An Extended Manufacturing Management Model: Control Principles and Aspects in Production Networks

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Abstract

Integrating the flow of materials and information is a challenge, independent whether it is inside a company or between companies in the value chain. The paper refers to different surveys that seeks to explain the growth of production networks. It also propose several definitinions and descriptions of networks. Control, information, and organisational aspects, economical issues, as well as geographical aspects are discussed. The paper describes a method for designing a Manufacturing Management Model. The paper also describes the structure and content of an Extended Manufacturing Model, based on the thinking behind the Extended Enterprise, which is now applied in several research projects in Norway. Finally the paper discusses the challenges of controlling the resources, the information flow and the material flow in production networks. This will reflect the findings from current research going on at our laboratories as well as some case studies.

Keywords

Production networks, relations, information and material flow, control principles, management model, extended enterprise.

1 INTRODUCTION

Integrating the flow of materials and information is a challenge, independent whether it is inside a company or between companies in the value chain. Internal and external changes cause alterations in the conditions for the flow of goods and information that necessitate changes in how we organise manufacturing and logistic procesess between companies and geographical places. In the paper, different approaches will be taken in order to discuss these challenges. Organisational and work environment aspects, economical issues, as well as geographical aspects will be discussed. These aspects have been studied in an extensive study within the research programme Productivity 2005 which has been launched in Norway last year.

The paper describe briefly a method for designing a Manufacturing Management Model. The paper also describes the structure and content of an Extended Manufacturing Model, based on the thinking behind the Extended Enterprise.

Finally the paper will discuss the challenges of controlling the resources, the information flow and the material flow in production networks. This will reflect the findings from current research going on at our laboratories as well as some case studies.

Integration has been on the logistics agenda for several years. During the 1980s' the focus was directed towards integrated logistics management which means integrating inside a company (Coyle, Bardi and Langley, 1996). The purpose was to develop an efficient and effective flow of materials and information by means of a holistic view of the company. However, this approach over looked external actors such as suppliers, customers and distributors. Nor did it manage to break up the traditional functional organisation structure (Bowersox, 1996). Thus, the approach never managed to utilise the fully potential in internal integration in addition to problems of sub-optimisation.

Thus, the logistics approach was forced to broaden its perspective and to become more open, horizontal, and process oriented. During the 1990s, the philosophy of supply chain management developed which is "...an integrative philosophy to manage the total flow of a distribution channel from supplier to the ultimate user". Compared to internal integration, supply chain management raises new questions. For example, how to get from a functional to a horizontal structure? How to integrate and manage the logistics processes between autonomous actors? Who shall be responsible for the different processes?

2 A POSSIBLE DEFINITION OF NETWORKS AND RELATIONS

The concept "network enterprises" is, at the moment, not explicitly defined. At the moment we think that such a network must be characterised by a number of nodes and relations among these. By the concept "node" we mean an enterprise or an

organisation limited and located physically at one place. Two or more departments of the same enterprise which are physical separated in distance, may be regarded as two different nodes. A classical definition of a network is abstract by nature; It refers to nodes (enterprises) and connections to nodes or edges between nodes (relations/connection) (Fombrun 1982). At least it must exist minimum three nodes before we may call it a network.

Relations are cornerstones in every network of that kind. A relation shows a connection or a contact. To be able to talk about relations, the contact between the nodes may be of a certain length in time. Bjørge Johansen (1993) defines such networks as different types of economical chains or connections between enterprises. Examples of such chains may be: An enterprise delivers input goods for continuous consumption in another enterprise. An enterprise delivers technical solutions in case of equipment and knowledge in another enterprise. Two enterprises co-operate about purchases to obtain better economical and delivery conditions. Two enterprises co-operate in the sales market. Two enterprises co-operate around research and development.

If we include dyadic relations in the definition of network relations, following characteristics are important for identifying a specific network relation:

- Two or more enterprises will have some commercial relations together.
- Each of the enterprises is dependent of resources controlled by some of the others.
- The partners in a network have some independence and may follow different development paths.
- Network relations is dependent of investment in time and economical resources by all the partners in order to solve the common challenge.
- Making of such relations is dependent of social relations which are created and maintained over time.
- One enterprise may be a member of different networks.
- There can be identified different political structures – some are based on a leading enterprise which set the conditions and controls the relations, other are based on equality in power and politics.
- Different types of incentives internal in the network must be present in order to control the relations.
- Common decisions are achieved mainly through negotiations and consensus.
- The control of such networks will be organised according to strategic interests and different relations of power among the partners. In some cases this will lead to relations of formal economical character where self-interest controls the behaviour. In other cases, the control is based on confidence and adaptation of behaviour which develops over time.

From these conditions we may see the importance of not defining all types of relations as networks. Because, if such relations shall be defined as network

relations, the co-operation must include more long term commitments. Short term relations between partners based, for instance, on a “lowest price”-condition, will not fulfil the definitions of a network. (A collection of enterprises will not operate as a network, in our definition, if the only relation is the “buy at lowest price”.) A network or enterprises may be characterised as a destiny of community where the survival in some way is dependent on the competition advantage and survival of each enterprise. This may represent self-reinforcing processes in the network (Maskell,1990).

2.1 Different Perspectives on Networks

Previously, we have defined networks as enterprises and their common relations. This do not exclude that network have been studied from different levels of details. The perspectives used are: network, enterprise and individual.

Economical geography is one example which mostly consider the influence of physical dimensions to network organising. The economists is mostly regarding the network from the enterprise perspective. Focus on organisational learning, communication and culture takes normally the individual perspective.

The different perspectives contribute in different ways to our understanding of networks. Late economical theory try to explain networks based on exchange of competence and resources between the network partners. These theories are limited in the sense that they only explain networks of territorial neighbourhood and the potential found in such surroundings. Nearness seems to have an intrinsic value according to different concepts collected around learning processes.

2.2 Different Types of Relations

We agree upon that the relations between two nodes normally have more than one dimension. We talk about primary, secondary and tertiary relations.

In many situations the secondary relations will influence directly on the primary relations. Very often will the tertiary relations also be connected to other nodes rather than nodes with primary relations.

The different symbols in the figure may represent different types of nodes: Producers, humans, suppliers of services and know-how., etc. Examples of different relations are as follows: Primary relations as exchange of products, services and money. Secondary relations as information, learning, know-how, community and friendship. Tertiary relations as conferences, professional meetings, educational programmes, business sector organisations.

We mean that there is the mutual dependence between primary and secondary relations. The tertiary relations are dependent on, in the first hand which types of meetings and conferences the enterprise want contribution to. On the second hand, the selection of such meetings and conferences will be influenced on the primary and secondary relations.

This three-dimensional mutuality, do we want to define as the dynamical element in a network. Network is, in other words; an arena of learning. An arena which can be thought of as an fundamental instrument for development of new knowledge for the enterprises.

In a new article of Van Alstyne (1997), he divide between three perspectives in the understanding of network organising; network as “information-processing”, network as economical structures and network as society. The author points to that the extensive literature concern especially five subjects: balance between stability and flexibility; balance between specialisation and generalisation; balance between centralisation and de-centralisation; synergy between complementary praxis and information technology as an important enabler of networks.

3 CONTROL PRINCIPLES AND ASPECTS

Of extreme importance in manufacturing networks is the control principles and systems to be used in the network. There is extensive research ongoing in this area. Also in our laboratory such research is taking place. Typically there are two approaches pursued: a) Companies, as suppliers to car manufacturers, expanding from part suppliers to system suppliers, and therefore creating a network of part manufacturers. b) Companies producing a core product in a large range, expanding to become a ”complete package supplier by integrating logistics, distribution and on-site assembly

We are developing network control mechanisms for these type of companies based on further development of the method “Design of a Production Control Model”, a method developed at NTNU/SINTEF (Strandhagen and Skarlo, 1995). The method is based on principles both from supply chain management and flow oriented production philosophies and it has been named the “Extended manufacturing model” for manufacturing business process redesign, as the method has been expanded upstream and downstream from the previous method. The method exists of five steps:

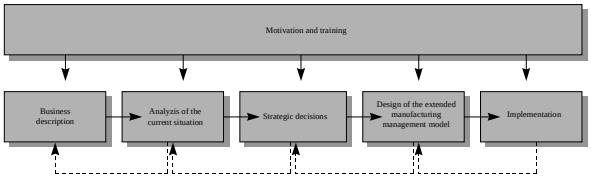

Figure 1 Key steps in design of an extended manufacturing management model.

The method we have developed is a re-organisation process based on five phases. The first phase consists of data collection and identification activities. Phase two is

an analysis of the current situation. The third phase consists of the strategic decisions. The fourth phase is the design of the model, while the fifth phase is the implementation of the model. Through the whole process, motivating and training efforts are carried out. The method is iterative.

Of special interest are the strategic decisions related to flow of information and materials/goods. Examples of strategic choices are: selection of a proper customer de-coupling approach; selection of control principle; make or buy; postponement versus speculation and centralised or decentralised distribution systems.

The extended management model should be based on a combination of several control principles. Each company has the responsibility of managing its own production and logistics system as it is defined in the overall model. In community the companies has the responsibility of the overall management of the collaboration. Among other things this means to distribute the co-operation achievements and to make sure that the system develops according to internal and external changes.

A general model for network is showed in figure 4, illustrating the challenge and need for a co-ordinating function within the network.

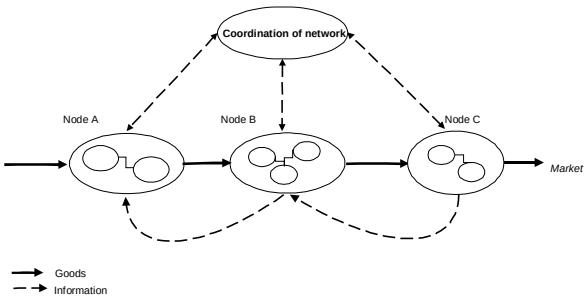

Figure 2 A general model for network.

It is possible to distinguish between different types of collaboration from market to hierarchy as done by Lorange and Roos (1992) and Cooper and Gardner (1993). At one end we consider relations with few obligations, low degree of formality and short contract periods. At the other end of the scale we are talking about partnerships, alliances and joint ventures.

Several questions arise when companies with different ownership should operate in a production network with a common goal: To what degree can different control principles be accepted within this network? Is there any superior control principles in networks? Will the principles be different dependent on how strong the relationships are in the network, according to the following characterisation? Will the access to instant and correct information throughout the network reduce the need to plan, and increase the need to execute? How will the small suppliers, with minimal of expert knowledge and capacity of IT be integrated to large companies,

without loosing the independence they need to be able to operate towards many companies?

Haugland (1996:14) has made a survey of Norwegian companies motives for collaboration. The survey showed that increased product range was more important than large-scale economical benefits. Other motives identified were: increased access and exploitation of resources; improved flexibility; increased influence (as a network compared to single unit); increased legitimacy and support; increased predictability; reduction of risks and increased market potentials.

Browne and Jagdev (1997) points out that control and management in production networks should be developed from the following principles: world class manufacturing; concurrent engineering and Engineering around the clock; agile production; lean production and supply chain.

These principles are pursued in our ongoing research involving the above mentioned companies.

From a planning and control perspective there are several aspects that increase the challenge of network controlling compared to single unit controlling. This is complexity, uncertainty, co-ordination and information and conflicts.

Complexity stems from having to integrate different organisational structures, company cultures, increased range of products and actors (customers, suppliers, etc). The uncertainty increases as the degree of freedom is increased, as an increased number of players are involved. The co-ordination and information handling is a challenge, both from a cultural and a systems perspective. Possible conflicts arises as different ownership's and customers claims are forced to a unit serving as anode in the network

According to Carvalho and Campos (1997:420) the control tasks can be performed by four different approaches: hierarchical planning; partly distributed planning; completely distributed planning and hybrid planning.

Three important conclusions on further development have been made within the research, regarding future focus:

- Simulation functions will become an necessity within the co-ordination function.
- Risk analysis, robustness performance and economical issues must be integrated in the control system.
- An extreme focus on real-time processing and information display (visualisation)

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5 BIOGRAPHY

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