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**Outsourcing vs. Collaboration in Manufacturing Networks –  
From a manufacturing strategy perspective**

Track title: Operations Strategy

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*Abstract*

One of the most important components in manufacturing strategy is quality, which in fact has become more or less a matter of course. Purchased material is subject to inspection upon reception. At the same time, the degree of outsourcing is steadily increasing in the manufacturing industry, often motivated by reduction of cost. The dimension of interaction, concerning e.g. product design, is often lost on the way, which can cause problems in manufacturing. The company is thus forced to keep a certain competence in manufacturing in order to be able of discussing with the suppliers. One way of getting the advantages of outsourcing and still keeping a climate of continuous learning between the companies is to cooperate in manufacturing networks. This paper elaborates on different views on manufacturing strategies among Swedish manufacturing companies and the suggestion that collaborating networks can give certain competitive advantages.

Key words: Manufacturing strategies, production systems, competitive priorities, supply chain

## *Background*

Many Swedish companies tend to outsource more and more of their manufacturing to specialists, but this does not mean that the companies can afford to lose their competence in manufacturing. It is still essential that the companies, even though other companies perform parts of the actual manufacturing, understand the special conditions for manufacturing. Otherwise they are not in a position where they can discuss product development, specification of the different tasks that they want the contractors to do, and they can certainly not make the right decisions when buying components and parts from suppliers. It is still their responsibility, as system builders or just coordinators, to guarantee that the products get the properties that the customers expect. It is merely a matter of understanding the processes, which the companies are involved in. It is also impossible to improve if the company does not have sufficient knowledge of the activities that the suppliers are performing. If companies collaborate in manufacturing networks, the operational strategies must, to a certain degree, be extended and include the entire network.

### *Manufacturing Strategies*

The general purpose of a manufacturing strategy is to show how manufacturing can be utilized to get competitive advantages (Winroth, 2001). The manufacturing strategy, as well as other strategies on a functional level, should also support the overall business strategy of the company. The decision categories composing a manufacturing strategy are shown in figure 1 (Hayes and Wheelwright, 1984).

<i>Decision Category</i>	<i>Design variables within the category</i>
<b>Structural</b> Capacity Facilities Process technology Vertical integration	Amount, timing, type Size, location, focus Equipment, automation, linkages Direction, extent, balance
<b>Infrastructural</b> Manufacturing planning and control Quality Organization Work force	Computerization, centralization, decision rules, sourcing Defect prevention, monitoring, intervention Structure, reporting levels, support groups, control Skill level, wage policies, employment security

Figure 1. The decision categories composing a strategy, Hayes and Wheelwright (1984).

These decision categories have impact on the strategic output criteria: cost, time, quality, flexibility, and innovativeness (Säfsen and Winroth, 2002). They are however interlinked and almost all decisions may influence e.g. the manufacturing cost. The combination of two interlinked performance categories can follow a so-called trade-off or relationship curve. An example of a movement, following schematic two-dimensional relation curves, is shown in

figure 2 (Winroth, 2004, adopted from Slack and Lewis, 2002, p. 97). The two variables, variety and cost performance, are traditionally negatively linked to each other. In the figure, position A supports a specific combination of cost performance and variety. If the competitive analysis indicates that variety is an important order-winning criterion, and a reduced cost performance is acceptable, the trade-off curve can be followed up to position B. If this reduced cost performance is not acceptable, and an improvement in both aspects is necessary, an improved trade-off curve is reached. This could lead to position C. An improvement from point A to point C is however difficult to perform in one step. Thus, an improvement in cost performance, while maintaining variety, is first performed (reaching the A'). If this improvement is maintained, the next step is to improve in variety, while maintaining cost performance, and point C is reached. The real life is however more complicated and the trade-off situation is multi-dimensional with several factors affecting each other. This leads to the need for addressing several decision categories when trying to improve one single strategic parameter. During a case study, one of the companies pointed out that they wanted to reduce the number of variants in order to reduce manufacturing cost. This was however not acceptable since this flexibility aspect was highly appreciated by the customers. As a consequence, in order to meet market requirements, the company increased the number of variants considerably and they now manufacture about three million different variants, which of course could imply the need for more efficient routines in other aspects in order to reduce the cost.

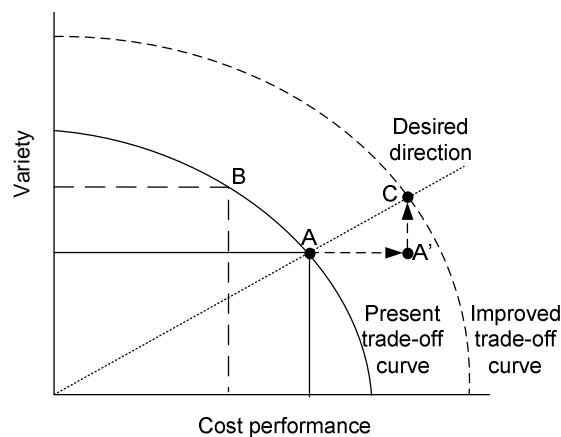


Figure 2. Transition in a trade-off situation (Winroth, 2004. Adopted and developed from Slack and Lewis, 2002), p. 97).

While striving to improve different decision categories, a company should aim at being equally capable according to the four level grading system of manufacturing capability presented by Hayes & Wheelwright, 1984. Otherwise, the outcome of good efforts in some areas may be hampered by lower performance in other areas. If, for instance, the operators are skilled and capable of making qualified decisions, but the organization is centralized and does not permit the employees to develop, the full effect of training personnel will be obstructed. Delegation of responsibility must also be accompanied by delegation of authority. Manufacturing strategies could be a tool for handling this dilemma.

Some of the decision categories of figure 1 are further commented below:

*Quality* has traditionally only the meaning of product quality, but over the years quality has got a wider meaning. The, so far, most advanced concept is called Total Quality Management – TQM. The previous attempts have been Quality Inspection, Quality Control, and Quality Assurance

(Dahlgaard et al, 1998). TQM is based on the previous levels, but involves the entire organization and the way the activities are coordinated (Collard, 1993):

*Quality management is a systematic way of guaranteeing that all activities within an organization happen as planned. It is a management discipline concerned with preventing problems from occurring by creating the attitude and controls that make prevention possible.*

Another definition on TQM, which includes also customer satisfaction, is given by Persson (1997):

*TQM is the way of leading an organization towards long term advantages for the organization as well as for the society, emanating from customer satisfaction and active collaboration from the entire staff (free translation from Swedish)*

Both these definitions talk about “an organization”, but the definitions could be broadened and applied on a supply chain or collaborative networks. A large number of activities are involved in the process of producing with right quality (Crosby, 1982) and these activities cost money. The costs could be separated into three different categories: prevention costs, appraisal costs, and failure costs. If the faulty goods reach the customer, thus leading to failure costs, there is also a considerable risk that the manufacturer suffers from goodwill loss, which could be far more costly than to put efforts into preventing failure. Costin (1999) states that TQM is a system for meeting and exceeding customer needs through company-wide continuous improvement based upon the implementation of the Plan-Do-Check-Act cycle supporting processes, organization, and tools by every manager and employee. He also points out that TQM is only a means to satisfy the customer. In that sense he has a more practical view than the previous definitions. In order to achieve TQM, cross functional cooperation and vertical alignment is required. The focus is in that discussion mainly on one single organization.

*Vertical integration:* An organization’s vertical integration strategy, see figure 3, is defined in terms of (Hayes and Wheelwright, 1984):

- The *direction* of any expansion
- The *extent* of the process span required
- The *balance* among the resulting vertically integrated stages

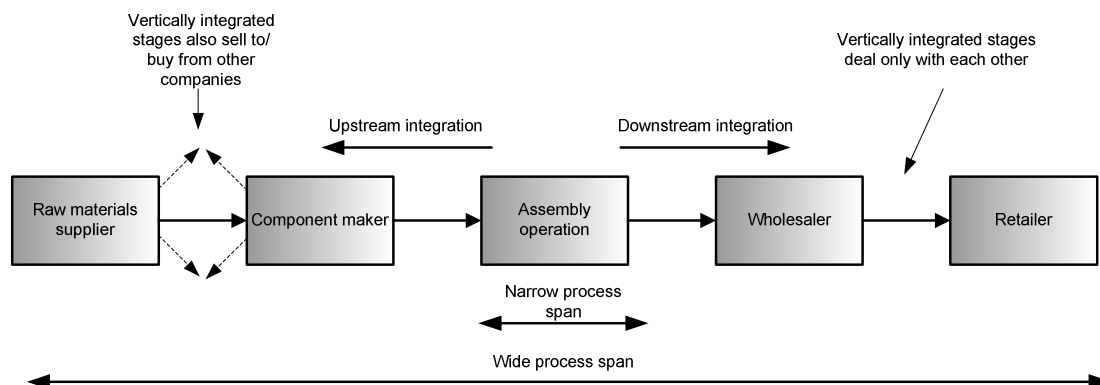


Figure 3, Example of the direction, span and balance of vertical integration (Slack et al, 2001)

**Direction:** The strategy of expanding on the supply side of the network is sometimes called backward or 'upstream' vertical integration, and expanding on the demand side is sometimes called forward or 'downstream' vertical integration.

**Extent:** Having established its direction for expansion, an organization must then decide how far it wishes to take the extent of its vertical integration. Many organizations want to focus on what is considered as their 'core competence' and as a step in that direction they reduce the extent of vertical integration by selling part of their business. At the same time they of course reduce the value adding activities, which are supposed to make it possible to make a profit.

**Balance:** The amount of the capacity at each stage in the network which is devoted to supplying the next stage. Hence a totally balanced network relationship is one where one stage produces only for the next stage in the network and totally satisfies its requirements. Less than full balance in the stages allows each stage to sell its output to other companies or to buy in some of its supplies from other companies.

One potential result of vertical integration is that quality benefits from the increased closeness of the operation to its customers and its suppliers. The experiences are however quite varying and some people say that things have become better when outsourcing, i.e. reducing the extent of vertical integration. One reason is that when buying from other companies, the organization is forced to specify more thoroughly what it wants. If an internal department is doing the task it is often more vague what is expected.

*Process technology:* By having good control over the manufacturing processes, the level of quality could be guaranteed without extensive quality inspection. The company also has the knowledge that makes it possible to optimize the process, e.g. in terms of cutting speed, balancing of assembly lines, or setting the correct parameters for mixing chemicals in a plastic resin. The different states of process knowledge are described in figure 4, (Sousa and Voss, 2001).

<i>Stage</i>	<b>Description of Knowledge About Process Variables</b>
1. <i>Complete ignorance</i>	You do not know that a phenomenon exists, or if you are aware of its existence, you have no inkling that it may be relevant for your process.
2. <i>Awareness</i>	“Pure art.” You know that the phenomenon exists and that it might be relevant to your process. There is still no way to use the variable in your process, but you can begin to investigate it in order to get to the next stage.
3. <i>Measure</i>	“Pretechnological.” You can measure the variable accurately, perhaps with some effort. Variable can still not be controlled.
4. <i>Control of the mean</i>	“Scientific method feasible.” You know how to control the variables accurately across a range of levels, although the control is not necessarily precise.
5. <i>Process capability</i>	“Local recipe.” You can control the variables with precision across a range of values.
6. <i>Process characterization (know how)</i>	“Tradeoffs to reduce costs.” You know how the variable affects the result, when small changes are made in the variable. Now you can begin to fine tune the process to reduce costs and to change product characteristics.
7. <i>Know why</i>	“Science.” You have a scientific model of the process and how it operates over a broad region, including non linear and interactive effects of this variable with other variables. You can optimize the process in respect to the variables.
8. <i>Complete knowledge</i>	“Nirvana.” You know the complete form and parameter values that determine the result as a function of all the inputs.

Figure 4, States of Process Knowledge (Sousa and Voss, 2001)

Good process control also increases the possibilities for the company to eliminate waste in production, thus making it possible to become a lean enterprise. It is however difficult to have good control over the entire manufacturing process if large parts are being carried out by different outsourcing partners. The control over the entire process is reduced to measuring some key data after the actual process. We will continue to apply these ideas on process knowledge on a case study, which showed the importance of having control over the entire supply chain.

#### *Experiences from a case study*

A study of Ericsson Mobile Communications AB was carried out in year 1999 (Winroth and Björkman, 2000<sup>1</sup> and Winroth and Björkman, 2001). At that time Ericsson owned their manufacturing facilities to a large extent. The company had large problems achieving acceptable levels of quality yield in the production of mobile phones. These problems were to large extent the result of poor quality of the purchased components. Another reason was that there was not enough cooperation between the product development team and the manufacturing experts, which resulted in products that were not fit for production. The lack of control over the manufacturing processes also forced the company to test all phones three times in the automatic assembly lines.

Due to the recession in the telecommunications market after this study, Ericsson has been forced to drastically reduce its costs. One of Ericsson's actions has been to considerably reduce its level of vertical integration. The manufacturing of mobile phones has been sold to Flextronics and product development and marketing has been transferred to a company, jointly owned with Sony. One major reason for choosing Flextronics was the company's recognized ability to have good control over supply of components. Ericsson has however only given Flextronics the responsibility for purchasing of standard bulk components, while Ericsson still kept control over key components. This was one of the major problems when Ericsson manufactured the phones in their own factories. In fact, the outsourcing seems to have resulted in a reduced control and interaction between product development, carried out by the Sony Ericsson Company, and manufacturing, mostly performed by Flextronics. Flextronics has however not taken over all of the manufacturing units. In China the phones are going to be produced directly by Sony Ericsson. In that aspect the outsourcing strategy has not been fully consequent. By applying the discussion in this article on the previous study of Ericsson Mobile Communication, it is possible to perform an analysis of the strategic decision areas during the period of automation (adopted from Hayes & Wheelwright, 1984). The result is shown in the following table, Figure 6:

<b>Decision area</b>	<b>Characteristics</b>	<b>Ericsson Mobile Communications</b>	<b>Estimated Capability Level (levels 1-4)</b>
Process technology	flexibility, type of equipment, technology level, layout	high degree of automation, high technology level developed externally, rigid flow layout	2-3
Facilities	location, size, focus	condensed layout and complex flows	2
Capacity	amount, acquisition time, type	low volume flexibility	2
Vertical integration	amount, degree, relations	low degree of vertical integration, both upstream and downstream, problems with sourcing	2
Quality management	definition, responsibility, reporting	unstable processes, low quality yield, 100 % testing several times in the process	2
Human resources	skill level, wage, training and promotion policy, employment security	mix with a large degree of low skilled personnel, 2-3 days of training of short-term hired personnel, technology managed by external personnel	2
Organization structure and control	relationship between groups, decision	hierarchical, centralized	2
Production planning and control	responsibility, rules and systems	centralized planning, complex	2

Figure 6. The decision areas and estimated characteristics at Ericsson Mobile Communications AB during the automation period (Winroth, 2004. Adopted from Hayes & Wheelwright, 1984).

The expansion of the manufacturing capacity was performed rapidly and it was considered necessary to automate the lines for final assembly or relocate the assembly to low wage countries. This automation was however mainly performed with external expertise from Sony, who delivered the robotized assembly cells. The facilities were not optimized for the layout and it was difficult to get a clear overview of the material flow with all the parallel manufacturing lines and complex layout. The volume flexibility of the system was low and when the market expanded, the company could not correspond to the demand and thus lost market shares. Later, when the market dropped drastically, the system did not support a reduction of the production volume without extensive capital loss. The vertical integration was low, with both sourcing problems from suppliers and low support from retailers who often presented other brands instead of presenting the equivalent Ericsson phone. The quality yield was low and all products were tested three times in the line. Due to problems in finding personnel and the company's desire to have a flexible work force, the company hired temporary staffing mainly from Andersen Consulting. The organization as well as production planning was highly centralized. This analysis thus indicates that Ericsson was about 'Average' in all the decision areas as described by Miltenburg (1995) (Säfssten and Winroth, 2002). It seems that the low performance in all decision areas contributed to the large problems of the company. This result is somewhat surprising since the interviewees at Ericsson during the study claimed that the manufacturing strategies of the company were working very well and that they were implemented in the daily activities. The problem could be that Ericsson had been focused on manufacturing and selling large telephone systems to network operators, which never had forced the company to improve the manufacturing. The manufacturing issues are more crucial when acting on the consumer product area, which is subject to fierce competition. Collaborating with Sony, who has a tradition from manufacturing consumer products, may be a working strategy for the future.

### *Conclusions*

The opinions of manufacturing's role in companies are divided and changes in manufacturing strategies, which often are initiated for financial reasons, are not always successful. A reduction in vertical integration involves large transaction costs. It could also, but not necessarily, lead to reduced control over the processes. Since many design categories of the manufacturing strategies are closely linked together, a reduced process control leads to other problems, such as increased quality cost or reduced delivery capability. A more advanced cooperation between companies, e.g. in collaborative networks, can turn the transaction problem into a possibility of interaction. The interaction creates possibilities of creating a learning environment, where it is possible for the partners to learn from the other members' knowledge. There are however several issues, e.g. legal and financial agreements, to solve if the network cooperation is to become successful.

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