysis of the changes in specific and integrative knowledge using the matrix from Figure 4.

Summary and conclusion

Departing from the model of a competence suggested by /Nielsen 1997, 1998/ this paper has developed a number of methods and tools whereby competencies can be described and analyzed. The model conceives a competence as consisting of three different types of knowledge – specific, integrative and deployment knowledge. The model has been substantiated through case studies, but the case studies also revealed that using the model created a number of problems, as it is difficult capture the three different types of knowledge by relying on verbal descriptions.

This paper has attempted to develop means by which a competence can be described and analyzed from a knowledge-based perspective. The major challenges involved in describing a competence is related to the nature of the knowledge involved, as parts of the knowledge often is tacit and shared among members of the organization. To overcome these problems it has been suggested to describe a competence using a matrix resembling the first house from Quality Function Deployment. Using the matrix (see Figure 3) makes it possible to capture elements of the integrative and deployment knowledge of a competence. Furthermore, the description of a competence enables the analysis of the effects of changes in one body of knowledge on the other bodies knowledge within the competence. Analyzing the changes in the different bodies of knowledge makes it possible to determine the magnitude of the knowledge development activities at hand. Based on the relations between changes in the different types of knowledge it is possible to outline a number of different situations ranging from no development at all to the development of completely new competencies. The paper concludes by emphasizing the competence development can be triggered by mechanisms related to “technology push” as well as “market pull.”

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Biographic Sketch:

Anders Paarup Nielsen holds a Masters Degree in Industrial Engineering from the Technical University of Denmark. He also holds a Ph.D. in technology management from the Technical University of Denmark. Presently he is assistant professor at Department of Production, Aalborg University in Denmark. The area of research include technology and competence development and he is presently part of the management group in the "Center for Industrial Production" Aalborg University. The center is considered to be the national center of excellence in industrial manufacturing in Denmark. Anders Paarup Nielsen has published in a number of Danish and international journals and conference proceedings on issues related to competence development in industrial enterprises.