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COLLABORATIVE PLANNING IN COMPETENCE-CELL BASED NETWORKS

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Autonomous, elementary units of production, co-operating in temporary networks, are considered as a key organisational form of enterprises in the 21st century. A scientific approach is provided by networks based on customer-oriented, directly linked, smallest autonomous business units called Competence Cells. This approach leads to new requirements for the planning of production systems of such networks. To meet them a framework called 'PlaNet – Planning Concept for Networks' has been developed and is outlined. PlaNet provides the means for Competence Cells to solve their planning problems. The implementation of PlaNet is the Net Planning Assistant as a modular toolset.

1. INTRODUCTION

Autonomous, elementary units of production, co-operating in temporary networks, are viewed as a key organisational form of enterprises in the 21st century. A scientific approach is provided by Non-hierarchical Regional Networks based on customer-oriented, directly linked, smallest autonomous service units called Competence Cells. Simultaneously this concept points out perspectives for present-day small and medium-sized enterprises (SME) to face ever-changing economic conditions.

The approach results in new requirements on the planning of logistics structures and production plants. Therefore the Planning Concept for Networks 'PlaNet' has been developed. PlaNet assists the Competence Cells in tackling their planning problems. The methodical concept of PlaNet is based on the Systems Engineering Methodology.

The implementation of PlaNet is the Net Planning Assistant (NPA). NPA can be configured according to the requirements of the particular planning process by choosing the appropriate tools. These commercially available and proprietary tools are cross-linked through a Production Database. A special emphasis is placed on tools for participative planning.

The approach of Competence-cell based Networks is introduced in section 2. PlaNet is introduced in section 3. NPA is then presented in section 4.

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2. COMPETENCE-CELL BASED NETWORKS

2.1 Motivation

There are currently two extreme cases regarding the development of enterprises.

Firstly, there are mergers and acquisitions leading to the development of large-scale enterprises, who usually act as 'global players', concentrating more and more capital.

The other extreme is characterised by an increasing 'atomisation' of enterprises, which concentrate exclusively on their core competences. The economical impact of SMEs is undisputed. With their high share of gross value added they form the backbone of most economies in terms of employment and innovation. For example in Germany the SMEs earn about 50 percent of the gross value added and employ two thirds of the workers. (BMWi, 1998)

Furthermore since the start of the 21st century empirical evidence suggests that the economical impact of micro-enterprises will increase (European Commission, 2004). The bottom line is that

the typical European enterprise is a micro-enterprise.

In this context a key scientific question is how small performance units can become while still remaining capable of competing in the market place independently? Another relevant question is how these smallest-scale enterprises need to act in order to optimally exploit existing potential? This potential is lying in an increase of the competitiveness compared to large-scale enterprises as well as in the increase of the share of exports in the revenues.

Small enterprises have apart from their specific core competences only limited resources. Due to this they can realise only sub-sequences of process chains. Missing competences must be obtained or be supplemented by co-operation and cross-linking. That way the ability for a holistic customer-oriented provision of complex products respectively services can be acquired.

Present forms of co-operation are mainly based on hierarchical structures within and between enterprises. These co-operations are often dominated by a single large-scale enterprise. Dependencies are mandatory. The achieved advantage of relative stability conflicts with the disadvantage of unilateral dominance. These dependencies work as restrictions for regionally established enterprises. They lead to significant market entrance barriers for small- and smallest-scale enterprises and in particular for business start-ups. As a result some regional competences are not completely utilised and an economically desirable dynamic in establishing and developing small enterprises is obstructed.

To overcome these disadvantages it is necessary to aim future efforts at the development of non-hierarchical production structures. This is supported by studies that consider autonomous, elementary business units (Laubacher et al., 1997), co-operating in temporary networks (Malone and Laubacher, 1998) also called 'nanocorps' (Salmons and Babitsky, 2001), as the form of enterprise organisation of the future.

Clusters of SMEs have gained considerable importance in a number of other European countries besides Germany such as Italy (UNIDO, 2006) and France (Villarreal Lizárraga et al., 2005).

There is a need to lay a scientific foundation to the so far rather empirical exploration of collaborative networks. (Camarinha-Matos and Afsarmanesh, 2005)

2.2 Vision and Concept

Due to this development in manufacturing organisation, which in recent years has been lastingly influenced by phenomena of elementarisation and specialisation of competences as well as customer-oriented networking, a specific vision aimed at small and medium-sized business (Figure 1) has been developed (SFB457 1999).

Elementary business units – called Competence Cells – are co-operating in Non-hierarchical Regional Production Networks in a customer-oriented manner and thus capable of facing global competition.

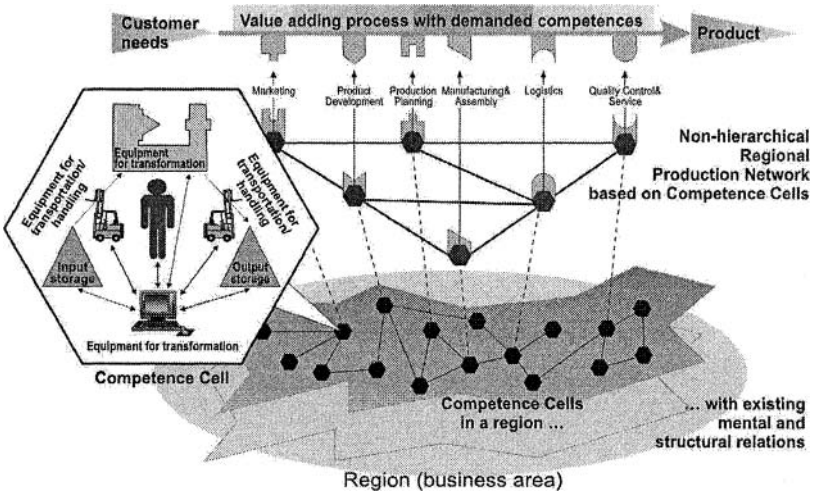

Figure 1 – Conception of Non-hierarchical Regional Production Networks (SFB457 1999)

It is the long-term goal to investigate this vision in its entirety from a scientific perspective. Theories and models will be formulated in order to describe standards of Non-hierarchical Regional Production Networks and to subsequently develop concepts, methods and instruments for generating and operating such networks.

Such structures of the value adding process will contribute to the development of micro firms and furthermore sustainable regional production profiles.

Initially objects of research will be determined by the customer-oriented single piece and small-batch production conducted by mechatronical engineering companies and regional profiles. (SFB457 1999)

In recent years an increasing attention has been paid to 'Virtual Organizations' (Camarinha-Matos et al., 2005), 'Collaborative Business Networks' (COBTEC, 2005) and 'Virtual Organization Breeding Environment' (ECOLEAD, 2005). Often similar assumptions to those of the vision of Competence-cell based Networks have been made. All these research projects are striving for new forms of organisation which meet the new opportunities provided by working together in networks of production. However the central features of the Competence-cell based Networking

Approach – elementarity and autonomy of the performance units as well as the lack of hierarchies and the regionality of the networking – are not explicitly investigated. The focus of these projects is rather on supra-regional, hierarchical value adding organisations with special emphasis on certain aspects of information and communication technology.

2.3 Competence Cell

A Competence Cell is considered as the smallest autonomous indivisible performance unit of value adding, able to exist independently.

The model of the Competence Cell (Figure 2) consists of:

- the human with his competences, arranged according to professional, methodical, social and personnel competences (Erpenbeck, 1998)
- available resources as well as
- the fulfilled task or executed function.

With this function a business entity can be transformed and a certain performance can be achieved. The aspects of dimension and structure were supplemented to obtain a complete technical description. (Müller et al., 2004)

2.4 Networking

In order to substantiate the vision of Competence-cell based networking a Procedure Model has been developed (Figure 2).

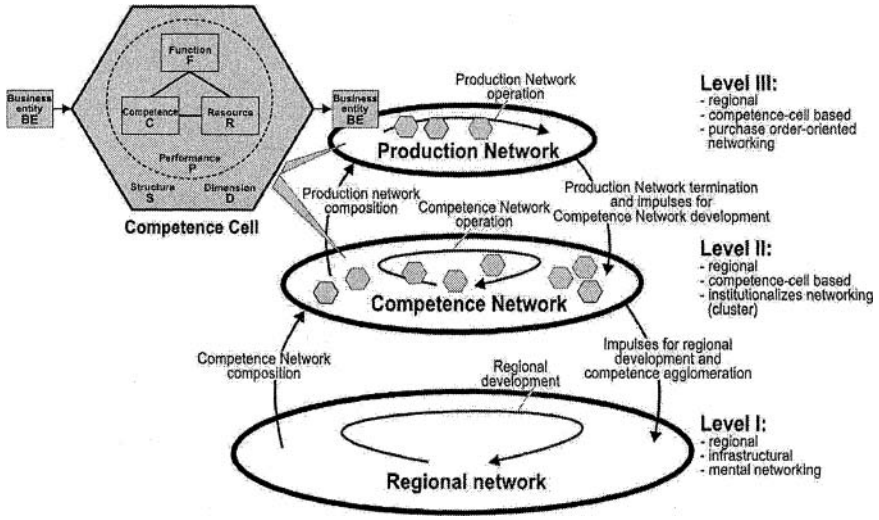

Figure 2 – Model of the Competence Cell and Procedure Model of Competence-cell based networking (revised from Müller et al., 2004)

The model comprises three levels and seven phases.

From loose infrastructural and mental relations present in a regional network (Level I) there initially emerges an institutionalized Competence Network, based on Competence Cells (Level II). Institutionalisation takes place via the coordination of

behaviour (e.g. agreements on offer generation, agreements on cost allocation) and via the pooling of capacity (e.g. common servers and data bases). These facilitate an efficient acting towards the customer and avoid internal discrepancies. Institutionalisation thereby creates the basis on which autonomous Competence Cells join to find to a collective creation of value. In order to hold fixed expenses down, the institutionalisation is to be limited to the necessary amount.

The actual creation of value takes place in a Production Network (Level III), i.e. a temporary linking of selected Competence Cells, initiated by customer request. In order to select and cross-link Competence Cells and to operate the network, co-ordinated ways of behaviour and pre-installed structures are available in the Competence Network. (Müller et al., 2004)

3. PLANET – A PLANNING CONCEPT FOR NETWORKS

3.1 Requirements on Planning of Logistics Structures and Production Plants in Competence-cell based Networks

The Competence-cell based Networking Approach puts special requirements on the planning of logistics structures and production plants. Among them are the extended domain of planned objects, the greater responsibility of the autonomous units which on the other hand might lack planning competence and the participative way in which planning needs to be done due to the lack of hierarchies. Those requirements are only partly met by existing planning approaches.

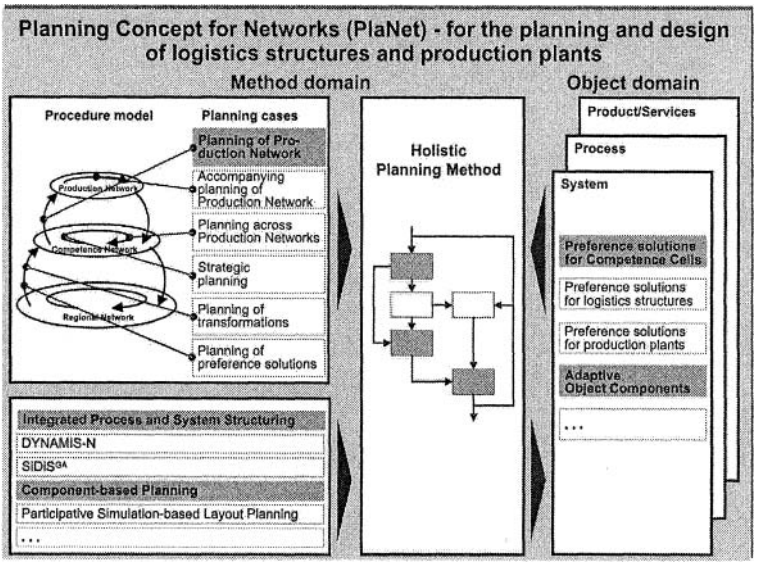

Figure 3 – Planning concept with Holistic Planning Method (Müller et al., 2004)

Therefore a new framework for planning in networks of competence is needed. Such a framework has been developed with the Planning Concept for Networks.

3.2 Contents of PlaNet

PlaNet is intended to enable and support Competence Cells in solving different planning problems in the field of logistics structures and production plants in Competence-cell based production systems, so that they can plan networks in case of need as well as in advance.

PlaNet was designed as a framework, which embraces suitable theories, models, concepts, methods and preference solutions for logistics structures of Competence Cells linked to production systems as well as the planning of network-able production plants (Figure 3).

Both Competence Cells with special planning competences and Competence Cells without such competences are addressed by PlaNet, also for working together in a collaborative way.

3.3 The Methodical Concept

After detailed assessments of existing problem solution and planning approaches the universal, domain-neutral, flexible and adaptable Systems Engineering Methodology (SE) (Daenzer and Huber, 1994) proved to be a suitable basis for the methodical concept. If the components of SE are considered as framework for PlaNet, the respective specific components of PlaNet can be classified in this framework.

With the methodical concept adapted design solutions for logistics structures and production plants can be generated as depicted in Figure 3. Procedures to solve planning cases are formed with the Holistic Planning Method as a template. Methods like Integrated Process and System Structuring and pre-configurated object solutions such as Adaptive Object Components are integrated. (Müller et al., 2004)

4. NET PLANNING ASSISTANT

The Net Planning Assistant (NPA) is the implementation of PlaNet.

4.1 Requirements and Concept

Besides general requirements on software, additional requirements rise from special aspects of Competence-cell based Networks (Müller et al., 2004). Those are the consideration of missing planning competences in non-planning Competence Cells, small funds and heterogeneous software environments. On the other hand a holistic approach, internet-based connecting of Competence Cells and Participative Planning should be pursued.

To meet these requirements NPA has like PlaNet a modular structure. Commercially available software tools together with proprietary developments are interlinked through an interface concept. An integrative Production Database (PDB), which is based on the production data model of PlaNet, is in the centre of NPA.

Due to the modular structure the planning instance is able to configurate NPA to its special needs. Those needs are determined by the procedures in which this instance is involved and there especially the underlying methods. Thus the

configuration of NPA should contain the appropriate tools for the methods that a particular planning instance has to employ.

NPA is not depending on particular software solutions. It should be rather seen as a general concept for linking together different software solutions which are necessary in the process of planning logistics structures and production plants.

4.2 Components

Potential components of NPA are shown in Figure 4.

A user interface called DataMan supports the management of the Production Database. The usage of a web-based application which can be accessed through an internet browser is suggested for this interface. NPA also contains tools for modelling, planning of logistics structures and production plants, participation and visualisation, simulation and knowledge management.

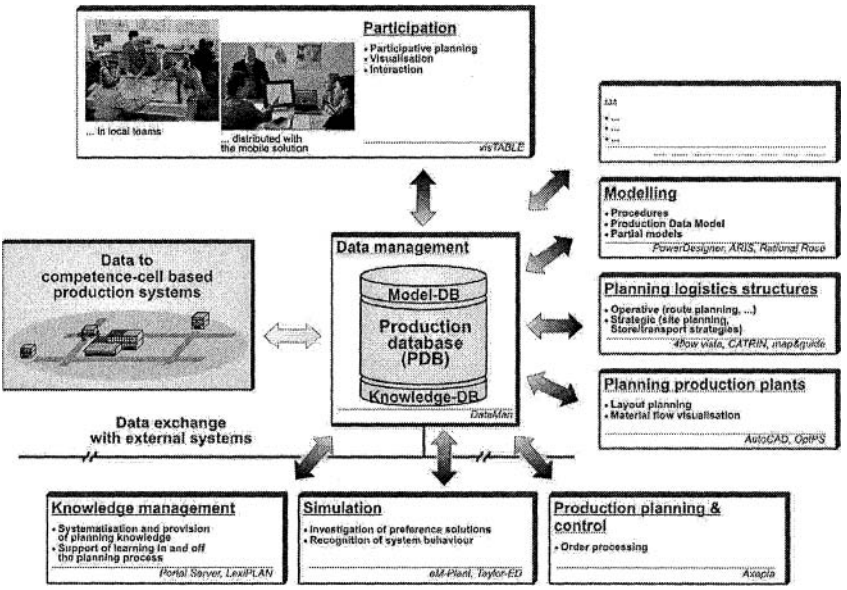

Figure 4 – Net Planning Assistant (Müller et al. 2004)

Planning in Competence-cell based Networks has to be done in a collaborative/ participative way. This does not necessarily take place in one location where all involved parties meet. In fact the participants can stay at different places while the planning is done jointly through the internet. Both ways of participative planning are supported by the planning and visualisation tool visTABLE. Layouts are displayed on a two-dimensional drawing which can be manipulated with a touch screen and also in a three dimensional view which shows the spatial implications of the developed layout. The large size of the screen allows a group of people to work on the layout together as can be seen in Figure 4. Alternatively the underlying software can be used for a distributed planning, accompanied by a chat application to discuss the suggestions of the different planners. For the distributed scenario especially the mobile version of visTABLE (Figure 4) is suitable. (Müller et al., 2004)

5. CONCLUSIONS

Competence-cell based Networks provide a promising approach for future forms of value adding organisations. The approach also points out perspectives for present small and medium-sized enterprises to face ever-changing economic conditions. The Planning Concept for Networks PlaNet serves the special requirements on planning of logistics structures and production plants in such networks. Suitable tools are provided through the Net Planning Assistant as the implementation of PlaNet.

6. ACKNOWLEDGMENTS

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