MANUFACTURING FOOTPRINT STRATEGY:
COMING OUT OF THE “BLACK HOLE”
A POSITIONING STRATEGY WITH CONCEPT FACTORIES SUPPORTING THE PRODUCT LIFE CYCLE AND MAKE-OR-BUY DECISIONS

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Abstract

The role of the manufacturing units has a big impact on a company’s business. If competitive priorities and the production weapons can be merged together and describe a factory profile, it can be a factor that provides the competitive advantages for the company. This thesis has two objectives in this area, the industrial and the academic.

The industrial objective will investigate how we can visualize and describe a manufacturing structure and make the desired positioning. The manufacturing footprint structure will be set up according to the performance objectives Innovation, Flexibility, Lead-time and Efficiency representing the product life cycle that also support decisions for the make or buy process. The result is a model that describes the manufacturing structure and a conflict area, or a “Black Hole”, is identified and is leading to the academic research questions; why most of the manufacturing units are positioned in the conflict area and how to leave the “Black Hole”? The intersection in the views of positioning, knowledge and the network paradox are analysed and a scaled model connected to Dreyfus knowledge model, brings some understanding to the positioning problem.

A process model is proposed for the characteristic profiles of the concept factories and how to move to the desired positions. This concept can be applied on a group of manufacturing units and handle the trade off dilemmas for the separate units by letting a group of units achieve top performance for all the performance objectives. The visualization and relation to the products life cycle can contribute to communication and developing the manufacturing footprint strategy. The model has been tested, in a positioning context for strategic purchasing with experience of supplier quality audits for positioning suppliers, with positive result.

Further research of top performance factories would be interesting to do in order to find out their 8M profiles and identify more trade off dilemmas, connecting them to the different performance objectives in order to support the development in moving to different desired directions.
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Used Definitions

Core competence
“Core competence is the most critical and most distinctive resources companies possess, and are hardest for other to copy when it is in a number of processes connected with relevant strategic goals the company striving against”

Manufacturing strategy
“Manufacturing strategy as decision and plans affecting resources and policies directly related to sourcing, production and delivery of tangible products”

Performance objectives
“The generic set of performance indicators that can be used to set the objectives or judge the performance of any type of operation”

Production system
“The production system is the process of creating products from suppliers to customer. Production as a whole must be seen as an integrated process that converts materials into gods, that is into economic satisfaction”

Trade off
“The idea that the improvement in one aspect of operations performance comes at the expense of deterioration in another aspect of performance”
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1. Introduction and Positioning

Introducing the Industrial Challenge

Differentiation is a competitive strategy and by exploring the market position and understanding where the business imperative is driving, a manufacturing strategy and its positioning can support the long term objectives in a manufacturing perspective.

The role of the manufacturing units has a big impact on the company’s business and how their products are positioned. If competitive priorities and the production weapons can be merged together and describe a factory profile, it can be a factor that provides the competitive advantages for the company.

The need of strategic development of production systems

Competition is developing and operations need to improve their competiveness in many disciplines and it is recognized that low cost and high quality alone are not enough to sustain firm’s competitive position in the market place. Meeting customer demands requires a high degree of flexibility, low-cost/low-volume manufacturing skills, and short delivery times. In today’s highly competitive environment, companies are forced to identify and develop unique manufacturing capabilities as well as to be innovative in producing and delivering products.

Turbulent and volatile markets are becoming the norm as life-cycles shorten and global economic and competitive forces create additional uncertainty. The risk attached to lengthy and slow-moving logistics pipelines has become unsustainable, forcing organisations to look again at how their supply chains are structured and managed. Martin Christopher [5] suggests that the key to survival in these changed conditions is through agility, in particular by the creation of responsive supply chains. A distinction is drawn between the philosophies of leanness and agility and the appropriate application. This is an example of manufacturing strategic decision on a performance objective that can meet the turbulent market conditions.

Strategic development of production systems is of vital significance for future competition, and indeed survival. Success requires continuous development and improvement of the way we produce products and how to handle the features of the production systems according to the various challenges companies meet on the market.

Still, the emphasis today within manufacturing industries is often to work reactively by being operationally efficient rather than strategically effective. Managers must begin to think and act strategically instead of only in a reactive manner [6]. There are two principal views on manufacturing. One is that manufacturing shall be made according to technical documentation and to lowest possible cost. The other is that manufacturing also can support the research and development in the process of developing new products. This thesis will discuss the later view.

Globalisation and sourcing

Today we need a global perspective on how to set up and organise a manufacturing network, and how to find the roles for the manufacturing units. Together with purchasing strategies, supplier development and sourcing, it can create a supply chain structure taking competitive
advantages of the global changing market. This is the global manufacturing footprint structure. The purpose of a manufacturing strategy is to actively direct development of the production system to handle current and future challenges and demands. In summary, there is a need for strategic changes and trade-offs within the production systems.

Make or buy as a strategic trade-off

Typical strategic trade-offs are the make or buy decisions. The classic make-or-buy-question is if we shall buy this product from an external supplier or produce it internally. There are many triggers that raise question such as cost reduction, lack of capacity, higher quality etc and often there are many stakeholders with different views. McIvor is one author pointing out the fact that all sourcing decisions should be carried out from a strategic perspective and integrated into the overall strategy [7]. This is one of the practical reasons for linking a manufacturing strategy to the make-or-buy process which can guide and support the day-to-day work in the sourcing activities.

The objective with this thesis is to describe critical features of moving towards a manufacturing strategy supporting make-or-buy decisions and a global manufacturing structure.
2. Research Approach, Key Issues and Objectives

This thesis will investigate how we can visualize and describe a manufacturing structure and make the desired positioning and the core of strategy, trade offs. Which are the trade offs to do and how do they affect the production system and the companies positioning on the market. One of the triggers for this project is based on the decisions in the make or buy process and the transfer process of products between manufacturing units where the product shall be manufactured. One conclusion in literature is that many base their decision on short-term cost reductions and many face problems when they are dealing with sourcing decisions [10]. Which are the key elements in the make-or-buy analyse that can be answered in a manufacturing strategy? This thesis will set a structure according to the industrial reference challenges and which visualize the manufacturing footprint. The question is it possible to position the manufacturing footprint structure according to the performance objectives and how does that support the industrial references future challenges and also supporting decisions in the make or buy process.

Desired factory profile

This thesis will investigate how to move to the desired position and it will try to describe what the factory profile is. To do this positioning there is a need of a model that can indentify or describe the desired position so it can be useful for the manufacturing unit’s development. What is it actually the factory profile we are looking for and what do we want to achieve when we are setting the targets for the manufacturing units. Are the targets clear enough to identify a desired position? For practical reasons we can create a description for each factory so it can recognise its profile and get guiding and develop to the desired position.

Measuring the positioning and the “Black Hole”

Another issue is if this description of factory profile can be graduated or scaled and be located in the factory positioning map or the polar representation diagram that was development in the paper [11] and further developed in this thesis in the industrial questions of issues. By connecting KPI’s to the axis a factory profile can be set. In the paper [11] we used the performance objectives QLE (Quality, Lead-time and Efficiency) and below in figure 1 this is illustrated in the polar representation diagram in relation to Innovation, Flexibility, Lead-time and Efficiency. The circle represents an area of conflict with other units. It represents low or average levels performance by the units or suppliers and the diagram shows how crowded this area is. It also contains another critical issue; a big share of the available products and is therefore very attractive for the units. All units want to take part of this area considered as the “Black Hole”. The difficulties will be to really focus on the strategic position and go for the top grades. It will not be possible to reach the maximal grades for all dimensions without trade offs. This thesis will investigate why units are positioned in the centre and why it is so difficult to leave the “Black Hole ”.
Figure 1 Polar representation diagram with exponential grades.
3. Research Context: PREPARE

PREPARE is a concept of a one year project with the objective to develop strategic industrial competences for the future. One year of research studies prepares for further research studies or a master degree in Innovation and Product Realization.

The study is given financial support from the Knowledge foundation, Sörmland Regional Council and Robotdalen within the PREPARE initiative at Mälardalen University, in cooperation with Volvo CE, Seco Tools, Fuji Autotech and Nike Hydraulics.

The industrial objective with this project is to create a manufacturing strategy for Seco Tools product area Tools that makes it easier to handle current and future challenges and demands. The academic objective is to combine research and practical use and create a manufacturing strategy model that gives support to different stakeholder at companies and Mälardalen University.
4. Problem Statement, Industrial and Research Objectives

Problem Statement and Research Objectives

Companies need to improve their capabilities and performance objectives. But how shall we define them? This needs a clear description when a manufacturing unit shall develop in a desired direction. One paradox with manufacturing strategy is that the academic literature is quite extensive but the industrial practice is limited. Wickham Skinner [12] writes on the subjects and some of the reasons are:

- How to move from a manufacturing task to make essential choices in designing the structure? But there is no handbook. If it was an engineering problem, there would be formulas and design steps, but now managers have to use “common sense”.
- The second problem is also practical. Industrial managers are too busy when the plant is going full steam and strategic work has less priority.
- The third problem is: what is actually manufacturing stand for? It is not just what is going on in the factory, the complete supply chain needs to be considered.

The difficulties Skinner describes to be both strategic and operational are in this case visible e.g. in the make or buy process and the transfer planning process and a “hand on” model that can contribute and support industrial stakeholders in their work with a manufacturing strategy supporting the desired factory positioning is desired.

The area that can be considered as the “Black Hole” really points out the fact and the difficulties to really focus on the strategic position and go for the top grades. We need to understand the phenomenon of this “Black Hole” and the way out if we want to position as a top performance manufacturing unit.

Objectives

This thesis has two objectives to fulfill, the industrial and the academic.

The industrial objective with this project is to create a production strategy for the industrial reference that makes it easier to handle current and future challenges and demands. The strategy should support the decisions for in-/out-sourcing and transfer of production to the different production sites. The objective is - What shall a Manufacturing strategy contain to support a manufacturing structure and make-or-buy decisions? One of the results from the industrial objective - How can we describe the manufacturing footprint structure and its performance objective positioning, and how can we perform multiple capabilities? is answered with the polar representation diagram and the positioning which describes and visualizes the structure and capabilities.

These results show a “Black Hole” in the manufacturing footprint structure. The “Black Hole” represents a conflict area and also a limited objective performance for the desired capabilities.
in the structure and leads to the academic objective research questions why most of the manufacturing units are positioned there and how to leave the “Black Hole”?

Research questions and Industrial questions

To be able to meet the objective of the academic stakeholder following two research questions are raised.

RQ1 - Why are the manufacturing units positioned in the centre, in the conflict area, also considered as the “Black Hole” in a manufacturing footprint structure?
RQ2 - How can the manufacturing units leave the “Black Hole” and position as concept factories for the desired performance objectives?

The main industrial objective is what a manufacturing strategy shall contain in order to support a manufacturing structure and make or buy decisions?
To fulfil this objective a set of industrial questions have been put together as following.
Q1 What operations performance should be part of a manufacturing strategy?
Q2 How can a manufacturing strategy be used for trade offs and strategic development?
Q3 How should a manufacturing strategy be defined so it can be used for Make or Buy decisions?
Q4 How can we describe the manufacturing footprint structure and its performance objectives positioning, and how can we perform multiple capabilities?

Expected Results

There are two different results of which are expected to derive from this research: a scientific contribution to the research community; and a practical and usable contribution to the industrial problem targeted.

The expected scientific contribution of this research include theoretical and empirical studies of the conflict area the “Black Hole” and a conclusion of why the manufacturing units are positioned there and how to get out which are trigging demands of a description of a target position.

The expected industrial contribution is aimed at an industrial situation and is clearly connected to an industrial setting. All results, and the industrial questions, partially aim at providing industry with increased ability to use a manufacturing strategy which supports make or buy decisions and the industrial challenges.
5. Project Delimitations

Delimitations are to fulfil the objectives within manufacturing strategy development for the product area Standard Tooling at Seco Tools. However generic results that can be applied to other areas are appreciated. The result of the research questions and the industrial question will support the process of creating a manufacturing strategy at Seco Tools.
6. Frame of Reference

This chapter presents the theoretical framework of this thesis. It describes existing theories related to this thesis and also gives the reader an overview of the subject.

6.1 The Role and Content of Strategy

6.1.1 The strategic role and objectives of operations

If any operation wants to understand its contribution to the organisation of which it is a part, it must answer two questions. First, what part is it expected to play within the business? Second, what are the specific performance objectives in which the business can assess the contribution of the operation to its strategic aspirations? Both these issues are vitally important to any operation. Without an appreciation of its role within the business, the people who manage the operation can never be sure that they really are contributing to the long-term success of the business. The operation functions needs to take on three roles [3]:

Implement business strategy; most companies will have some kind of strategy but it is the operation that puts it into practice. You can not after all touch a strategy; all you can see is how the operations behave in practice.

Support business strategy; this goes beyond the simply implementing strategy. It means developing resources to provide the capabilities which allow the organisation to improve and refine its strategic goals.

Drive business strategy; the most difficult role is to drive strategy by giving it a unique and long-term advantage. For example, a company can develop unique customer and supplier relations and these unique capabilities are difficult for competitors to imitate. They are with other words core competences.

6.1.2 What is strategy?

One definition is “Strategy is art and science of planning and marshalling resources for their most efficient and effective use”. The term is derived from the Greek word for generalship or leading an army [15]. It can also be described as “Strategy is the total pattern of decision and action that position the organisation in its environment and that are intended to achieve its long-term goals”.

6.1.3 Manufacturing strategy

The concept of manufacturing strategy theory was to a great extent developed by Wickham Skinner, starting with his article in 1969 [8]. Several authors, such as [9] and [8], emphasise the fact that manufacturing can be a strong competitive weapon if it is run properly. According to Hill [6], the task can be accomplished with support from a well-formulated and implemented manufacturing strategy that comprises a series of decisions, which, over time, provide necessary support for the relevant order-winners and qualifiers of the different market segments of a company.
6.1.4 Manufacturing strategy as a competitive mean

In 1969 Wickham Skinner published an article in the Harvard Business review with the title Manufacturing – missing link in corporate strategy [8]. This is considered as the start of research of the manufacturing strategy. Skinner pointed out that the manufacturing strategy should investigate which qualities a production system has so that they later can use them as competitive advantages. The production system in the companies has the potential to strengthen or weaken the competiveness. There exist a number of definitions of manufacturing strategy and two of them are as follows:


Several authors, such as [9] and [8], emphasise the fact that manufacturing can be a strong competitive weapon if it is run properly.

6.2 Strategy Development

6.2.1 Developing a manufacturing strategy

A production strategy should describe a company’s long-term development plan from current situation to a target position in the future [16]. With other words, the production strategy should be a written document containing at least four overall parts describing:

- The business strategy requirements on the production system.
- Current situation.
- Target position
- A plan to get to the target position.

The literature has also separated the subject into:

**The content** of a strategy concerns the specific decision taken to achieve specific objectives.

**The process** of a strategy is the procedure which is used within the business to formulate its strategy.

6.2.1 Decision categories

To design a production system several strategic decisions need to be taken. These decisions are often described as structural and infrastructural decisions. The distinction is how changeable the decisions are. The structural decisions are often difficult to change since they consist of heavy investments and are difficult to change physically. The infrastructural decisions are easier to change, they are more tactical and decisions can be taken on department level.

6.2.2 The Hill methodology
One of the first approaches to operation strategy formulation is the “Hill methodology”, illustrated in Figure 3.

### Figure 3 Illustrating the Hill methodology. [6]

The Hill methodology is a five-step procedure based on “top-down” and “market requirement perspective”. It is an iterative process, whereby operation managers iterate between an understanding of long-term strategic requirements of the operation and the specific resource development which is required to support the strategy. In this iterative process, the identification of competitive factors in step 3 is seen as critical. Step 1 is describing the corporate objectives. Step 2 involves an understanding on how the marketing strategy of the organisation has been developed. Step 3 translates the marketing strategy to competitive factors. Hill goes on to divide the competitive factors into order winners and order qualifiers. Step 4 is what is called “process choice”. This is similar to “structural decisions”. Step 5 involves a similar process, but this time with the “infrastructural features” of the organisation. This is an approach that is merging the functions together and is an important part of the process of the strategy.

### 6.2.3 The Platts-Gregory procedure

A second classic example on operations strategy development is the Platts-Gregory procedure, reported by Slack [3]. The Platts-Gregory procedure has three stages illustrated in Figure 2.
Stage 1 involves a development and understanding of the market position of the organisation. This is done by assessing the opportunities and threats within the competitive environment. More specifically, it also involves identifying the factors required by the market and compares these to the level of achieved performance. This procedure makes the explicit comparison between what the market wants and how the operation performs.

Stage 2 involves assessing the capabilities of the operation to help achieve the performance that was indicated as being important in stage 1.

Stage 3 concerns the development of new operation strategies. This stage involves reviewing the various options that are available to the organisation and selecting those that best satisfy the criteria identified in the two previous stages.

This gap-based procedure is visualized as interesting and similar to the importance-matrix described in figure 18.

6.2.4 Strategic coherence

A manufacturing strategy is a functional strategy, together with e.g. marketing, R&D and accounting strategies. Together, all functional strategies should support the business strategy of a company. There are different views, and authors have different perspectives, of developing a complete and coherent operations strategy. Four perspectives of operations strategy are illustrated in figure 5 [3].
The two most important perspectives are Market requirements and Operations resources. These two perspectives represent the two main pressures which are on all operations managers when they are making strategic decisions. On the one hand they must satisfy the customers out in the market, on the other hand they must also build up resources which competitors find difficult to imitate and which can provide continuing innovation and competitiveness in the future. Operation strategy is about reconciling these four perspectives shown in figure 5. It shows and trigger the trade off decisions that need to be taken within strategy.

6.3 The Concept of Manufacturing Footprint

Lean thinking is no longer enough to achieve global competiveness. A new business process is emerging that focuses on developing the right configuration of manufacturing plants around the globe - where to locate them, what their roles should be and how they should interact with each other. That is manufacturing footprint strategy which in the IfM-structure [18] addresses four issues for the network reconfiguration, illustrated in figure 6:

- Why is it necessary to evolve the network?
- What are the strategic parts and processes that form the basis of distinctive market position?
- Where should the plants be located and who is doing what?
- How can the transition best be achieved and monitored?
This concept gives a global perspective and a view of how a manufacturing network can be organized and makes the right things in the right place. It raises a number of questions which are essential for a manufacturing strategy. For globally networked companies with manufacturing sites in several countries there are decisions like roles for plants and how to coordinate their roles that are essential parts of the strategy. In this context the approach on the product life cycle becomes interesting, to position the products in factories that supports the current competitive situation.

6.4 Make-or-Buy

What shall be manufactured in-house and what shall be purchased from external suppliers has been a question for a long time and has been approached in different ways. Historically many companies, e.g. Ford, have worked with the principle of being owner of all the elements in their entire business system; all the way from the source to raw material to the final assembly and shipment [24]. Nowadays many organisations are finding it less attractive to own and operate a large number of factories. Focus is now on smaller parts of the supply chain. The key to success has changed from high volume to high value [35]. A common way to achieve this is through outsourcing hence the trend has turned from producing internally to external suppliers (Mcivor) [36] and (Prahalad and Hamel) [37]. This has affected many purchasing departments that have changed from being administrative departments responsible for the price of purchased goods to a strategic approach for establishment and development of the supplier base.

6.4.1 Reasons for out-sourcing

The most common reason for out-sourcing is cost reduction but there are a number of others. The reasons for outsourcing are described in Brannemos Strategic Rightsourcing [38] and are according to Poria [39], Mattson [40], Axelsson [1] and Bengtsson [41]:

- Achieve cost reduction
- Special contract suppliers can achieve economies of scale.
- Focus on core competence
Companies want to focus their internal resources on their core competence.
Access to other companies competences
Other companies have performed certain activities better.
Gain flexibility - manage increase and decrease in quantity.
Share the risk - the external supplier shares some of the risks.
Liberate capital
Outsourcing activities reduces the capital required.
Increase the speed or time to the market - in many cases, an external supplier can bring products to the market faster.

The most important reasons for in-sourcing seems to be; lower cost for logistics and administration, faster communications, flexible integration of new technologies, short time to market and the fact that the core competence stays in-house.

Companies need to develop their competitive advantages related to the core competence. This core competence approach is essential when make or buy decisions are taken. The challenge is to decide which core competences a company possesses and which to focus on in the future. Some authors state; keep core competence in-house, and out-source non-core activities [37] which could lead to faulty decisions. According to Cordon et al [42] a focus on core competences is an oversimplification of business reality and a further classification is developed for competences.

**Description**
**Out-source or not?**

**Distinctive competences** The most important capability of an organisation. Keep in-house.

**Essential competences** Activities needed for an organisation to operate. They can be out-sourced if an appropriate relationship and continuous availability can be created.

**Spill-over competences** Activities that obtains profits related to the distinctive competences. They can be outsourced if it is understood that the company is going to keep the profit of the distinctiveness.

**Protective competences** are related to activities that pose a considerable risk for the success of the whole organisation if they are not properly managed. They can be out-sourced if an appropriate relationship and continuous availability can be created.

**Parasitic competences** are activities that wasting the organisations resources. To be out-sourced to best deal available.
6.4.2 Risks of outsourcing

Wasner [43] states that the most obvious risk of outsourcing is to become dependent on the supplier. Dependence can, according to Quinn & Hilmer [44], be broken down into three areas:

- Loss of critical skills or developing the wrong skills
- Loss over control over the supplier
- Loss over of cross-functional skills

Loss of skills is the loss of critical skills or the risk of developing the wrong skills over time. Companies change and so does the core competence, which can make it hard for companies to in-source the activity again if they don’t have the skills needed. There is always a risk when outsourcing that the supplier builds up their expertise and becomes a competitor. The supplier could also try to sell knowledge learnt during the outsourcing process to a competitor. Intellectual right and confidentially – Outsourcing can result in some difficulties about immaterial rights, such as who owns the intellectual property rights and who can spread the information to a third party.

6.4.2 Make or buy decisions

Although the strategic implications of sourcing decisions have been discussed for many years, sourcing decisions are often made purely on the basis of cost [10] and many companies lack a firm basis for the evaluation of a sourcing decision. Many companies fail to integrate the sourcing decision into the overall production strategy [45]. Models for make or buy decisions have been developed from two perspectives: Cost perspective and Strategic perspective. The cost perspective aims to answer the sourcing decision with cost calculation as a base. The second angle on sourcing literature, which Probert et al [10] point out is the strategic perspective which focuses on other aspects of the sourcing decisions besides costs. Momme and Hvolby [46] have developed a more general model for sourcing decisions in six steps. Competence analysis, assessment and approvals, contract negotiations, project execution and transfer, managing relationships and contract terminations.

There exists different sourcing models and figure 22 is a model that combines these two perspectives, developed by Brannemo [38].

Stage 1- Analyse the production strategy and competences

In this phase core competences and capabilities needed are identified, it can also be strategic articles and strategic competence. At this stage the production strategy should be analysed and if no manufacturing strategy exists it should be developed before any sourcing decisions are taken.

Stage 2 - In this phase the companies capabilities are compared with external suppliers, benchmarking. If the benchmarking shows that the in-house activity is, without question, superior to the external suppliers it should generally be produced internally. If it shows that external suppliers can perform better than in-house, a total cost calculation is required.

Stage 3 - Risk analysis.
Risks can be different for different companies and here it is reasonable to use the company’s standard risk analysis methods.

Stage 4 – Choose supplier.

Now it is time to analyse all information from the model and make a decision of what is the most advantaged choice of internal or external supplier.

It is significant to draw up a contract with the external supplier when choosing to out-source an activity. During the sourcing process, it is important to document the arguments and results from all stages in the process. This is due to the fact that the company, after some years, can go back and see if the decision is still strategically right for them or not.

Some time after the implementation of the sourcing process the activities should be followed up.

The author of the model argues that the sourcing decision process should be a continuously revised process.

The make-or-buy trade off decision is a critical consequence for the company. The basis for making right decision is to understand where the business is moving. There are several reasons and risks within sourcing decision and it is important to understand and link and the connection to the manufacturing strategy. The challenge is to decide which core competences a company possesses and which to focus in the future. That is one of the most valuable competitive advantages for the company to keep control over and develop. Brannemos, Strategic Rightsourcing [38] model includes these parameters in the make or buy analyse.
6.5 Representing Operations Performance

6.5.1 Performance objectives and strategic decisions

Companies need to develop their operations performance objective [3] capabilities. This is one of the key decisions how to connect the companies’ competitive priorities to the performance objectives so the factories, can from a manufacturing perspective, support the companies’ long term objectives. To make the right supply chain decisions over time requires a need to understand the market position for the products and the advantages manufacturing can give to the business. Strategic decisions involve making trade-offs i.e. the essence of strategy is choosing what not to do. Without trade-offs there would be no need for choice, thus no need for strategy. Manufacturing could and should also be linked to corporate, marketing and R&D strategies.

Links between manufacturing effectiveness and corporate success go far beyond merely ensuring high efficiency and low cost [8]. Analysis and strategies in different areas will support organisations in the daily work. The company’s strategies in the areas: business, research & development, market, production etc will, if they are well made, support employees in making the right decisions in the right directions.

Behind the strategies, an analysis has been made on the overall business targets and the core competences and order-winners that exist. In the end, well defined strategies will guide and support for example make-or-buy processes within the company.

6.5.2 The five performance objectives

Operation strategy must include a relative wide range of objectives which takes into account the needs and aspirations of its stakeholders. Each of these objectives has both internal and external effects. Externally their relative importance will differ depending on the nature of the market served by the operation and its products and services. Internally these objectives can be mutually dependent. Operations require a tightly set of objectives that relate specifically to its basic task of satisfying customer requirements. These are the basic five “performance objectives” in figure 7 and they apply on all types of operations described by Slack [3].

Quality – (error free processes, on-specification products/services)
Speed – (fast throughput, short delivery, lead time)
Dependability – (reliable operation, dependable delivery)
Flexibility – (ability to change, frequent new products/services)
Cost – (high total productivity, low price, high margin or both)
Figure 7 Performance objectives have both external and internal effects. Internally, cost is influenced by other performance objectives [3].

The relative importance of each performance objective varies for different business operations and it is a responsibility of the operation functions to understand the (sometimes conflicting) objectives of its stakeholders and set its objectives accordingly.

6.5.3 Polar representation

A useful way of presenting the relative importance of performance objectives for a product or services is called polar representation. The scales have the same origin and the closer the line is to the common origin the less important the performance objective is. In the figure 8 a taxi service and a bus service are compared providing basically the same service but with different objectives.

Figure 8 Polar representations of the relative importance of performance objectives for a taxi service and a bus service [3].
6.5.4 Competitive factors

One way of determining the relative importance between the performance objectives is by analyzing the order-winning factors and the order-qualifiers. In addition to these factors some authorities add a third category, generally known as “delights”. Delights are aspects of performance that customers have not yet been made aware of. These factors which define the customer’s requirements are called competitive factors. They show the relations between some of the more common competitive factors and the operations performance objectives.

<table>
<thead>
<tr>
<th>Competitive factors</th>
<th>Performance objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low price</td>
<td>Cost</td>
</tr>
<tr>
<td>High quality</td>
<td>Quality</td>
</tr>
<tr>
<td>Fast delivery</td>
<td>Speed</td>
</tr>
<tr>
<td>Reliable delivery</td>
<td>Dependability</td>
</tr>
<tr>
<td>Innovative products and services</td>
<td>Flexibility</td>
</tr>
<tr>
<td>Wide range of products and services</td>
<td>Flexibility</td>
</tr>
</tbody>
</table>

Figure 9 shows the difference between order-winning, qualifying and less important factors in terms of their utility or worth to the competitiveness.

- Order-winning factors are those things which directly and significantly contribute to a winning business.
- Qualifying factors may not be the major competitive determinants of the success, but are important in another way.
- Less important factors are things that don’t influence the customers in any significant way.

Order-winner factors show a steady and a significant increase in their contribution to competitiveness. Qualifying factors are “given”; they are expected by customers. Less important objectives have little impact on customers no matter how well they perform.
6.5.5 The effects of the product/service life cycle on the performance objective

One way of generalizing the behaviour of both customers and competitors is to link it to the life cycle of the products or services that the operation is producing. The important implication of this, for operation management, is that products and services will require operation strategies in each stage of their life cycle, (see figure 10). This will be an important factor for the positioning of the manufacturing units, and a guiding picture for the transfer of manufactured products.

Figure 10 The effects on the product life cycle on the performance objectives. [19]

6.6 The need for Innovation

The performance of Innovation can also be considered as a performance objective from a manufacturing perspective and give competitive advantages to the company. The ability to use and develop knowledge and creativity is considered to be the major strategic factors for future competitiveness [20]. Significantly, knowledge and creativity are not just additional production factors alongside the traditional ones, these are the most meaningful and important resources for innovation and product realization in a company. Technological excellence by itself is no
guarantee in a dynamic and growing economy. On an open market today with free access to new and advanced technology, this must be linked to other competencies in the development of new technology, which can improve productivity and create competitive advantages. The connecting links are innovation and design, where creative, questioning, different and flexible thinking are characteristics.

Research on product realization from an innovation approach shows that most products, services and processes, when implemented as innovations or technological breakthroughs, will soon or later come into a stage of dominant design. This is a stage when more and more companies work more and more competitive within the same product range. In such stages the so called second movers or followers will compete on incremental improvements, their productivity, cost reduction and services then on the novelty or innovativeness of the product.

Figure 11 states that the rate of major innovations in technology for both products and processes follows a general pattern over time and that product and process innovation share an important relationship.

![Figure 11 A model of product and process innovation over time [20].](image)

In the dominant design model product related innovations prevails over process innovation. The market contenders are a growing number of small as well as large companies pursuing competing product concepts (fluid phase). But typically, the market prefers one of the product concepts which establish itself as a dominant design. During the emergence of dominant design, competition between companies shifts from product to process innovation (transitional phase). Those companies unable to make this transition will disappear. Only a few companies will remain in the market when technology has reached a mature stage (specific or rigid phase) [21, 22]. This transition phase will impact the positioning and focus of the factories and their profiles.

Innovation and creativity are probably the most powerful sources of the human intellect. It is only through them that all worlds of art, science, and technology are conceived and ultimately realized. Creativity is the mental process about how new ideas and new combination of existing ideas are shaped. There are several definitions today of the term innovation. Innovation is about channelling ideas into producing and implementation of new products. Companies that want to remain as a leading competitive company need to adapt new methods to generate new innovations through knowledge and creativity which are the major strategy factors for the future competitiveness in order to get innovation capacity. A new method to approach this is done by the company IDEO. They have a methodology of five basic steps for a process of innovation and engineering in product and product realization [48]. The insight of the innovation process is a characteristic that has a key role for innovation driven manufacturing profile.
6.7 The noble art of Trade-off

6.7.1 The Trade-off as a central part in a strategy

Strategy is making choices of what to do and what not to do. This can be achieved in different ways. Wickham Skinner at Harvard University [8] proposed that companies must make selection of those competitive priorities which are most important and thus demand more investment of resources. A company is not expected to perform well on multiple manufacturing targets simultaneously. Instead some features must be traded off. This notion is termed as a trade-off model. Companies need to trade-off the competitive priorities on the basis of their relative significance. According to this model, a company should focus on one priority at a time because e.g. cost, flexibility, quality, and delivery require quite different operational infrastructure.

We can find the trade off dilemma in many situations and it require decision-making and different stakeholders are making different priorities. The project triangle in figure 12 [22] the classical performance triangle with quality, cost and time describes the basic problem. You are given the options of Fast, Good and Cheap, and are told to pick any two. Here Fast refers to the time required to deliver the product, Good is the quality of the final product, and Cheap refers to the total cost of designing and building the product. This triangle reflects the fact that the three properties of a project are interrelated, and it is not possible to optimize all three – one will always suffer. In other words you have three options:

Design something quickly and to a high standard, but then it will not be cheap.

Design something quickly and cheaply, but it will not be of high quality.

Design something cheaply with a high quality, but it will take a long time.

![Figure 12: The classical project triangle. [22.]

6.7.2 Introducing trade-off dilemmas

One trade off situation we have is that the market requirements of products are changing over time and the operations resources must be made to fit whatever the market dictates. At other times, the capabilities and constraints of the operations resources will place restrictions on the organisations choice of its market positioning.
Figure 13 shows the relative importance of the market requirements and operations resource perspective, how performance objectives trade-offs between each other [19].

Some of the performance objectives have clear relation to each other. The relation between variance and cost is well described e.g. in [19]. If an operation choose to focus on cost efficiency they need to make trade off in variety, they can not supply same numbers of variances and at the same time reduce cost. The other performance objectives have not such clear relations.

Figure 14: The relation between variance and cost [19].

6.7.3 Agile or lean production

A key characteristic of an agile organisation is flexibility. The origins of agility as a business concept lies in flexible manufacturing systems (FMS). Initially it was thought that the route to manufacturing flexibility was through automation to enable rapid change (i.e. reduced set-up times) and thus a greater responsiveness to changes in product mix or volume. Later this idea of manufacturing flexibility was extended into the wider business context [23] and the concept of agility as an organisational orientation was born. Agility should not be confused with leaness. Lean is about doing more with less. The term is often used in connection with lean manufacturing [24] to imply a “zero inventory”, just-in-time approach. Paradoxically, many companies that have adopted lean manufacturing as a business practice are anything but agile in their supply chain. The car industry in many ways illustrates this conundrum. The origins of lean manufacturing can be traced to the Toyota Production System (TPS) [25] with its focus on the reduction and elimination of waste. In figure 15 Martin Christopher describes the criteria for agile and lean.
Figure 15 Agile or Lean, suggests that the three critical dimensions of Variety, Variability (or predictability) and Volume determine which approach - agile or lean - make greatest sense [5].

6.7.4 Inventory level and service level

Another interesting trade off relation is the inventory level and the service level. What service targets shall be reached and what inventory level can be accepted? If a company is targeting 100% service level it will affect the inventory cost dramatically. Companies need to identify their current performance and valuate target direction and make the strategic trade offs needed to reach an accepted position. The figure 16 is an example of how a company can move towards the optimal curve depending on strategic decisions. The efficient frontier was first defined by Harry Markowitz [26] in his groundbreaking (1952) paper that launched portfolio theory. That theory considers a universe of risky investments and explores what might be an optimal portfolio based upon those possible investments.

Figure 16 The efficient frontier showing the relation between Inventory and Service level [26].

6.7.5 Handling Trade-off dilemmas: The Sand cone theory

Some authorities believe there is a generic “best” sequence in which operations perform should be improved. The best known theory of this type is sometime called the sand cone theory. The
theory is proposed by Arnoud de Meyer and Kasra Ferdows. [27]. In fact the sand cone model incorporates two ideas. The first is that there is a best sequence in which to improve operations performance. The second is that effort expended in improving each aspect of performance must be cumulative. In other words moving on to the second priority for improvement does not mean dropping the first, and so on. According to the sand cone theory; the first priority should be Quality followed by Dependability, Speed, Flexibility and Cost.

![Figure 17: The sand cone model of improvements; cost reductions relies on a cumulative foundation of improvement in the other performance objectives [19].](image)

6.7.6 Multiple capabilities

It is concluded within manufacturing strategy literature that competing on the basis of one or two capabilities as suggested by a trade-off model is no longer acceptable. Better performing companies are competing on the basis of multiple capabilities. Progression of priorities from cost, quality, delivery reliability, and flexibility to additional new innovative factors would suggest that scope still exists for new competitive factors. The Factory-in-a-Box [28] project indicated that it is possible to develop conceptual as well as operational manufacturing cells that meet the requirements mobility, flexibility, and fast set-up and ramp-up of production. To combine several capabilities that match the market position is an approach that merges the business strategy into the production system. Turbulent market condition with increasing demand on the manufacturing system requires performance with several capabilities.

6.8 Setting the direction in practice

Following section is introduced by the structure from Slack and Lewis, Operations Strategy [19], How to address the positioning to manufacturing targets? At its simplest, it involves translating the intended market position of the organisation into performance goals or targets for the operation. Below are three approaches discussed: Performance measuring systems, Benchmarking and Importance-performance.
6.8.1 How to measure performance targets?

The five performance objectives - quality, speed, dependability, flexibility and cost - are composites of many smaller measures. For example, an operations cost is derived from many factors which could include the purchasing efficiency of the operations, the efficiency with which it converts material, the productivity of its staff, the ratio of direct to indirect staff, and so on.

6.8.2 Benchmarking

There are many types of benchmarking. Performance benchmarking is a comparison between the levels of achieved performance in different operations. For example, an operation might compare its own performance in terms of some or all of our performance objectives - quality, speed, dependability, flexibility and cost - against other organisations performance in the same dimensions.

6.8.3 Importance performance mapping

By bringing importance preferences of customers and performance and activities against competitors we can get a good picture and judgement of what performances or activities that need to be prioritized to improve. By scoring important performances by judging on a nine-point scale and plot them on the matrix we can position and value them. This matrix is divided into four zones; Urgent action, Improve, Appropriate and Excess.

Figure 18: The importance-performance matrix [19].

6.8.4 The Positioning Dilemma

How to position the operations after identifying the performance importance?

To start with there are different types of positioning focus. Just as there are many ways of segmenting markets, there are several approaches to focusing operations. The focus can be based on different criteria:

- Performance objectives
- Product/service specification focus
6.8.5 Positioning from a location perspective, the Hotelling Model.

The story below is an introduction to Hotelling's model by Robert Schenk [30] which can explain business positioning concerning location and product characteristics.

Suppose that two owners of refreshment stands, George and Henry, are trying to decide where to locate along a stretch of beach. Suppose further that there are 100 customers located at even intervals along this beach, and that a customer will buy only from the closest vendor. Finally, assume that the beach is short enough so that total sales are independent of where the vendors locate.

Assume that initially the vendors locate at points A and C in the illustration below. These locations would minimize the average travelling costs of the buyers and would result in each vendor getting one half of the business. However, this solution would not be equilibrium. If George moved from point A to point B, he would keep all customers to his left, and get some of Henry's customers. For similar reasons, Henry would move toward the centre, and in equilibrium, both vendors would locate together in the middle.

![Figure 20: Hotelling Beach](image)

This story of the beach was first told half a century ago by Harold Hotelling and is called Hotelling's model. Although it can give some insights into businesses decisions concerning location and product characteristics, the model has been more useful in explaining certain political phenomena. Instead of two refreshment stands along a beach trying to attract dollars from customers, consider two political candidates along the political spectrum trying to attract votes. Only the candidate who attracts the most votes will win, and a candidate must locate nearer to more voters than his opponent to attract votes. With these rules, there is a strong tendency for each candidate to move to the middle. In American politics this tendency has a predictable consequence for presidential candidates, who must "sell" on two beaches. To gain the nomination, the candidate must position himself in the middle of the party. The average Democrat has significantly different views than the average Republican therefore Republican and Democratic candidates sound quite different before nominations are decided. After the party nominations are determined, the two candidates must "sell" to the same beach. Republican candidates move to the left and Democratic candidates move to the right. By election time, their positions on issues usually sound close enough so that factors such as personality emerge as keys to the election.

6.8.6 The networks paradox, the difficulties to make the operations move in desired direction
Why are we getting better at generating and realizing ideas in an area? Even though it is clear that increased experience is an important factor, there are many other factors that contribute to individual or a company’s success in an area here discussed in by Franz Johansson [31]. We succeed because we have good relations with business-partners and mentors and because we understand what customers and employers want. Our objectives are in line with the company and we do what we have learnt. The relations are strengthening in a strong network; Clayton Christensen defines this value network [32]. When companies get experience in a network they will probably develop competence, organisation structures and cultures that are suited to the value network’s special demands. These networks are necessary for success in areas and that is the reason for creating them. It is there the problem begins.

What happens when you decide to try an idea in the intersection between areas or disciplines? Imagine that you manage to cut the association obstacles between different areas and disciplines and create a number of new ideas. The only thing that remains now is to put your idea into practice. Then something unexpected happens. Almost all your existing relations and structures seem to hold you back. Your colleges, your carrier direction, your mentors, your customers, your traditions, your friends, your suppliers - all those who contributed to support your success before – now seem to be obstacles. They want you to stay in your area. The network is not doing this by purpose; it is no conspiracy but the network supports the ideas that are highly valued within itself. They will abandon the ideas that do not fit in.

To develop innovations in new directions seems to be a problem in existing networks. Groups, organisations and companies establish cultures with common interest and a view of how things should be. People with same interests and views attract each other. They hesitate to participate in mixed teams, with people of other background. If someone tries to move in another direction and tries something new they will often be pulled back by the existing network and the existing network becomes the obstacle of the progress. This can bee seen in many different situations e.g. in a small town where you are supposed to have small town behaviour. If you try to do something new you will be considered as a strange person. One way to succeed is to move to a bigger city where more people try new things and are more accepted. Walt Disney failed with introduction of computerized animation and the network was holding them back and decided to continue with the traditional animation film. Another company, Pixar, was not hold back by an existing network continued to develop the animated film and made a success. Disney decided to cooperate with Pixar which was much easier compared to developing this in the existing network.

An operation in a value network will have much more difficulties to trying new innovation ideas compared with the operations that have managed to stay outside of them. Both people and operations in our networks are controlled by processes and routines which in principle are stopping all attempts of breaking the network. New ideas that are not in line with the network are usually eliminated. Therefore we need to leave the networks if we shall have the best conditions to succeed in the intersections.

6.9 The Process Knowledge

Central to developing operations capabilities is the concept of process knowledge. The more we understand the relationship between how we design and run processes and how they perform, the easier it is to improve them. One approach to this has been put forward by Roger Bohn [19]. He described an eight-stage ranging from “total ignorance” to “complete
knowledge” of the process. The steps are Complete ignorance, Awareness, Measurement, Control of the mean, Process capability, Know how, Know why and Complete knowledge.

6.9.1 The four stage model

The ability of any operation to contribute to opening up market potential for the organisation and the organisational aims, expectations and aspirations of the operations function has been captured in a model developed by Professor Hayes and Wheelright of Harvard University [29]. The model traces the progression of the operations function in four stages from what is a largely negative role of stage 1 to it becoming the central element of competitive strategy in excellent stage 4 operations.

Figure 19: The four-stage model of operations contribution [19].

6.9.2 Measuring knowledge performance, context, experience, and intuition

Detailed phenomenological studies of human learning indicates that people pass through several phases or levels in the learning of skill, where “skills” are understood to range from the technical to the intellectual, e.g. building a house, being social adapt, analysing a text. Various studies have divided the learning process into a varying number of such models. Flyvbjerg. (2001), Making social science matter [33] discusses The Dreyfus model which operates with five levels in the human-learning process, Novice, Advanced beginner, Competent performer, Proficient performer and Expert. Not all people achieve the highest levels in a given field. Some fields, such as chess, guitar playing, or surgery, are characterized by only a small fraction of novices becoming experts. In other areas, such as bicycling and driving, a large number of novices reach the expert level.

1. Novice

Novices act on the basis of the context-independent elements and rules. The individual experiences a given problem and a given situation in a given task area for the first time. During the instruction the novice learns what various objective facts and characteristics of the situation
are relevant for the performance of the skill. The Novice has a rigid adherence to taught rules or plans and little situational perception.

2 Advanced beginners

The beginner advances from the first levels in the learning process by achieving real-life experience. Via these further experiences, the advanced beginner learns to recognize and use relevant elements in the relevant situations. The beginner uses guidelines for actions and situational perception is still limited.

3. Competent performer.

Competent performers are characterized by the involved choice of goals and plans as a basis for their actions. Goals and plans are used to structure and store masses of both context-dependent and context-independent information. Still there is a lack of feeling of what elements are important, in other words the, the individual is unable to prioritize. The lack of terra firma for choosing a plan, combined with the competent performer’s need to have a plan, produces a new, important relationship between the performer and surroundings: a relationship of involvement. The competent performer after selecting a plan feels responsible for the consequences of the choice precisely because selecting a plan cannot be done objectively, but must nevertheless be carried out in order to be act competently.

4. Proficient performer

Proficient performers identify problems, goals, and plans intuitively from their own experientially based perspective. Intuitively choice is checked by analytical evaluations prior to action. Proficient performers tend to be deeply involved in their actions and have evolved their perspectives on the basis of prior actions and experiences. The proficient performer understands and organises her or his tasks intuitively, but intermittently continues to reflect analytically over what will happen.

5. Expert

Expert behaviour is intuitive, holistic, and synchronic understood in the way that a given situation releases a picture of problem, goal, plan, decision, and action in one instant and with no division into phases. This is the level of true human expertise; it is the level of virtuosity. Experts are characterized by a flowing, effortless performance, unhindered by analytical deliberations. Expert soccer player’s assess the moment for dribbling or the possibility to score a goal by the entire visual situation in front of them, together with the sensations in their bodies releasing memories of earlier situations, where dribbling or attempts at scoring have succeeded. There is nothing which indicates that soccer players utilize general rules to combine various facts about their own and their opponent’s position, movement, speed etc., and then select a course of action on this basis. Intuitive, holistic, and synchronous action is now at the centre.

The Dreyfus model enables us to understand why: virtuosos simply do not use rules. They recognize thousands of cases directly, holistically, and intuitively on the basis on their experience. Dreyfus and Dreyfus downgrade the importance of storing memories and recognizing similarities. Instead, because of her or his experience, “the expert holistically discriminates among classes of situations and associates with these classes appropriate responses”. Research shows that heuristic expert systems, being rule-based, are unable to go further than level three in the learning process. The heuristic system cannot make the quality jump to levels four and five and therefore never become as skilful as human experts. The Dreyfus model contains a qualitative jump from the three first to the fourth and fifth levels. The jump implies an abandonment of the rule-based thinking as the most important action, and its replacement by context and intuition. Logically based action is replaced by experientially based
action. Intuition is the ability to draw directly on one’s own experience—bodily, emotional, intellectual—and recognize similarities between these experiences and new situations.

6.9.3 The Components of Expertise

Another perspective of describing the knowledge is made by Atherton J S. [34].

Note that this is not intended to replace Dreyfus. It is consistent with their model but provides a slightly different perspective: it concentrates on exploring the components of expertise, rather than the stages on the way to it. It does work in some measure for that purpose, but of course as a graphic model it is less detailed.

The model takes the familiar form of a pyramid figure 21 in which each successive level presupposes those below and requires them as a foundation. Creativity without competence is the prerogative of the child and the charlatan: it is submitted that the expert works at all four levels.

The pyramid is not labelled itself, but the background instead: the pyramid may be the map of an individual's achievement, while the background represents the field of expertise. The horizontal bars are arbitrary dividers, but the graduated background is intentional. It represents something like "accessibility to consciousness": for the expert, competence in performing the individual component parts of his craft or profession is taken for granted, and as discussed above, may no longer be explicable or articulate. It is second nature: but the higher reaches have to be thought about. It is of course precisely freedom from the need to think consciously about the lower levels which frees practitioners to concentrate on the higher ones.

Competence: is the simple ability to perform the requisite range of skills for practice. As represented here, it has a broad base. In all areas of practice there will be some skills in which experts are "merely competent".

Contextualisation: is knowing when to do what. It is the additional skill of flexibility, discrimination and discretion which enables a practitioner to select the appropriate method for the situation. The competent teacher has a range of skills, but not necessarily the tactical ability to select which to deploy the contextualising teacher knows which ones to draw on in a given situation. Dreyfus' stages 2 and 3 draw attention to this feature. Knowing when to do what is the beginning of strategic thinking.

Contingency: is the greater flexibility to be able to cope when things go wrong. It implies a great depth of understanding of the situation, which can be drawn upon to develop a strategy for action which does not simply rely on predetermined recipes. There is an element of strategy in contextualisation, but here it comes far more to the fore.
Creativity: is the capacity to use all the "lower" level skills in new ways to solve new problems. As with all these pyramid models, the top level tends to be vague and aspirational. (But nevertheless recognisable when you get there).

The element which is growing in importance as one goes up the pyramid is the strategic component. Competence does not require it: contextualisation is a prerequisite for it, and it makes a tentative showing: contingency planning presupposes it: and creativity is mainly the strategic deployment of the lower levels.

6.10 Reflections on the Theory

There are several ways to develop a production strategy described in literature. A simple three step approach is suggested in paper [11] based upon the components and steps in a manufacturing strategy:

Analyse where we are today – Includes a specification of strengths, weaknesses, threats and opportunities within operations as well as long term trends and challenges.

The future scenario – To direct development, a future scenario needs to be developed which will enable the production system to be competitive in the future. The future scenario includes the formulation of a vision, a desired production philosophy, specification of core competencies as well as development of a conceptual production system. A concrete and hands-on “picture” of a future production system should be developed.

The way to implement and realize the future production system. – If we know the future scenario and where we are today we can describe how to implement and realize the future production system. This includes e.g. a formulation of important development-projects and necessary competence development.

The industrial objective and the industrial questions can find several answers in the frame of references regarding the performance objectives that is well described by e. g. Slack and Lewis, [19]. For the industrial objective it is the relevant set up of the performance objectives that are to be analysed. The trade off dilemma is the core of strategy that is discussed by several authors. In the frame of references a number of trades offs are discussed in order to understand some of the problems. The purpose is to find out how a company shall approach these dilemmas. The trade off decision is a central part of manufacturing strategy. Brannemo, Strategic Rightsourcing [38] give a great input to what manufacturing strategy should contain so it can be used for make-or-buy decisions. The description of the manufacturing footprint structure is inspired by IfM [18] and the related performance objectives. What needs to be developed is the visualizing and description of the manufacturing strategy.

The phenomena of the “Black Hole” is not found in the frame of reference, but it is studied from different views and the intersection in Dreyfus model [33], Hotelling model[30] and the Network paradox [31] describes this from knowledge, positioning and organisations perspectives. There seems to be a gap in describing concept factories so it can be used for strategic developments in clear directions. Improvement tools like the importance performance described by Slack and Lewis, [18] will be a useful part of the movement to a desired position as a concept factory.
7 Empirical Study at Seco Tools

Seco is today a global company with approximately 4000 employees with manufacturing all over the world. The market position can be described as high quality products with strong customer intimacy. Seco supplies standard and custom designed products that contribute to improving productivity and competitiveness in metal cutting machining. The company has a strong position as tool supplier, a good profitability and a long tradition of manufacturing.

Inserts standard manufacturing is made in four factories; Fagersta, Sweden, Sumperk, Czech republic, Pune, India and Guanzate, Italy.

The Standard tooling manufacturing units are also four; Arboga, Sweden, Bourges, France, Pune, India and Lenoir City, USA.

There are also 11 units globally located in the organisation for making special products, Custom Tooling.

7.1 Introducing the Industrial situation at Seco Tools

7.1.1 Market changes

When the economy is expanding many companies are struggling with supplying the capacity to the demanding market. It was not along ago when the industrial reference was lacking of capacity. The priorities were on capacity expansion. Investments were required in the production systems and the global supplier base was increased. It was difficult to catch up with the increasing demand and the transfer of products was based on what quickly can be transferred. A manufacturing strategy was desired. Then, when the global finance situation quickly changed and manufacturing units needed to fill up with more capacity and in-sourcing was ongoing, a manufacturing strategy again was desired to support in the make-or-buy decision process.

7.1.2 New Supply Chain organisation and challenges

During this period a new organisation was taking place. Production, Logistics and Purchasing created the new supply chain organisation. The purpose was to set an organisation that can support and meet the supply chain challenges. In this new structure strategy developed for Supply Chain and its functions and also in other parts of the company as for Market organisation. One of the major challenges in the production system for Seco tools is to clarify roles between different factories, which is doing what, and with what core competences. When the manufacturing sites expands and develops, and external sources are used, a picture of the approach was desired of how the resources shall be handled.

This has been a central part all through this study -How to position the different factories? This is a very important key to support make-or-buy decisions and transfer of production in order to create the picture of the manufacturing structure globally with which factory is doing what, and with what strengths and advantages. What kind of criteria products do they do best and how do they handle volume variances, high runners and low runners? This is a factory positioning
process which contains a number of interesting perspectives. How shall the factories be positioned and with what focus?

7.2 The Strategy Process at Seco

7.2.1 The strategy development process

At Seco Tools the corporate strategy is described by MD Kai Wärn as in Figure 23. The business is driving, and the road to get to the target is the Seco way. The market share target will be reached by high performance in the QLE issues and a set of high performance products and services. With a customer approach the company listens and addresses customer’s business needs and supply solutions. The ability to work together in a global network is also a key factor.

Figure 23 The Seco way, illustrating the corporate strategy.

The overall corporate strategy at Seco Tools is input to the functional strategies, in line with the functional strategy development process presented by e.g. Olhager [47] in Figure 24. The responsible functional managers handles the projects to create the functional strategies. A new Supply Chain organisation has been set including manufacturing, purchasing and logistics. Plans are made and are reported back to top management for reviews and approvals. Based upon corporate targets and business targets, functional level analyses are made, such as SWOT e.g. together with internal priorities. The functional strategies for manufacturing, purchasing and logistics will create the supply chain strategy. The functional strategy for manufacturing tools will contain: Internal targets, Core competence, Characteristics, Positioning, Rules, KPI’s and Organisation.
7.2.2 Strategic coherence at Seco Tools

The functional strategies are brought together by cross functional work and an understanding of the business strategic structure. This is easy to say but difficult to attain. A supportive leadership and an organisation that make priorities for a cross functional approach towards the overall business targets is necessary. The new supply chain organisation is set in order to encourage this. Company values will also support this cross functional approach. Three of the values for making the Seco culture strong and help to link the strategies together are:

- Passion for our customers
- Family spirit
- Personal commitment

7.2.3 Manufacturing as a competitive mean at Seco

Seco Tools major products are carbide inserts and holders for the inserts. The manufacturing of the carbide inserts is a competitive weapon together with the R&D when new products are developed. The know-how in inserts’ manufacturing process – a long process with many operation steps – is a critical resource for the R&D when new products are developed.

The tool-holders’ manufacturing process is a more common industrial process and external supplier can be used. There are however critical parts of the holders that can be treated as core competence and need attention. Making the pocketing in a holder with a high quality fit for a carbide insert is an advanced machining operation which contains competence and preparation in cad/cam and design. It is a high precision operation and contains substantial knowhow together with the challenge to be able to measure this pocketing in a coordinate measuring machine. Quality and reliable deliveries are competitive factors and manufacturing has big impact.

A way of securing the quality and the reliability in the manufacturing process is using the SPM (Seco Production Manual). This is guide to help and assure that the right quality from all manufacturing units is provided. A global production network is established and the network share ideas and improvements. One example is a yearly machining competition where teams from the manufacturing units compete with selected Seco products in order to find the most efficient process. The solution is then shared with all teams and a further improvement is made.
Another competitive strength for Seco is the intimacy between customer, manufacturer and local R&D. Seco is supplying productivity improvements and not only inserts and holders. The manufacturing units with local R&D are supplying innovative products and this approach triggers manufacturing volumes for the unit.

Special solutions need different manufacturing processes and the product categories are separated in standard tools and custom tools. The Custom tools units have very close contact with customers act as a catalyst for implementing new products. They get involved with many challenges from customers and some of them can be adapted to standard products. One illustrative example is the Jetstream technology, illustrated in Figure 6, which was custom-made for Rolls Royce but later adapted to a standard tool-holder program, becoming a commercial success. This system have a number of interesting properties, it deliver the coolant concentrated on the cutting edge, it makes chip breaking easier and improves the cutting speed and tool life etc.

Figure 25 The Jetstream solution is an example on manufacturing as a competitive mean.

7.2.4 Make-or-buy decisions at Seco Tools

The process for make-or-buy decisions at Seco is owned by the purchasing department. In figure 26 the reporting structure is described. The coordinator of the process is the CPO (Chief purchasing officer) who is responsible and key contact with other stakeholders.

Figure 26 Make-or-buy reporting structure at Seco

The work-flow in the make-or-buy process in figure 27 starts with setting the scope of what shall be reviewed; next step is to set the targets/requirements for quality, cost, R&D or other
reasons like workload. The sourcing alternatives, both internal and external are analysed and initial samples are ordered. The best solution is presented for the PMM (Product Management Meeting) for approval of the products features and quality.

Figure 27 Work-flow, the make-or-buy process at Seco

Then the CPO negotiates to an agreed decision for choosing supplier with main consideration departments. If no agreement can be made with stakeholders in the consideration departments, or other major issues controls the decisions like investments, the decision is escalated to the EPC (Executive Purchasing Council).

7.3 Summarising the Industrial Challenges

7.3.1 To establish a global production structure in order to increase flexibility between sites

Seco Tools has a global organisation and a number of processes that can support the manufacturing structure. Seco Production Methods (SPM) are corporate methods that will secure the quality and the reliability in the manufacturing process. The production network is also sharing ideas and improvements. Seco Supply Chain Methods (SCM) are the supporting process from a logistics perspective and it contains methods and polices for order handling and stocking polices etc. The whole company is involved in assuring a continuous global business development in a program named LIFE (Little improvements for everyone). This is a program and a culture which involves all employees in a daily basis. The competitive market priorities are Quality, Lead-time and Efficiency. This is clearly outspoken from the management and together with the corporate strategy the Seco way it forms a view which is corporate for all units. All these supporting processes will be valuable when the global production structure will be put together.

7.3.2 Balanced production load, allocation between the different factories, capacity balancing

With a group of factories the logistic department has a role to control and balance the production load allocation between the different factories in order to optimize QLE, (Quality, Lead-time, Efficiency). This is done in the long term planning with transfer of production between operations which will be easier with a clearer picture of the
manufacturing structure. Also a more flexible approach to handle quick market changes is under discussion to be a tool for the capacity planning to balance production load in short terms. This is more detailed described below with a proposal using a flexible pot.

In order to be more flexible it is an objective to have a structural overcapacity of 8% and using outside vendors for extra capacity to handle the variances in forecasted volumes. This capacity buffer will make it possible to maintain the delivery services.

7.3.3 Positioning, clarify different roles

One of the major challenges in the production system for Seco tools is to clarify roles between different factories, which one is doing what, with what core competences. When the manufacturing sites expands and develops and external sources is used a picture of the approach is desired of how the resources shall be handled.

This has been a central part all through this study how to position the different factories. It is really a key to support make-or-buy decision and transfer of production to create the picture of the manufacturing structure globally with which factory is doing what, with what strengths and advantages. What kind of criteria products they do best, how they handle volume variances, high runners and low runners. This is a factory positioning process which contains a number of interesting perspectives. How to position factories with what focus?

The clarification of this positioning is made in relation to QLE (Quality, Lead-time, and Efficiency) together with the manufacturing volumes. Seco’s overall business priorities are Quality, Lead-time and Efficiency and this shall be guiding the products market position. However, manufacture units can be positioned different in relation to the three priorities within QLE. Quality is a profile that positions the unit to product innovating or complex products, Lead-time is positioned to a more flexible unit and Efficiency is a more high volume and productivity position. These priorities can be illustrated as in Figure 28. The products life cycle is considered as a stream from right to left.

![Figure 28 Factory roles in relations to QLE with grades of volume and complexity](image)

When the existing positioning is demonstrated in this metaphor it is difficult to set the distinct boarders and the manufacturing units overlap each other in their profile. This is indicated in Figure 29 where an area of conflict needs to be solved for today’s position.
Figure 29 Factory roles in relations to QLE. The boats represent different factories.

One critical question is how to position the factories on cost efficiency, low volume and flexibility or complexity and new product developments? Different scenarios can be reviewed to obtain the best structure and cost evolution according to QLE. One scenario is illustrated in figure 30, containing a flexible pot that will encourage factories to improve and perform better. The flexible zone in Figure 13 consists of high volume products which more than one factory has the capability of producing. This pot will be managed by rules and be a tool for balancing production load allocation between the different factories. Who is doing what, in what volumes and what products will change over time. The factories that deliver good results will grow and factories that can develop new products will strengthen their position. The factories Key Performance Indicators (KPI) will control how much they can get from the flexible pot. All products will also continuously be challenged in make-or-buy analysis in order to be competitive.

Figure 30 The flexible zone to balance manufacturing load.

7.4 Concluding the Empirical Findings in the Case Study

Conclusions of empiric finding in the case study related to a manufacturing perspective are summarized below.

- Core competences are identified and there are strengths in quality, customer intimacy, innovations and several supporting processes in the organisation. There is a competitive advantage to have R&D close to the manufacturing when new products are developed.
- Requirements are to reduce lead-time and reduce the stock situation. There are opportunities to find more products that can be “make to order”.

- Improvements are required to be done in cost and lead-time to meet new future competitors.

- There are weaknesses in the product introduction launches and further improvements are needed to fulfill the reliability in the basics.

- Customer inquire, highlights the importance of priorities of dependability, flexibility and product innovations.

A manufacturing strategy is desired;

- To guide product transfer and in or our sourcing of products.

- To plan and combine the product life cycle and the flexible pot

- To positioning factories

- For risk management

- To visualize the structure

A picture for transfer plans would be appreciated. The discussion was when a new product is introduced: we don’t know how the development in sales volume will be. If there is a success there will be a need of more capacity. A proposal was discussed to combine the product life cycle and the flexible pot, figure 31.

![Figure 31 A proposed pictures for transfer plans](image-url)
7.5 Reflection from the Case Study

To fulfil the three supply chain challenges a manufacturing strategy is desired to guide product transfer and in or out sourcing of products. This will support balancing of production together with the discussed flexible pot. The clarification of the different roles between the factories, which are doing what with what competences will position the factories and is a key issue for the manufacturing footprint strategy together with the risk management approach. Positioning can be in relation to the five performance objectives. Seco has a high Quality level on the products; there can be space for improving Lead-time and Efficiency.

Short lead-time, dependability, reliability in the basics is required from Market. Which is confirmed by the customer inquire that also highlights the importance of priorities of dependability, flexibility and product innovations. The forecasted growth in Asia will trigger for performance objectives Dependability, Lead-time and Efficiency, the European plants will be important for the products in the beginning of the product life cycle.

Strategic decisions of performance that are reducing the inventory level and improving the delivery services will be important factors. The visualization of the strategy will also be an important part of carrying out the strategy.

There is a big advantage to have R&D close the manufacturing when new products are developed. This is essential factors for setting up the manufacturing footprint structure.

An internal best practice for product innovation is highlighted; one of the factories has an extraordinary performance of developing and introducing new products. Some of the reasons are connected to key personnel and culture.

What seems to be a core issue in this case study is the factory positioning and the approach for the trade off in the manufacturing strategy and the industrial challenge. It is interesting in the empirical data what is indicated in figure 12 where an area of conflict needs to be solved for today’s positioning. The distinct boarders are difficult to set and the manufacturing units overlap each other in their profile. This will be input to the research questions in this thesis.
8. Research Set Up and Methodology

8.1 Research Methodology

The method used in this thesis is the main first three steps in DRM a Design Research Methodology) [13]. Research Clarification (RC), Descriptive Study I (DS I) and Prescriptive Study I (PS I).

8.1.1 Project phases and research plan

Research Clarification is where the literature is reviewed and focuses on setting the scope.

The following Descriptive Study I, is review-based and have industrial practice as reference and further literature studies. It will deliver a conclusion supporting the describing of the characteristic for the desired positions of the performance objectives in a manufacturing structure.

The Prescriptive Study I, delivers a model and some tools which supports the design and development of the manufacturing structure to the desired performance objective.

The questions in the research plan, see figure 2, have been split in two categories:

- Industrial issues which are related to the Industrial objective where most answers can be found in the literature.
- Research question which are academic questions where answers don’t exist today.

![Figure 2 The Design Research Methodology plan for this research.](image)

This research has been carried out through a case study and a study of relevant literature. Based on the study, manufacturing strategies are discussed for creating a global manufacturing structure that will support in balancing forecasted manufacturing volumes including make or buy decisions at the company. As an employee at Seco Tools I had the possibility to perform a case study in the process of moving towards a manufacturing strategy at Seco Tools and making the documentation required. This has been made by working closely to the Tool
Manager during the development of the manufacturing strategy at Seco Tools. Data collection has been conducted through semi structured interviews and open interviews with managers in leading positions at Seco Tools. The selected managers are those who are responsible in creating the functional strategies connected to manufacturing within the company.

8.1.2 Data sources

The empirical data is collected by:

- Case study at Seco Tools when a manufacturing strategy is developed
- Data gathered at Seco Tools in Fagersta, Sweden
- Semi-structured and open interviews
- Dialogues with key personnel
- Own experience from the organisation.
- Working close to the Tool Manager

The supervisor resources at Mälardalen University in the area production systems with both academic and industrial knowledge from the subject Manufacturing Strategy have been important resources. During the PREPARE concept the author of this thesis has participated in different courses in Innovation and Product Realization and Research Methodology and has approached the subject from different perspectives which has been valuable for the result.

Another paper is written by the author et al, during this period of research which supports the thesis; Paper A [11], “Towards a manufacturing strategy supporting make or buy decisions and a global manufacturing structure”.

8.3 Ensuring Research Quality

The fact that qualitative research should be evaluated is something most researchers agree on but how is not an easy question. However, in general, research results are measured using Validity and Reliability.

8.3.1 Validity

Yin [14] defines three types of validity: Construct validity, internal validity and external validity. **Construct validity** is a question of whether correct operational measures are used for the phenomenon that has been developed. This has been made by using multiple sources evidence during the case study; documentation, interviews, dialogues with key personnel and own experience from the organisation. The **internal validity** is defined as the reliability of the results regarding the studied reality. This is has been done through the case study where results from interviews and documentation has been communicated in an iterative process. **The external validity** is defined as the reliability of the results regarding the applicability to other situations besides the one studied in the current case study. This has been done by communicating the results to different stakeholders and the model has been simulated and tested within the industrial reference at other considerations departments with positive result.
8.3.2 Reliability

Reliability is the ability of a researcher to repeat the same studies and to reach the same results and conclusions as the first researcher did. Yin [14] proposes that reliability is possible to obtain if other researchers would gain access to the same documentation as the first researcher, and well documented research procedures used by the first researcher. This research has been carried out using methods such as interviews, project documentation, and an iterative process within an industrial context. Another researcher would be forced to repeat the same research and obtain the same results due to changes in the context and access to the same documentation and situations. The building of the positioning model would probably not look similar if someone else was to build it. This is due to the fact, that the author builds the model after his conditions. However, the main contents would be most similar in essence.
9. Fulfilment of Objectives

The main industrial objective, - the industrial challenges and what shall a manufacturing strategy contain to support a manufacturing structure and make-or-buy decisions - has been fulfilled by analysing and answering the industrial questions of issues Q1-Q4 in chapter 10 Analysis of the Industrial questions of issues.

Q1 What operations performance should be part of a manufacturing strategy?
Q2 How can a manufacturing strategy be used for trade offs and strategic development?
Q3 How should a manufacturing strategy be defined so it can be used for make-or-buy decisions?
Q4 How can we describe the manufacturing footprint structure and its performance objectives positioning, and how can we perform multiple capabilities?

The academic objective formulated in two research questions below has been analysed and answered in chapter 10 Analysis of Research Questions.

RQ1 - Why are the manufacturing units positioned in the centre, in the conflict area, which is also considered as the “Black Hole” in a manufacturing footprint structure? RQ2 - How can the manufacturing units leave the “Black Hole” and position as concept factories for the desired performance objectives?

Här finns din text med lämpliga underrubriker …
10. Analysis

10.1 Analysis of the Industrial issues

Analysis, discussion and proposed answers of the industrial issues.

10.1.1 Q1 What operations performance should be part of a manufacturing strategy?

There are many demands on production systems such as comprehensive view, cost-efficiency, flexibility in volume mix and variance mix, environment-friendly, short lead-time, high quality, dependability, innovative and different manufacturing focus as, mass-production and mass customization and philosophies as lean or agile production and the human role in the production process and the level of automation.

The challenge for the production system is to meet all these demands and approach them in a successful way. Differentiation is a competitive strategy and there are many ways of segmenting markets and several approaches to focusing operations such as performance objectives and different focuses, geographic, product/service, specification, variety, volume and process requirement.

The literature in manufacturing strategy is rich and one of the main central issues is in the five performance objectives, Quality, Speed, Dependability, Flexibility and Cost [3]. These performance objectives can be attached on almost all operations and are therefore useful as generic objectives.

Manufacturing strategy has much focus on these performance objectives and the analysis of different factors lead to which objectives the manufacturing units should focus on. There are more performance objectives as Innovation and Agile and if there are identified performances with core competences they should be treated such as performance objectives in a manufacturing strategy.

The analysis of the industrial reference shows core competence in innovation and producing “pockets” for tool holders. One of the reasons for being successful in the market is the close relation to the customers all the way through the product life cycle. The industrial reference also has a very wide product portfolio.

What looks interesting is to apply the product life cycle on the performance objectives. It would also support the transfer process of the products within the company which is a continuously activity. The product life cycle starts with the product development phase where Innovation can be a performance objective. There is a need to continuously develop new products with close contact to the customers and with the competitive advantage of R&D resources at the manufacturing units. The ability to support R&D, from a manufacturing perspective, and be prepared for new products in terms of required equipment and industrialize the new products in time for the product launch, is a prioritized area for improvements for the industrial reference company. There is also a best practice example within the group of this performance. To focus on innovations with the aim to support R&D and make efficient product introductions is a way to meet the demand from Seco’s organisation.
When the products are introduced to the market they will come to a phase that is difficult to forecast, the expected volumes will depend on the market response. A manufacturing unit with a Flexible approach in terms of volume mix is then desired.

Later when the products are forecasted stabilised and volumes are increasing, the demand on the production system is to supply the market fast and a Lead-Time approach is important. In this phase companies meet competition when they are moving from the product development process to a process development process, described in figure 11, a model of product and process innovation over time [20]. The ability to fast supply the market will be an order-winner. To improve lead-time is a clear demand from the industrial reference organisation.

When the products reach the mature phase the competition will be on Efficiency and costs will be the focus. In this phase there will be lots of competition from other companies and similar products and a performance objective with focus on Efficiency is required.

Besides all product cycle demands there are demand on Quality and Dependability. These are expected to be fulfilled from all manufacturing units and are considered by the industrial reference as Reliability in the basics. They can also be considered as Order qualifiers. This is also an important risk management factor, that all manufacturing units has a common level of capability.

The proposed answer for the industrial issue Q1, “What operations performance should be part of a manufacturing strategy?”, is that after the demands from Reliability in the basics is fulfilled in terms of Quality and Dependability further improvements can be done in performance objectives Innovation, Flexibility, Lead-time and Efficiency which are following the product life cycle.

10.1.2 Q2 How can a manufacturing strategy be used for trade-offs and strategic development?

Strategy is making choices of what to do and what not to do, this is the core of strategy; trade offs. The manufacturing unit has the role in the business to provide and develop the capabilities that can supply the products for the company. The manufacturing strategy is the decisions and plans affecting the resources they can have influence on. It means developing resources to provide the capabilities which allow the organisation to improve and refine its strategic goals. The resources are limited and therefore we need to do the trade offs.

The classical project performance triangle with quality, cost and time describes the basic problem. This triangle reflects the fact that the three properties of a project are interrelated, and it is not possible to optimize all three – one will always suffer. If we should apply this on the production system we design, it would be an oversimplification. Under some conditions these three capabilities are improved to an accepted level for all of them. As discussed in Q1 there are many demands on the production system. Except these three we have demand of flexibility, service-levels or dependability, agile production environment-friendly etc. For example when we add the performance objective Flexibility we have to manage volume mix and product mix, and here we meet a number of challenges in which we either make trade offs or develop a production system that can handle the paradox.

There are a numbers of trade offs to do and many demands are triggers that are challenging the production system. Some are;

- Markets requirements - Operations resources
10.1.3 Trade offs vs. multiple capabilities

There are trade offs to do in the theories and models regarding developing capabilities as well. Wickham Skinner [8] proposed a trade-off model that companies must make selection of those competitive priorities which are most important and thus demand more investment of resources and on the other side the Sand cone theory states there is a generic sequence in which all operations perform should be improved [19].

In the Factory-in-a-Box project [28] it is concluded that competing on the basis of one or two capabilities as suggested by a trade-off model is no longer acceptable and better performing companies are competing on the basis of multiple capabilities. Progression of priorities from cost, quality, delivery reliability, and flexibility to additional new innovative factors would suggest that scope still exists for new competitive factors.

Concluded in Q1 that the Reliability in the basics, the accepted level of quality, delivery and cost need to be fulfilled before improving further capabilities combines these models of developing generic sequence and makes the trade offs according to the focus profile. Let’s look at some of the dilemmas we have;

**Markets requirements vs. Operations resources** (See also Frame of reference, Trade off, figure 13)

The problem we have is that the market requirements of products are changing over time and the operations resources must be made to fit whatever the market dictates. At other times, the capabilities and constraints of the operations resources will place restrictions on the organisations choice of its market positioning.

If we can organise the production system according to the performance objectives discussed in Q1 we can have manufacturing units which are focusing on different trade offs made for the single units but for the group of manufacturing units don’t need to do the trade off. But they will need to evolve the production system to its performance objective relating to the market demand.

**Variance vs. Cost** (See also Frame of reference, Trade off, figure 14)

If an operation choose to focus on cost efficiency they need to make trade off in variety, they can not supply the same numbers of variances and at the same time reduce costs. This is a dilemma for a single unit but for two separate units they can handle the situation together.

**Lead time reduction – With lean production or agile production** (See also Frame of reference, Trade off, figure 15)

When the organisation demands lead time reduction we have a dilemma in approach that we can apply on the performance objectives. We need to define what product category we are required to supply the capabilities for. What seems reasonable is Martin Christopher’s [5]
approach if the unit shall supply product variability an Agile production system are required and if the products are predicted a lean production approach is more relevant. In the selected performance in Q1 it connects to Flexibility and Lead-time.

**R&D demand of manufacturing resources vs. Manufacturing capacity**

Another dilemma we have is the resources and capabilities that R&D is demanding in the product development and the product introduction. When the load on the manufacturing units is high it increases the dilemma but both have to be done. A clear connection to where products are developed and introduced will support and an Innovation factory profile will be valuable.

**Inventory level vs. service level** (See also Frame of reference, Trade off, figure 16)

This dilemma has a complex relation with several capabilities and strategic decisions. It can be discussed what the performance objectives are that reduces inventory levels and improves service levels.

Lead-time and Flexibility are performance which will reduce inventory and can improve the service level. If cost-efficiency performance is driven by limited set ups and big batch sizes it will increase the inventory level. There are many other parameters affecting this as well, however, a focus on Lead-time and Flexibility will have positive effects. If the cost-effective manufacturing unit shall contribute to reducing inventory levels they need reliable forecasts and “tail-products” (in a product family with low volume) should be considered to be produced at a Flexible unit.

There are different theories, sand cone theory [27] which develops all capabilities and trade off model [8] which focus on one priority. For a single unit to fulfil all capabilities with a top performance can seem like a paradox, but for a group of manufacturing units it can be managed together and achieve the balance between performance objectives.

One way to answer to the Q2 “How can a manufacturing strategy be used for trade offs and strategic development?” is by defining the manufacturing strategy in positioning according to the performance objectives e.g. Innovation, Flexibility, Lead-time and Efficiency and giving them those focus areas and factory profiles. The trade off decision will be following the focus area and strategic positioning. This positioning will show the way to a strategic development of the production system to its performance objective. A company with several manufacturing units can when organise the manufacturing units according to the performance objectives discussed in Q1 and achieve the advantage of the trade off dilemma of being able to make performance objectives trade offs for the separate units but as a group achieve top performance for all the performance objectives.

10.1.4 How should a manufacturing strategy be defined so it can be used for Make-or-Buy decisions?

There are several reasons and risks within sourcing decisions and it is important to understand the connection to the manufacturing strategy. There are several parameters to consider in make-or-buy decisions and some of them are connected to the manufacturing strategy. When a manufacturing strategy is designed most of these parameters are analysed and structured to a document, guiding and supporting the decisions taken by the make-or-buy process. In this way
The main parameters in a make-or-buy analysis that are effecting the sourcing decision are listed as follows by Brannemo [38]: Manufacturing strategy, Core competence analysis, Benchmarking, Cost calculation, Logistics aspects, Evaluation of both qualitative and quantitative data, Risk analysis, Choice of supplier, Competitive priorities and Capacity. There are different models of make-or-buy analysis and stakeholder with different perspectives. Where to evaluate the make-or-buy parameters and who are the consideration departments are put together in the table fig 33.

<table>
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<th>Where to evaluate or consideration department</th>
<th>Purchasing (KPI)</th>
<th>PMM</th>
<th>Toll gate</th>
<th>Manufacturing</th>
<th>Economy</th>
<th>Logistic</th>
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Figure 33 Make-or-buy parameters, where to evaluate and who are consideration departments.

The economy department is the consideration department for supplying the model for cost calculation and the logistics supplies the logistic aspects. Benchmarking is made from several stakeholders in the organisation but in the make-or-buy process it is owned by purchasing at the industrial reference. Benchmarking is also an important parameter for the manufacturing strategy when it is created for valuating the core competences. The quality is verified by the product owner and the quality department. The choice of supplier is made in the make-or-buy process including risk analysis.

The main parameters for the make-or-buy analysis that should be defined in a manufacturing strategy are Core competence analysis and strategic articles, Competitive priorities and Capacity, Risk analysis and Benchmarking.

Further issues which can be defined in a manufacturing strategy are the positioning of the factories of their profiles in relations to the performance objectives and product life cycle as discussed in Q1. This will support the make-or-buy process when we need to position the products for the supplier choice. One way to support this is with a product positioning guide which contains criteria for:

- Production volume (high-low)
- Product life cycle stage
- Technical complexity
- Strategic importance
- Sales patterns

The answers to these questions will guide the make-or-buy process to where in the manufacturing footprint structure the products are placed.

10.1.5 Product transfer process
The product positioning guide can also support other decisions at the companies. The capacity planning process and balancing of production volumes including strategic purchasing need strategic plans in order to easier plan and react on changes of markets forecast and decide where production shall be made. These decisions can be make-or-buy or transfer of production within the group to different global production sites. A product positioning guide could be a link from the company’s strategies and the manufacturing structure to support these decisions.

The Q3 “How should a manufacturing strategy be defined so it can be used for make-or-buy decisions?” can be answered by analysing and making plans for the main parameters Core competence analysis and strategic articles, Competitive priorities and Capacity, Risk analysis and Benchmarking and besides that the positioning of the factories of their profiles in relations to the performance objectives and product life cycle.

10.1.6 Q4 How can we describe the manufacturing footprint structure and its performance objectives positioning, and how can we perform multiple capabilities?

The concept of manufacturing footprint strategy in the IfM-structure [18] gives a global perspective and a view on how a manufacturing network can be organised and make the right things at the right place. It raises a number of questions that are essential for a manufacturing strategy. For globally networked companies with manufacturing sites in several countries it is decisions like roles for plants and how to co-ordinate their roles that are essential parts of the strategy. This is an interesting approach and has inspired to describe the structure and the positioning.

As discussed in Q2, Trade offs vs. multiple capabilities, there are different views on whether companies manufacturing strategies should focus on one performance objective or two (Skinners trade-off model [8]) or if there is a generic “best” sequence in which operations perform should be improved (Sand cone theory [19]). Winroth and Jackson [18] conclude that competing on the basis of one or two capabilities as suggested by a trade-off model is no longer acceptable. Better performing companies are competing on the basis of multiple capabilities.

The proposed model below (figure 34) will combine these views and If we can organise the manufacturing units according to the performance objectives discussed in Q1 we can have units that are focusing on different trade offs made for the single units but for the group of manufacturing units we can achieve top performance for all objectives. The group together don’t need to do the trade offs. However before any trade off and focus on a profile is made the demands on Quality and Dependability (Reliability in the basics or order qualifiers) are expected to be fulfilled from all manufacturing units.

In the paper [11] we used in the case study QLE (Quality, Lead-time, and Efficiency) to point out the desired direction and factory roles in relations. We will here from the competitive priorities relate to the performance objectives Innovation, Flexibility, Lead-time, and Efficiency due to the proposal of factory positioning in the industry reference in Q1. These performance objectives relates also to the effects in the products life cycle. [19]. A company with several manufacturing units as in the industrial reference can set up there own unique manufacturing footprint structure.

In the centre of the figure 34 we have the conflict area which we consider as a “Black Hole”. This area contains a big share of the available products and is therefore very attractive for the units and is representing average levels performance as well. This circle can also be considered as order-qualifiers [19].
A company that has its performance objectives in this circle can be considered as having multiple performances capabilities to a limited extent. If the companies expand the diameter of the circle it corresponds to the progress of the sand cone theory [19], despite that the sand cone theory creates improvements in a particular sequence.

All units have their own speciality outside the circle, but inside the circle they have the performance in common.

These values in the circle can be considered (in the industry of reference) as Reliability in the basics, (the performance of delivering products as agreed quality, delivery date and cost). In literature this can also be considered as order-qualifiers. What makes the operations competitive in long terms is more the unique profile of e.g. Innovation. In literature [19] this is called order-winners or delights.

The visualization of the strategy will also be an important part of carrying out the strategy. Wickham Skinner writes [12] about the paradox of the great academic interest of manufacturing strategy with a limited industrial practice. The visualization can be one of the criteria that can contribute to an industrial practice.

By using the polar representation diagram with exponential grades [11] and by connecting KPI’s to the axis a factory profile can be set. This is one of the challenges to actually measure or scale the factory profile. We need to describe the characteristics and performance in the desired direction which will be discussed in RQ2.

We can describe the manufacturing footprint structure and its desired performance objective positioning including the multiple capabilities as in the Reliability in the basics (or the “Black hole”) as the picture below showing four manufacturing units.

If we look at the product life cycle perspective we can start the cycle at Factory A where the products are developed and introduced to the market. The growing phase then starts and demands Flexibility as for Factory B. Moving on to Factory C where the priority is to supply the market in short lead time and finally meeting the mature phase where competition is mainly on cost. This set up will also function as a guide when the company perform product transfers between the units.
Figure 34 The manufacturing footprint structure and its performance objective positioning.

The first two phases (Innovation and Flexibility) represent the products development phase and the later two (Lead-time and Efficiency) represent the process development that follows a general pattern over time and shows that product and process innovation share an important relationship. During the emergence of dominant design, competition between companies shifts from product to process innovation (transitional phase). Companies unable to make this transition will disappear. Only a few companies will remain in the market, when technology has reached a mature stage (specific or rigid phase) [20, 22].

Some of the performance objectives are opposites of each other such as Efficiency and Flexibility (discussed in Q2) if you consider them as cost and variances. Others like Innovation and Flexibility have more in common in the same way as Lead time and Efficiency. That gives an option to develop units with a combination of those performance objectives with different scaling.

The Q4 “How can we describe the manufacturing footprint structure and its performance objective positioning, and how can we perform multiple capabilities?” is then answered with the polar representation diagram and the positioning which describes and visualizes the structure and capabilities.

10.2 Summary and Result of the Case study and Empirical Studies for the Industrial Questions

By answering the set of questions Q1-Q4 for the case study the main industrial objective “what shall a manufacturing strategy contain to support a manufacturing structure and make-or-buy decisions?” has been fulfilled.
The proposed model for a manufacturing footprint structure and its performance objective positioning has been an input to the strategic process at Seco Tools and has also given spin off effects to strategic purchasing on how to position the external suppliers.

The result from this case study raises two research questions that will form the academic objective with this research.

10.3 Analysis of Research Questions

10.3.1 RQ1 - Why are the units positioned in the centre, in the conflict area, which is also considered as the “Black Hole”.

When the analysis was done in the industrial reference to find out the existing positioning a conflict area was identified. The manufacturing units were overlapping each other in their profiles and were gathering in the centre of the polar representation diagram. This area contains a big share of the available products and is therefore very attractive for the units. All units want to take part of this area. The difficulties will be to focus on the strategic position and go for the top grades. It will not be possible to reach the maximal grades for all dimensions, there will be trade offs to do. The conclusion is that this area can be considered as the “Black Hole”. But why are they gathered and positioned in the centre? Is there an intersection in the views of positioning, knowledge and the network paradox discussed in the frame of references section between Hotelling positioning model [30] and Dreyfus Competence model [33] and difficulties in existing networks, Medicieffect [31]?

10.3.2 Hotelling positioning

If we add a manufacturing perspective to the Hotelling model [30], and project the model on the polar representation diagram, the operations tend to move into the centre. They don’t want to leave the centre and give up the opportunities there. The Hotelling model gives some insights into business decisions concerning location and products characteristics and can explain this kind of phenomena. As the vendors in the example initially positions in A and C since they will minimize the travelling costs of the buyers, but they only get access to half of the potential market. This is the reason why they all end up in the centre in order to have access to the whole market potential and could explain why the units are gathering in the conflict area, in the “Black Hole”.

10.3.3 The Dreyfus model

Detailed phenomenological studies of human learning indicate that people pass through several phases or levels in the learning of skill. Various studies have divided the learning process into a varying number of such models. The Dreyfus model [33] operates with five levels in the human-learning process Novice, Advanced beginner, Competent performer, Proficient performer and Expert.

Research shows that heuristic expert systems, being rule-based, are unable to go further than level three in the learning process. The heuristic system cannot make the quality jump to levels four and five and therefore never become as skilful as human experts. The Dreyfus model contains a qualitative jump from the three first to the fourth and fifth levels. The jump implies
an abandonment of the rule-based thinking as the most important action, and its replacement by context and intuition.
If we project Dreyfus model in an operation perspective and project the model on the polar representation diagram with exponential grades, we can assume that we have the same jump from the circle (the “Black Hole”) to the outside the circle as Dreyfus model contains a qualitative jump from the three first to the fourth and fifth levels.

10.3.4 The network paradox

When companies obtain experience in a network they will probably develop competence, organisation structures and cultures that are suited to the value network special demands. These networks are necessary for success in areas and that is the reason for creating them, but this is also a problem. When a company develop innovations in new directions seems to be a problem in existing networks. Groups, organisations and companies establish cultures with common interests and views on how things shall be. If someone makes an attempt to move in another direction and try something new they will often be pulled back and in that way the existing network becomes the obstacle of the progress itself [31]. Just like in the example with Walt Disney who failed with introduction of computerized animation the network was holding them back and decided to continue with the traditional animation film. Pixar was not trapped in such culture and could continue to develop the computerized animation film with success.

Both people and operations in the networks are controlled by processes and routines which in principle are stopping all attempts of breaking the network. New ideas that are not in line are usually eliminated.

If we project the network paradox in an operations perspective and project it on the polar representation diagram we could assume that an existing network is positioned in the circle area, the “Black Hole” and it is very difficult to get outside and make developments in new directions. The existing networks competence and culture is in that circle area.

10.3.5 A common behaviour

There are probably more reasons to why the operations are gathered and positioned in the centre of the diagram, but these three models can give some understanding and views from different perspectives. The three models can represent views of positioning, knowledge and operations networks, and by using the polar representation diagram with exponential grades in mind we can identify a common behaviour from these three models in the circle area.

10.4 RQ2 - How can the manufacturing units leave the “Black Hole” and position as concept factories for the desired performance objectives?

Whether if the focus is on one or multiple performance objectives there is a need to understand what the characteristics are for the different performance objectives. The approach for this thesis is to describe the characteristics for the desired positions of the performance objectives, the concept of the factory positioning profile. To accomplish this there is a need for a model that can indentify or describe the desired position so it can be useful for the manufacturing unit’s development.

This will to some extent, contribute to what Skinner [12] refers to in the paradox with manufacturing strategy that the academic literature is quite extensive but the industrial practice is limited: - How to move from a manufacturing task to make essential choices in designing the
structure? However there is no handbook, if it was an engineering problem, there would be formulas and design steps, but now managers have to use “common sense”. The way to address the positioning to manufacturing targets at its simplest involves translating the intended market position of the organisation into performance goals or targets for the operation. We choose here to combine two approaches: Performance measuring systems and Importance-performance. The idea is to describe the characters of the different performance objectives as factory profiles with driven profiles in the directions of Innovation, Flexibility, Lead-time and Efficiency.

10.4.1 Connecting factory profiles to competitive priorities

By connecting the competitive priorities QLE to a desired factory profile, see figure 35, as Innovation driven profile etc and setting relevant criteria we are starting to describe what we want to achieve as performance objectives priorities.

![Figure 35 Linking the criteria to the factory profiles.](image)

10.4.2 8M analyse describes the factory characteristics

By making the further descriptions of the factory profile according to the 8M analyse (see figure 36) based on the criteria, we get the characteristics for the concept factories profile. The 8M analyse is based on the Ishikawa diagram (Wikipedia; also called fishbone diagram or cause-and-effect diagram) that and shows the causes of a certain event. Common use of the Ishikawa diagram is product design and quality defect prevention, to identify potential factors causing an overall effect. The categories typically include:

- **People:** Anyone involved with the process
- **Methods:** How the process is performed and the specific requirements for doing it, such as policies, procedures, rules, regulations and laws
- **Machines:** Any equipment, computers, tools etc. required to accomplish the job
- **Materials:** Raw materials, blanks, spare-parts, etc. used to produce the final product
- **Measurements:** Data generated from the process that are used to evaluate its quality
- **Environment:** The conditions, internal and external, and culture in which the process operates
In this analyse the categories Management and Market are added due to the strategic importance.

Management: How the organisation is set up
Market: Depending on the core competence customer intimacy for the industrial reference.

The analysis below can be considered as a proposed characteristic for the concept factories profile towards the desired positions for the performance objectives.

<table>
<thead>
<tr>
<th>8M analyse</th>
<th>Innovation driven profile</th>
<th>Flexibility driven profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td>Organisation for Innovations</td>
<td>Organisation for flexible approach</td>
</tr>
<tr>
<td>Market</td>
<td>Customer intimacy focus on profile</td>
<td>Customer intimacy focus on profile</td>
</tr>
<tr>
<td>Machine</td>
<td>High tech resources</td>
<td>Flexible manufacturing system</td>
</tr>
<tr>
<td>Method</td>
<td>R&amp;D Supplier development</td>
<td>Flexible and reliable supplier base</td>
</tr>
<tr>
<td>Environment</td>
<td>Spatial design supporting profile</td>
<td>Process for flexibility</td>
</tr>
<tr>
<td>People</td>
<td>Creative people mix</td>
<td>Flexible people mix</td>
</tr>
<tr>
<td>Measuring</td>
<td>No of prod dev projects and manuf intro</td>
<td>No of products and LT development</td>
</tr>
</tbody>
</table>

**Leadtime driven profile**
- Management: Organisation for leadtime approach
- Market: Customer intimacy focus on profile
- Machine: Flow oriented manufacturing system
- Material: Reliable Supplier base and supply
- Method: Process for short Lead time
- Environment: Green production
- People: Process flow oriented people
- Measuring: Leadtime development

**Efficiency driven profile**
- Management: Organisation for efficient approach
- Market: Customer intimacy focus on profile
- Machine: Manufacturing productivity
- Material: Efficient supplier supplier base
- Method: Process for productivity
- Environment: Green production
- People: Productivity oriented people
- Measuring: Cost/pocket development

Figure 36 Linking the 8M characteristics to the factory profiles

10.4.3 Mapping the positioning

Now the concept factories are described and the directions to the targets can be pointed out. However we want to find out where the current positioning is in order to make further strategic movements. There are other options such as benchmarking comparisons. The disadvantage is that it can be difficult to access the benchmarking terms. The possibility to measure or scale the characteristics for the factory profile on the polar representation diagram is required. The performance objectives are composites of many smaller measures. But it is valuable to map the position visually to easier understand where the units are and the desired direction. What looks interesting is the Importance performance mapping (see figure 37) which can, by bringing importance preferences of customers and performance and activities against competitors, give a good picture and judgement of what performance or activities that need to be prioritized to improve. As we can see in the 8M analyse it consists of eight categories and all of them can be analysed and measured into further details. By connecting them to an overall KPI through all eight characteristics to each performance, it will be an overall KPI which can show current position.
We can consider the importance for customers as importance for the factory profile when we are judging the factors. Through scoring important performance by judging on a nine-point scale and plot them on the matrix we get a picture or pattern over the factory profile performance. The four zones in the matrix Urgent action, Improve, Appropriate and Excess will guide to further improvements.
If the majority of the scoring is at the upper bound in the Appropriate zone you can consider the result as proficient or expert performance. If the majority of the scoring is in the zones Urgent action or Improve then the overall KPI is still inside the circle or the “Black Hole” at the lower end of the scale.
The translation of the polar representation diagram can be done by the average number from the 8M factors judged on a nine-point scale and plot it as a single KPI in the polar representation diagram.

10.4.4 Scaling the positioning

When the connection is done to the overall single KPI the mindset of Dreyfus model [33] can be attached and further describe the positioning. This will then be a qualitative measurement by Dreyfus model as referred in RQ1. The model seems to fit well when it comes to describe to how to move outside the circle, the qualitative jump to the fourth and fifth levels, that makes Dreyfus model interesting.
If we consider that the scale 9-6 is inside the circle and scale 5 is on the boarder we can consider that as competent performer or as the Reliability in the basics. Proficient performer responds to scale 3 and Expert responds to scale 1 is the highest performance.
Further understanding to the qualitative jump and the strategic content is raised by Atherton J S [34] who discusses knowledge and the components of expertise in a slight different perspective and describes the levels as: Competence, Contextualisation, Contingency and Creativity (see figure 21 and the description of the components of expertise).
The element which is growing in importance as one goes up the pyramid is the strategic component. Competence does not require it, contextualisation is a prerequisite for it, and it makes a tentative showing: contingency planning presupposes it; and creativity is mainly the strategic deployment of the lower levels.
In the scale Atherton J S terms can be supplementary to Dreyfus by considering Competent performer as Contextualisation and Contingency and Creativity to Dreyfus Proficient performer and Expert when we make the qualitative jump out of the circle.

<table>
<thead>
<tr>
<th></th>
<th>Atherton J S [17]</th>
<th>9-plot scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Novice</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>2. Advanced beginner</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>3. Competent performer</td>
<td>Competence and moving to Contextualisation</td>
<td>5</td>
</tr>
<tr>
<td>4. Proficient performer</td>
<td>Contingency</td>
<td>3</td>
</tr>
<tr>
<td>5. Expert.</td>
<td>Creativity</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 38: Atherton J S supplementary to Dreyfus Model and related to the 9-plot scale.

Figure 34: Polar representing diagram relating to Atherton J S supplementary to Dreyfus Model and to the 9-plot scale.
11. Conclusions and recommendation

11.1 Summary and Result of the Case study and Empirical Studies for the Industrial Questions

By answering the set of questions Q1-Q4 for the case study the main industrial objective “what shall a manufacturing strategy contain to support a manufacturing structure and make-or-buy decisions?” has been fulfilled.

The proposed model for a manufacturing footprint structure and its performance objective positioning has been an input to the strategic process at Seco Tools and has also given spin off effects to strategic purchasing on how to position the external suppliers.

The result from this case study raises two research questions that will form the academic objective with this research.

11.2 Proposed Model

Following is a proposed model designing the manufacturing footprint structure and moving towards the positions of the concept factories.

1. The proposed process-model we can use starts with identifying the desired performance objectives. In our case we have selected four; Innovation, Flexibility, Lead-time and Efficiency. These we consider as the concept factory profiles which we approach when the demands from Reliability in the basics are fulfilled in terms of Quality and Dependability.
2. Set up these four objectives in the polar representation diagram with exponential grades.
3. Relate the scale in the diagram 1-9 to the Dreyfus/Atherton J S knowledge models as a mind set.
4. Connect competitive priorities criteria to the four concept factory profiles to get the characteristics on the desired profiles.
5. Use the 8M analyse to make further detailed descriptions of the characteristics for the concept factories profiles.
6. By the scoring important performance through judging on a nine-point scale and plot them on the importance matrix we get a picture or pattern over the factory profile performance. An average number can also point out where it is positioned and what including factors the manufacturing units need to improve to get to the desired position.
7. These result can then be indicated on the polar representation diagram with exponential grades that visually shows the manufacturing footprint structure according to the performance objectives and support of the improvements towards the desired positions. It can be used for a group of manufacturing units or for separate units. In the example in figure 35 the result is for one separate unit.
11.3 Conclusions on the Research Questions

The visually use of the polar representation diagram with exponential grades and Dreyfus knowledge model connected brings some understanding to the positioning problem and the conflict area or the “Black Hole” in the circle as discussed in this thesis. This is a proposed mindset when people shall make improvements for their production system towards a desired position. It can be used for describing the production system for the stakeholders in an organisation. There are also other issues and decisions needed to consider when setting up the positioning for the production system. This model does not cover all decision when a manufacturing footprint structure is set up.

Using the manufacturing structure with different concept factory profiles and giving them unique profiles and measure the current position they can make the qualitative jump and leave the “Black Hole”. If the factories can develop in different desired directions the conflict is reduced. By keeping the competiveness in the “Black Hole” and the possibilities there in terms of the big share of available products they will also access new possibilities and products if they reach top performance as concept factories of the different performance objectives. The cooperation between the units can also be improved when the units are encouraged to develop in different directions without competition. This can be seen as risk management approach since the manufacturing units have the same capabilities in the “Black Hole” and can be back up for each other.

The manufacturing footprint structure in this thesis is set up in a product life cycle perspective following the performance objectives Innovation, Flexibility, Lead-time and Efficiency which will guide the trade off decision following the focus area and strategic positioning. A company with several manufacturing units can organise them according to the performance objectives. In that way they can achieve the advantage of the trade off dilemma and be able to make trade offs for the separate units but as a group achieve top performance for all the performance objectives.
11.4 Contribution

The contribution in this research is an insight from the positioning perspective regarding the phenomenon of the conflict area the “Black Hole” in manufacturing footprint strategy structure, a proposed model is developed of describing concept factories and measuring existing positions and moving towards the desired positions. The model has been simulated proved, with positive results, in a positioning context for strategic purchasing within experience of supplier quality audit for positioning suppliers. The feedback is that the positioning model can be a first activity when a new supplier is considered in order to verify the suppliers’ position.

The model and the polar representing diagram with exponential grades underline and visualize the difficulties to reach the higher levels for the performance objectives. The visualization and relation to the products life cycle can contribute to communication and development of the manufacturing footprint strategy.

11.5 Future Work

During the research process there were many questions found which would be interesting to investigate further. Some of these questions are presented below as areas of proposed future work.

11.5.1 Best practice concept factories and their 8M analyse profile

It would be interesting to analyse companies that are considered as top performance organisation in the context of the discussed performance objectives and find out how their 8M analyse profile looks like. And further develop the 8M characteristics that are matching the desired factory profiles. Another interesting issue can be to identify the suitable characteristics for the factories managers to fit into the development of the desired factory profile.

11.5.2 Trade offs and relations to different performance objectives

It would also be useful to identify more trade off dilemmas and analyse and connect them to the different performance objectives in order to support the development in moving to different desired directions. This could be a “toolbox” where different trade offs lead to different performance objectives and that can show the relations to the performance objectives that are related more or less to each other.
12. References


