JÖNKÖPING INTERNATIONAL BUSINESS SCHOOL
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Knowledge creation within an innovative unit

-A case study of Robotic Mowers

Master Thesis within Business Administration

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Abstract

Problem Knowledge is becoming ever more vital in today's economy and organisations are realising the need to act on the advantages it provides. Knowledge is complex and contradictory, making it difficult to be created and managed by organisations.

Purpose The purpose of this research is to see how knowledge is created and subsequently managed within an environment characterised by progress and innovation, and to identify the most problematic areas in knowledge creation processes as well as suggest improvements.

Method Overall, qualitative methods were used in this study. In-depth interviews were conducted with management level within three product development units, two of these were only used for support to the third and main case, Robotic Mowers. Issues of trustworthiness and ethical implications were confronted in order to provide the most advantageous method to conduct the study.

Result Knowledge creation at Robotic Mowers originates from both external and internal sources. The most important external source and activity to create knowledge are suppliers/consultants and the most important internal sources is the use of tests. Further, the unit has a highly informal approach to the creation of knowledge and the management of it. Support to knowledge creation is mainly found in cultural aspects.

Conclusion The unit's knowledge creation is dependent on informal and unstructured interaction among group members and to external parties. Overall, low managerial control is exercised and the group has developed a strong culture that enhances informal ways of knowledge creation and its management. The main problem of knowledge creation is that the group fails to realise a long-term need, which is revealed through inadequate efforts in trying to turn tacit knowledge into explicit knowledge.

1 Introduction

The beginning is the half of every action.
Greek proverb

This introductory section intends to guide the reader into why the subject is of interest, what problem this research looks into and how it will be approached. Also, a disposition of the study will present the different parts of the study to the reader.

1.1 Background

Organisations of every kind are reliant on how well they can competitively act in the external environment, but also on how they can arrange and manage its inside. Traditionally, when it comes to competitive efforts, a great deal of attention has been given to land, labour and capital. The world has however changed and so has the ways organisations compete. Today, attention is still given to traditional factors of production but above all, knowledge is seen as the primary competitive resource that organisations can possess (Nonaka & Teece, 2001). Knowledge is also what provides substance to the traditional factors since if there is no knowledge to acquire or employ them, they mean nothing to the organisation. There is however interdependency between the two since knowledge in itself does not produce something tangible for organisations and it becomes useful only when it is turned into a task. The society of organisations creates a desire for knowledge since the aim of every organisation is the integration of knowledge into a common task (Drucker, 1995).

Healthy and thriving organisations pro-actively reap benefits from the knowledge that resides in their surrounding environment through working in symbioses with it. Engaging in this type of behaviour is crucial since organisations absorb information, transform it into knowledge and subsequently act on it in relation to their experiences, values and internal rules. Knowledge has thereby been made useable for their own specific purposes. Without knowledge, organisations would not be able to structure it or its output, and it would never be able to survive (Davenport & Prusak 1998). The individual is at the heart of every organisation, but also at the heart of knowledge creation. In the new knowledge economy, the challenge for organisations is to construct, combine and integrate the knowledge of all the employees, a much more difficult task than simply managing its products (Nonaka & Teece, 2001).

Knowledge is complex and volatile. It is conflicting by nature since it represents a requirement for organisations although it is highly individual, and it conveys both positive and negative influences. Further, it is an intangible asset although created through concrete processes. This makes it hard to manage, yet this is imperative since it is organisations' main competitive resource. Knowledge processes are embedded in the organisational life, whether they are deliberately managed or not. The contradictory character and the competitive contribution however, stress the necessity for organisations to engage in knowledge creation and subsequently manage it (Davenport & Prusak, 1998).

Competition has become knowledge-based and in knowledge-intensive industries, organisations' competitive advantage is highly related to its ability to create and apply new knowledge approaches (Watsson & Hewett, 2006). Today, markets shift rapidly, new technologies are developed, competition is high and products quickly become obsolete, the well-performing organisations are the ones that constantly generate new knowledge and use it in new product development (Nonaka & Takeuchi, 1995).

1.2 Problem discussion

To a large extent, literature popularise the concept of knowledge management and subsequently, much importance is put on this research field. Knowledge creation per se however, is not as commonly discussed, although it is a part of this field. Nonaka and Takeuchi (1995) state that the only thing that is for certain in today's economy, is the certainty of uncertainty, and that the only way to create a long-term competitive advantage is through knowledge. As a consequence, organisations should look for how value can be obtained through creating, and as a subsequent step, manage it effectively. Nonaka (1994) further argues that any organisation operating within a changing environment needs to possess information and knowledge, but above all, it needs to possess the ability to create the two. It is evident that knowledge provides great benefits for organisations since it is sustainable and therefore it creates a continuity of advantages. Further, the potential for organisations to generate new ideas from its knowledge base is limitless (Davenport & Prusak 1998). Also, development and change are actions that are vital in order to stay competitive in any market context. It is argued that market-related influences may steer a company on what actions to engage in, however, if a company possesses great knowledge it holds the power and also ability, to shape its own path (Prahalad & Hamel, 1990).

Robotic Mowers is a product development unit within Husqvarna with the aim to develop an automatically driven lawn mower. From the initial stage, the group has focused all efforts on development of the product and hence, throughout the department's history, it has been marked by innovativeness, residing in a knowledge-intensive environment. As a consequence of the innovative spirit and nature of the group, main focus has always been directed towards product-development actions and not on how to structure work. Hence, the knowledge creating routines and procedures are weak. The complexity of the product in combination with the highly specialised group members implies that Robotic Mowers could benefit from improving their knowledge management. Further, the product development has now entered a mature stage and therefore, the group have distinguished a need to structure their current operations due to an upcoming expansion.

Status quo is a dangerous state for any company. Development and change are examples of actions that are vital in order to stay competitive in any market setting. Market-related influences can steer a company to what actions to engage in but the company itself can also hold the power to shape the demand through the product they offer to the market (Prahalad & Hamel, 1990). Robotic Mower face an emergent need to adjust their knowledge creation processes to new circumstances in order to stay competitive. Therefore, it is crucial to realise the importance of how the knowledge can be created and subsequently, managed in order to remain competitive.

1.3 Purpose

The purpose of this research is to see how knowledge is created and subsequently managed within an environment characterised by progress and innovation, and to identify the most problematic areas in knowledge creation processes as well as suggest improvements.

1.4 Research questions

Within this study the research questions are viewed from a management perspective, and put in the context of an innovative and flexible company unit, Robotic Mowers;

- How is knowledge created in this unit and how is that process managed and supported?
- What are the unit's most evident problems in knowledge-creation processes?
- How can the current ways of creating knowledge within the unit, benefit from other units' ways of creating and treating knowledge?

Although general in nature, theses issues are placed in the context of Robotic Mowers and supported through SAAB Avitronics and Litim Affärskommunikation.

1.5 Disposition of this study

The report starts with an 'introduction' where the reader is familiarised to the importance, and problematic nature, of knowledge creation. In addition to providing a background to the investigated parties, it presents the research purpose and the questions it relies on.

The 'knowledge creation perspectives' is the theoretical framework that intends to help the reader follow the report. It shows the logic that connects the empirical findings and the following analysis. The framework puts theories concerning the development of knowledge at the heart of the discussion but puts it in the context of; knowledge management and knowledge support.

The 'research design' is the framework that presents how the research was conducted in order to fulfil the research purpose in a scientifically suitable manner. The section describes what methodological thoughts that guided the research, how the data collection was conducted and subsequently analysed. A discussion on trustworthiness finalises the section.

The 'knowledge creation in product development units' is the empirical findings, which provides the material that is to be analysed later through the use of the theories presented in the theoretical framework. Firstly, empirical findings from Robotic Mowers' are presented in terms of; positioning organisational knowledge, knowledge and competence composition, knowledge management through; develop, create and organise knowledge, and finally knowledge support through structure and culture. After this, findings from two support-cases are presented in equivalent order, however to a less extent.

The 'discussion of Robotic Mowers' knowledge creation' is the analysis that uses the theoretical framework in order to analyse the empirical findings. The discussion is conducted in order to provide a theoretically based direction fulfilling the purpose.

The 'concluding remarks and suggestions' is the final part that takes the most important points from the analytical discussions in order to explicitly fulfil the research purpose. It also presents the research contribution made by this specific study through; managerial, methodological and theoretical implications.

2 Knowledge creation perspectives

When employees invent new knowledge, they are also reinventing themselves, the company, and even the world.
I. Nonaka

This section presents the theoretical perspectives and discussions which is the foundation for the analysis of the empirical findings and further contributes in fulfilling the research purpose. The theoretical elaboration is put forward through relevant theories on knowledge creation and its management.

2.1 Theoretical overview

The below discussion will follow the model presented below (figure 1), which corresponds to this study's theoretical approach to fulfilling its purpose. The model is subsequently used as a guide throughout the theoretical presentation. The research purpose is to; *'see how knowledge is created and subsequently managed within an environment characterised by progress and innovation, and to identify the most problematic areas in knowledge creation processes and suggest improvements'*. Hence, the focus-theme of this study is knowledge creation which relies on the greater concept of knowledge management. In order to provide a foundation for this, a definition and discussion of the notion of knowledge is conducted and it is then positioned in an organisational setting. Then, connections between knowledge and organisational competencies are elaborated on and how they increase competitive strength. Subsequently, recognised knowledge theorists' views of knowledge management are considered and three sub-categories; develop, organise and transfer knowledge are looked into thoroughly. The purpose puts emphasis on the creation of knowledge but also the context in which it takes place and therefore support-perspectives are put forward which also deals with environmental-specific issues.

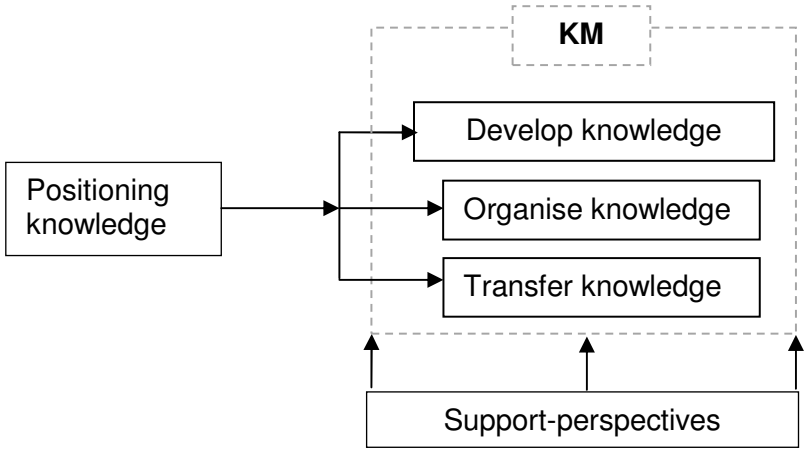
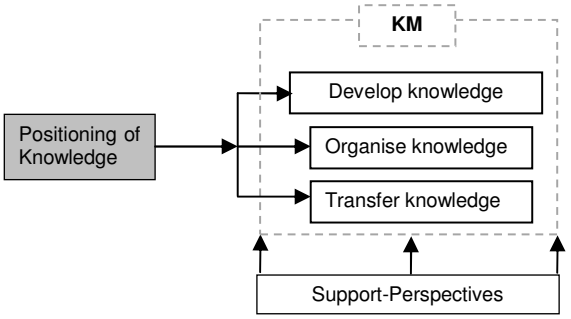


Figure 1 Theoretical overview

2.2 Positioning organisational knowledge

There are various and highly diverse perceptions and definitions of knowledge. Knowledge is an elusive concept, viewed differently depending on context and spectator and therefore it is important for the understanding of knowledge in this research to construct a shared view as well as to make certain distinctions about the concept of knowledge.



In general, knowledge is viewed as composed by two fundamentally different dimensions; one *explicit* and one *tacit*. According to Nonaka (2007) explicit knowledge is formal and systematic. Further, Alavi and Leidner (2001) argue that explicit knowledge is knowledge that can be communicated, articulated and codified in symbolic form or natural language. Tacit knowledge on the other hand has been described as something that, even though one does possess the knowledge, it is somewhat difficult to realise. The below statement emphasises the difficulty to understand what knowledge one possesses and subsequently the difficulty to communicate it;

> *'We know more than we can tell.'* (Polanyi, 1983, p. 4)

This aspect of knowledge is based on informal and indefinable technical competencies but also of cognitive and mental elements that are taken for granted. Further, it is subjective, practice-based and formed by the individual possessing the knowledge (Nonaka, 2007). Tacit knowledge also includes notions such as 'street smart' and 'know how' (Leonard & Insch, 2005). Through the statement below, Drucker (2001) puts forward that the individual is the very source of knowledge and since individuals are the foundation of organisations, their accumulated knowledge is equivalent to that of the organisation;

> *'Knowledge is not impersonal [...]. Knowledge is always embodied in a person; applied by a person; taught and passed on by a person; used or misused by a person.'* (Drucker 2001. p. 287)

As is also explained in the statement above, knowledge is often viewed as an asset and it can be put forward as something an individual possesses in the sense that it is an *intellectual resource, although created through a process* (Nonaka & Takeuchi, 1995). On the other hand, Backler (1995) has a somewhat differing opinion and, by taking a more action-directed stance, he claims that instead of viewing knowledge as something that an individual *has* it should rather be viewed as something that an individual *does* in a dialogue with others. Davenport and Prusak (1998) however reconciles the two views when arguing that knowledge can be seen as both a *process* and an *asset* that is possible to keep in stock. Knowledge is however perceived as intuitive and is subsequently difficult to explain merely through words.

There are a number of concepts that are closely related to knowledge. Some of the most commonly mixed up with knowledge are; data, information, insights and wisdom (Davenport & Prusak, 1998). Data is the simplest form and is merely raw material that can be processed into information. Information is the one to be most often used interchangeably with knowledge and setting out to make a distinction between information and knowledge, Stenmark (2002) argues that there is a clear difference between the two is that information

can be made tangible and represented as objects outside the human mind, whereas knowledge is much more difficult to capture. Further, information is turned into new knowledge through the mechanism of organisational learning, which is merely different ways of processing information (Sinkula, 1994; Slater & Narver, 1995) Nonaka and Takeuchi (1995) reinforce this view while also incorporating the individual's importance and state that;

> *'Information is a flow of messages, while knowledge is created by that very flow of information, anchored in the beliefs and commitment of its holder.'* (Nonaka & Takeuchi, 1995 p. 58)

While the above discussion stresses that knowledge is more complex than information, Davenport and Prusak (1998) strictly emphasise the difference in that knowledge should be viewed and treated as information that has been translated to apply the problem-solving context where it is used, which creates a competence or ability. They further, state that higher level and more complex features such as insights and wisdom share attributes with knowledge and for the sake of research they assimilate it with knowledge. This study follows their lead and treats these three concepts as one. The above discussion is summarised in the below illustration (figure 2).

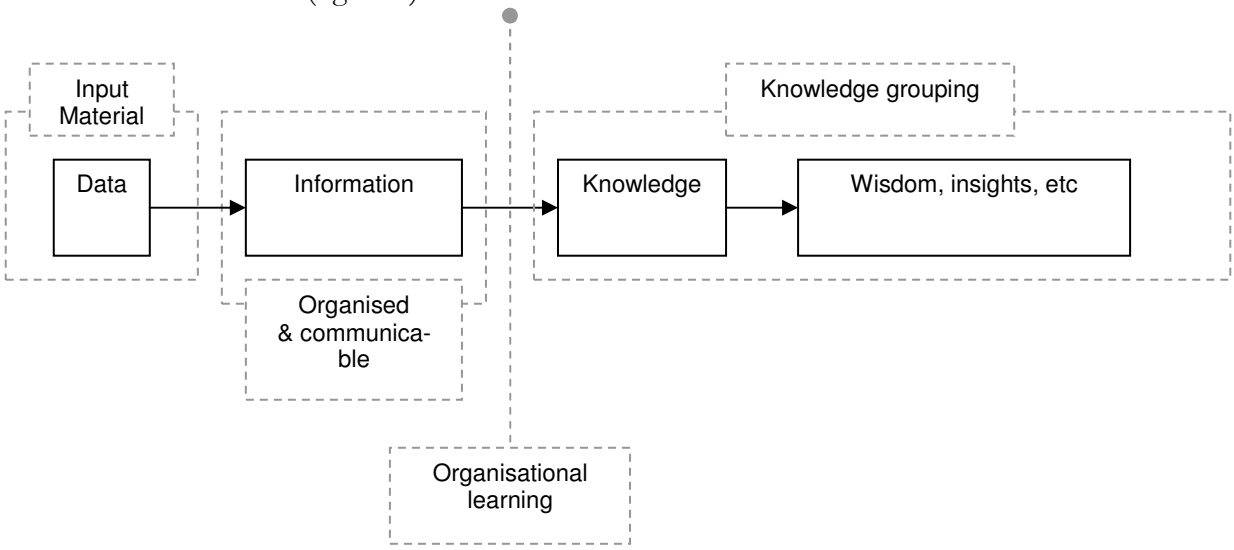


Figure 2 Distinguishing knowledge (Davenport & Prusak, 1998; Sinkula, 1994; Slater & Narver, 1995)

For the purpose of a common understanding of this study, knowledge as it has been discussed above is summarised through the following widely accepted definition of knowledge within an organisation;

> *'Knowledge is a fluid mix of framed experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organisations, it often becomes embedded not only in documents or repositories but also in organisational routines, processes, practices and norms' (*Davenport & Prusak, 1998, p. 5)

This statement stresses the features providing value to organisations, which are the also the reasons to why knowledge is difficult to manage. It further points out that knowledge is a complex phenomenon that is a mixture of various elements. It states what knowledge *is,* an intellectual resource, and what it *does,* providing a foundation for use of information and experiences. It further declares that it is the individuals within an organisation that is the

source as well as holder of the asset. Finally, the statement explains that knowledge can indeed be stored, through documentation but also through routines, processes, practices and norms.

2.2.1 Competiveness through knowledge and competence

Drucker (1995) argues that today's economical arena is founded on knowledge, making it the most valuable *competitive asset* any company can possess. Further, according to Barney (1991), sustainable competitive advantages are attained through resources that are *valuable*, *rare* and *inimitable*. Upon taking a resource-based stance to knowledge, i.e. seeing knowledge as any other asset contributing to competitive advantages, this concept is highly correlated to the attributes of core competencies. These are the underlying capabilities that a company builds its existing business offers, as well as new business development, upon and knowledge within these functions are of great importance to any company. Core competencies are the assets that provides for competition and they represent the collective learning of an organisation and how organisations match skills and technologies. A company can identify core competencies by investigating if a certain competence enables *access to different markets*. It should also *contribute substantially to the customer value* of the end product. Finally, the core competencies of a company must be *hard for others to copy or mimic*. Hardly any company is able to create and sustain more than five or six core competencies (Prahalad & Hamel, 1990). Knowledge and competencies, reside in a multitude of areas, however in business settings some areas are more important than others. According to Waltz (2003), management of knowledge requires a careful coordination of *people*, *processes* and *technologies*, an opinion strengthened by Leonard-Barton's (1992) elaboration on core competencies residing within; *a skills and knowledge base*, *managerial systems, technical systems* but with the extension on tying them together though organisational *values and norms*. These similarities and varying views on competitiveness through knowledge and competencies are illustrated below;

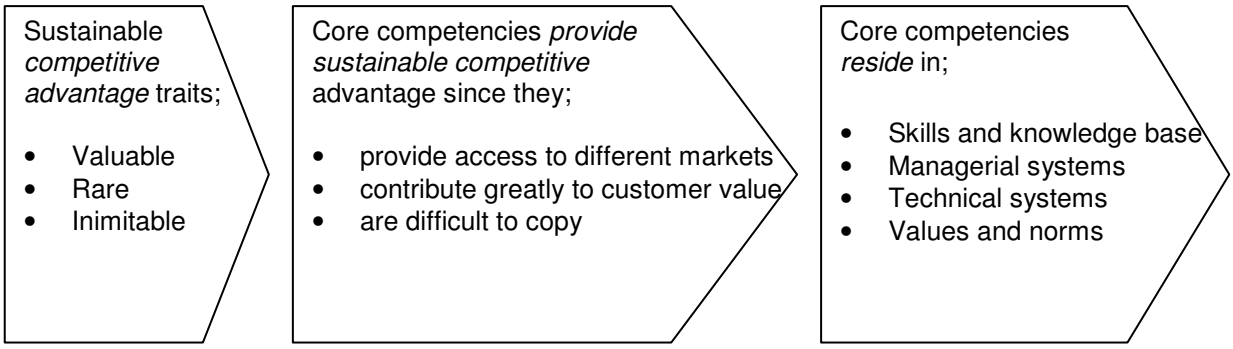


Figure 3 Overview and connections of sustainable competitive advantage and competencies

In addition to this, Prahalad and Hamel (1990) stress that, in the short-run, a firm's ability to compete may be based on features such as price and performance but that these features do not create enough differential power to provide competitiveness in the long-run. Long-run competition is built upon and originates from a company's core competencies, which also provides for short-run success. They stress the importance to recognise what knowledge one is in possession of, or what knowledge that needs to fostered for future requirements. This is also vital in order to connect competencies and core products for the sake of keeping competencies within the company and not divesting these to external parts. Once a core competence-related piece of knowledge is lost, it is very difficult to regain.

2.2.2 The two-sided effect of organisational knowledge and competencies

Knowledge is a rather complex concept and it can be viewed, as well as used, in a variety of ways. It represents different things to different people and when seen in different organisational contexts it is perceived to have both a positive and a negative side. This leads to differing opinions on what effect knowledge has on an organisation's operations and outcomes. On the one hand knowledge can be viewed as something that can facilitate defining a problem, generate alternatives, evaluate them and finally to provide a basis for decision-making. However, knowledge can also be seen as something that restrains the organisation by hindering it to discover new opportunities and to grow (Brockman & Morgan, 2003). An organisation's ability to function and to perform is founded on its core capabilities that, according to Leonard-Barton (1992) who argues for a knowledge-based approach to core capabilities, are reliant on; *technical systems*, *skills and knowledge base*, *managerial systems* and the interconnecting forces of organisational *values and norms* (figure 4).

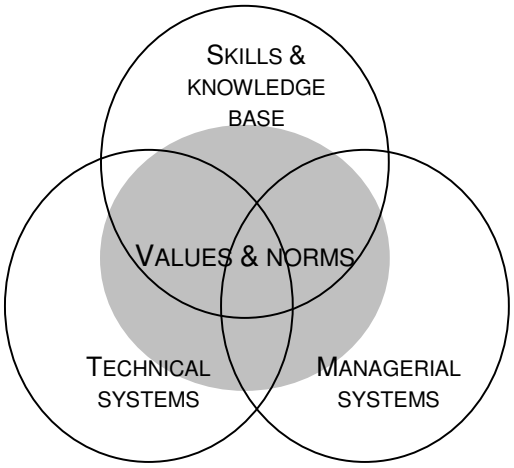


Figure 4 Competence areas (Leonard-Barton, 1992)

Leonard-Barton (1992) stresses that knowledge resides in the very fundament upon which a business is built. The first dimension, *the skills and knowledge base,* is only carried by the individuals, the knowledge source, within an organisation. A major determinant of an organisation's core capability is the actual degree of this knowledge and skills that the employees occupy, i.e. a high degree of possessed knowledge leads to a high level of development- and problem-solving capabilities. This is especially important when it comes to the major areas in which the organisation competes. When already possessing great knowledge it is easier to attract people possessing more and complementary knowledge. Also, the pool of knowledgeable people is useful in new ventures due to their expertise that can be used for creative purposes but also due to the quality and usefulness of their criticism. The dimension of *technical systems* originates from a multitude of employees' tacit knowledge that have been gathered, codified and structured into production or information systems. These systems then subsequently provide a knowledge source for others which can contribute beneficially to timing, accuracy and degree of accessible details. The third dimension*, managerial systems* represents the knowledge creation and its control, in formal as well as informal manners. Creation of knowledge may be done through usage of networks or apprenticeships whereas control may be exercised through incentives or reporting procedures. When these systems contribute to core capabilities, they tend to promote unusual and beneficial combinations of skills and sets of behaviour. The final dimension, *values and norms*, is the one at the very heart of an organisation's core capabilities. This dimension conveys the

value an organisation attaches to knowledge content and structure and two value-aspects are particularly important, empowerment of project members and the status that is allocated each discipline of the project team (Leonard-Barton, 1992).

The discussion has so far treated knowledge and competencies as something that is beneficial to the organisation but there are also negative sides to possessed knowledge. Cohen and Levinthal (1990) stress the general importance of knowledge for organisations' innovative intents but they also stress that the ability to capture the knowledge is highly *path-dependent*, meaning that what one already knows inevitably affect what one can learn. Davenport and Prusak (1998) also call for this path-dependency in their argument that individuals are subjected to 'bounded rationality', i.e. that individual's mere ability to engage in knowledge activities or even the need to develop is restricted and confined to what knowledge one is already in possession of. Cohen and Levinthal (1990) further argue that organisations need to have processes and routines that are adjusted in order to develop or capture as much new knowledge as possible. This path-dependency makes the mere process of using knowledge in a beneficial manner highly sensitive to not only core capabilities but also their inherent rigidities and other sources of inertia. These hindering forces are knowledge sets that are embedded in the organisational life and stem from; skills and knowledge base, managerial as well as technical systems and cultural aspects, each and every area representing challenges (figure 4). Hence, *new organisational knowledge is dependent on old organisational knowledge* (Leonard-Barton, 1992). Further, rigidities may hinder an organisation to develop the capability to cope with such changes. Returning to the above discussion on the knowledge-based view of core rigidities, when an organisation emphasises an area in which it possesses great strength, it may enjoy great achievements in that business area but as a consequence do worse in other areas. The organisation's established systems, managerial as well as technical, also contributes to rigidities in that the knowledge incorporated into these becomes old and inadequate. Finally, the different dimensions are joined through values and beliefs, which mean that rigidities originating from these carry great significance since they affect a large number of other areas (Leonard-Barton, 1992).

2.3 Knowledge creation founded on knowledge management

When it comes to knowledge creation within organisations, Quintas, Lefrere and Jones (1997) stress the importance for organisations to find proper ways to base this creation process upon, meaning how to manage and organise it. They state that;

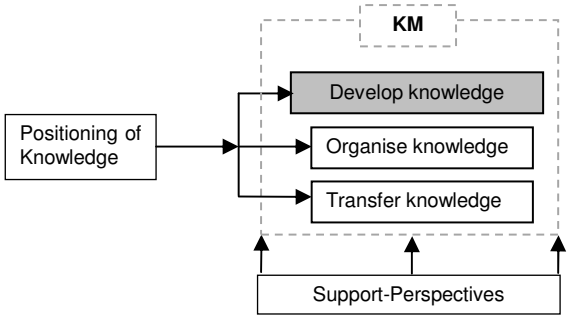
> *'Knowledge management is the process of continually managing knowledge of all kinds to meet existing and emerging needs, to identify and exploit existing and acquired knowledge assets and to develop new opportunities.'* (Quintas, Lefrere &Jones, 1997, p. 387)

This argument also connects to the need to engage in innovative activities and not only search for opportunities but also to create them, based on knowledge that resides within the company. The management of knowledge conveys different meanings for different people depending on which context it is experienced in. Alavi and Leidner (2001) include the following processes in the concept; *create* knowledge through the collection of internal and external information and *codify* it, hence making it explicit. *Store and retrieve* knowledge so that it can be relatively easy to access in order to create new knowledge. To *transfer and apply knowledge processes* refers to the allocation of knowledge to the needed parts of the organisation. Sabri (2005) argues that knowledge management is looked upon as a deliberate process to *create*, *capture*, *organise* and *transfer* knowledge. Davenport and Prusak (1998) sums up the different meanings of the same process in; *generation, codification and coordination* and

transfer within an organisation in order to create competitiveness. In order to reflect all necessary aspects, the above sated concepts are put into groups of; *develop, organise* and *share* in the following discussion, where they are looked into more thoroughly.

2.3.1 Developing knowledge

Knowledge has been put forward as a means to compete effectively and the importance in creating, learning and adapting new knowledge is generally acknowledged. For each and every organisation, the main goal of developing knowledge is to accumulate it and to increase the stock (Davenport & Prusak, 1998). The discussion below is based on these propositions, firstly it presents a knowledge creation model and subsequently it elaborates on definitions and its inherent distinctions.



Knowledge creation model

Nonaka and Takeuchi (1995) argue that all organisational knowledge is founded in tacit knowledge and that this knowledge is waiting to be converted into explicit knowledge in order to provide organisational benefits. The process of this transformation is a rather complex task since it is hard to define and communicate the tacit component. Nonaka and Teece's (2001) knowledge-creation model puts forward that knowledge in an organisation is created by means of the *interactions between explicit and tacit knowledge*. These interactions between the two types of knowledge are called knowledge conversions and there are four typical modes of these; externalisation, combination, internalisation and socialisation (figure 5).

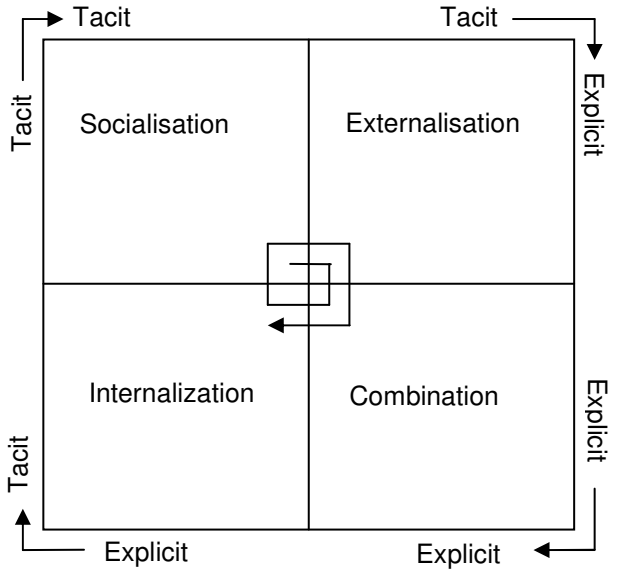


Figure 5 Knowledge creation process (Nonaka & Takeuchi, 1995)

1. *Externalisation* - from tacit knowledge to explicit knowledge
Externalisation implies the process of communicating tacit knowledge as explicit knowledge. When the tacit knowledge is converted into explicit knowledge it is concretised and can be shared by others, and it becomes the foundation of new knowledge.

2. *Combination* - from explicit knowledge to explicit knowledge
Converting explicit knowledge into more systematic and complex sets of explicit knowledge is described as combination. The explicit knowledge is gathered from inside or outside the organisation and then processed or combined into new knowledge. This new knowledge is then spread among the members of the organisation.

3. *Internalisation* -from explicit knowledge to tacit knowledge
The process of turning explicit knowledge into tacit knowledge is internalisation. Explicit knowledge created is shared throughout the organisation and transferred into tacit knowledge by the individuals in the organisation. "Learning by doing" is a concept that is highly related to internalisation.

4. *Socialisation* - from tacit knowledge to tacit knowledge
The process of converting new tacit knowledge through shared experiences is named socialisation. Considering that tacit knowledge is often time specific and difficult to formalise, it can be obtained only through shared experience, for example living in the same environment or spending time together. Socialisation may arise in informal social meetings where a world view, mental models and mutual trust can be shaped and shared.

The knowledge-creation process discussed above is highly theoretical in nature. It should be noted that not all knowledge-creating actions are the creation of universally new knowledge but rather it is new to the organisation. With roots in the above theoretical view, there are a number of hands-on techniques when engaged in knowledge creating and developing activities. Some of the more dominant ones are; *Fusion,* which is when different knowledge carriers meet and unite their knowledge in order to create a knowledge outcome not previously experienced. *Adaption* reflects the necessity for businesses and their actions, to adjust to changing circumstances. It is often the external environment that poses new requirements on knowledge and as a consequence, businesses have to accept this and change in order to perform well (Davenport & Prusak, 1998). Internally there are often constraining forces, which are often related to a business inertial and rigid forces originating from the core competencies. These rigidities may constrain vital business adaption processes (Leonard-Barton, 1992). *Networking* is the movement of informal socialising in a company that generate knowledge. Giving and receiving within networks build on supportive relationships. Over time these groups or networks may turn into formalised and pooled knowledge possible for others to use. *Acquisition,* which implies that existing knowledge, internal as well as external, is used in new ways. When looking to external knowledge sources it is not merely the procurement of knowledge but it may also indicate borrowing or hiring knowledge sources. Finally there is the ambition in *dedicating resources for this specific purpose.* The latter is often embodied in R&D units. In order to make full use of any knowledge creating capacity, it is important to see potential both internally and externally (Davenport & Prusak, 1998).

Nonaka (2007) claims that one of the organisation's tasks is to transform tacit knowledge into explicit knowledge and that one of the most powerful tools in order to do this is *figurative language* and *symbolism*. With this he claims that by using metaphors, analogies and actual

tangible models, knowledge is easier to create, organise and share. The use of metaphors is to initiate the creation of knowledge and to enable employees to express and process what they already know but can not yet communicate as well as to form new perceptions of what they already know, i.e. new combinations of old knowledge to create new knowledge. The use of analogies provides for structuring the disorder stemming from the metaphors and its accompanying contradictions and multiple meanings. The analogies are supposed to convert the metaphor's imaginative world into pure logic. This is done through merging opposing views and pointing out differences, meaning it is about explanations and clarifications. The final step is to create logical and coherent models for the entire organisation. This model creates sense out of disorder and is supposed to create plausibility and clarifications around the remaining question marks and contradictions in knowledge processing. In order for this creation to occur, however, there is an underlying need for redundancy in the organisation. This *'redundancy-principle'* implies that new knowledge is incorporated into an organisation through intentional overlapping and dual efforts and it can be seen in areas such as business information, activities and responsibilities.

Learn and assimilate new knowledge

Cohen and Levinthal (1990) argue that in order to enjoy innovative organisational abilities it is highly relevant for organisations to have the potential to appreciate the importance of external knowledge and to incorporate it into the organisation, hence they turn the attention outwards. They do however argue that the organisation's capacity to do this is highly path-dependent in that it is dependent of previous investment to develop knowledge and the subsequent knowledge the organisation actually possess within the specific area. Further, knowledge is not only learnt and absorbed from the external environment but may also come from *internal sources*. Nonaka (2007) argues that new knowledge starts with an individual and that the individual knowledge is subsequently converted into organisational knowledge, thereby creating organisational value. He further argues that this process of turning individual knowledge into an organisational asset, at all structural levels, is essential for any knowledge-creating company. Sinkula (1994) also stresses the learning component in knowledge development;

> '*Organisational learning is the means by which knowledge is preserved so that it can be used by individuals other than its progenitor.'* (Sinkula, 1994, p.36)

Through this Sinkula (1994) emphasise that *organisational learning* is vital for gaining sustainable competitive advantages. This learning process consists of three parts; *information acquisition, information dissemination* and *shared interpretation* (figure 6).

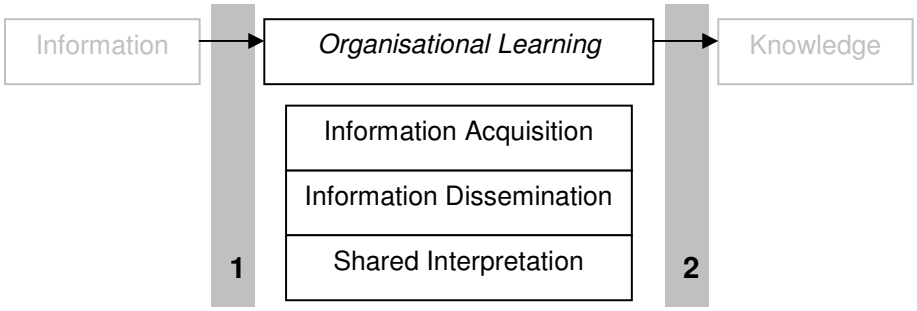


Figure 6 Organisational learning (Sinkula,1994)

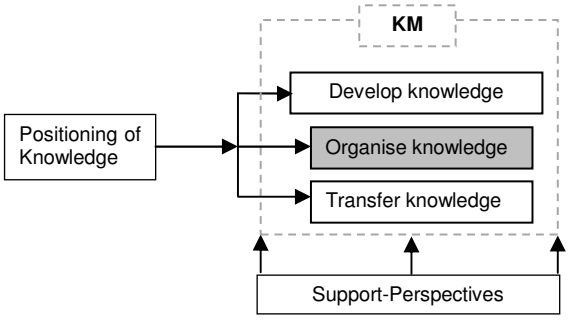
Information acquisition is the process to gather information from a variety of sources. It might originate *from direct experiences* that may be of both external and internal character as well as take on both explorative and exploitive features. The latter distinction, learning through explorative and exploitive actions, should be balanced in order to not loose learning or lead to expensive actions (Sinkula, 1994). When learning from others Webster (1992) stresses that relationship-prone actions, such as benchmarking, establishing strategic alliances and joint ventures, play important roles. In addition to stressing the importance of educational training, Slater and Narver (1995) add the value of employees with varying perspectives, constantly absorbing information from a variety of sources and the responsibility that managers carry in these circumstances. They further state that learning is also derived from the organisation itself and it's so called organisational memory, which is the knowledge that the organisation has acquired over time. This is also how information and knowledge is preserved within an organisation and takes on different levels of importance due to context. Huber (1991) further stresses the importance of organisational learning and decision making when it comes to organisational memory. This memory may not only provide a knowledge base for the organisation but it may also hinder it, Leonard-Barton (1992) refers to these obstacles as core rigidities. Slater and Narver, (1995) enforce Nonaka's (2007) view that knowledge comes from the individual but argue that this knowledge is not plainly the same as that of an organisation's knowledge base. Organisational knowledge is different in the sense that it needs to be *spread and shared*. This spreading enhance the value of information as well as increase its quality, also strengthening Nonaka's (2007) 'redundancy-principle', argued to provide for a knowledge-creating environment through communication. The organisational learning process is finalised by a *shared interpretation* of the information that is also a mere requirement of learning (Day, 1994). This is the stage where conflicts are to be resolved and consensus on what the specific information actually means is to be achieved (Slater & Narver, 1995).

Huber's (1991) four modes of organisational learning share attributes with that of Sinkula (1994) although he conceptualises them as; knowledge acquisition, information distribution, information interpretation, and organisational memory. He suggests that *as more differing interpretations are developed of one single piece of information, the more organisational learning is achieved*. This is due to the fact that the mere development of such interpretation changes the range of potential behaviour. The process of acquiring, distributing and interpreting information are often interpersonal or social but on the other hand they are often highly mechanical and can be viewed as logistical processes. Further, Huber (1991)

articulates two assumptions concerning organisational learning. The first one is that an organisation as an entity learns, if any of its parts acquires knowledge that it views as potentially useful to the organisation and its purpose. The second assumption is that an organisation engages in a learning process even if not all parts of the organisation learn that particular aspect (Huber, 1991). However, it is not the amount of accumulated learning that is the most essential issue according to Bierly, Kessler and Christensen (2000). Instead, they emphasise that success is not a function of the amount of knowledge and wisdom that is acquired but rather the selection of *what kind of knowledge* to select, use and institutionalise in the organisation. By claiming this they stress the relevance of used knowledge.

2.3.2 Organise knowledge

To organise knowledge essentially means to codify as well as coordinate amounts of knowledge, hence facilitating the subsequent distribution of it. The organisation of knowledge is closely connected to distribution and sharing of knowledge since it simply makes these actions possible. To codify and coordinate knowledge refers to the process of translating and making different types of knowledge available and useful. Even though structure is needed for an organisation to benefit from knowledge, too much structure possibly destroys it and therefore balanced decisions must be made (Davenport & Prusak, 1998).



There is a need for balance in the codification process in the sense that some structure is needed in order to capture knowledge and subsequently codify it but when doing this, one risk is to lose valuable attributes of the knowledge in question. The manners, in which one tries to organise knowledge is highly dependent on whether it is tacit or explicit knowledge which, as have been elaborated on before, is different at its core. Explicit elements may be relatively easy to codify whereas tacit elements are largely impossible to codify, at least in proper and effective ways. Tacit knowledge resides within any organisation and it often provides rich insights. In order to benefit from this tacit knowledge, the most useful way may simply be to make others socialise and interact with the person in possession of the specific tacit knowledge one is in need of. Trying to reap benefits from tacit knowledge through capturing it may prove to be difficult and costly but the benefits it conveys makes it worth the effort (Davenport & Prusak, 1998).

When engaging in knowledge codification, *relevance* to the specific use is of main concern. Some rules of thumb in doing this however, are; (1) Decide what purpose the codified knowledge is to serve. (2) Search for knowledge coming from different sources and in different shapes to reach this purpose. (3) Evaluate knowledge in order to assure suitability to the purpose but to assess the nature of it so that one subsequently can; (4) choose suitable mechanisms to codify and disseminate the knowledge (Davenport & Prusak, 1998).

Mapping and modelling knowledge is not the actual stocking of knowledge, instead it is a guide on what to find within an organisation and where to find it. The *mapping* of knowledge is merely a way to organise and search for it. Organisational charts represent some

part of the knowledge map but it is far from perfect. Although it may show where obvious person-related knowledge is situated relatively well, it is also ambiguous and carries many assumptions. It is not transparent enough to exactly show where to find knowledge that is essential for specific operations. In practice, the mapping is often done through investigating and recording what knowledge each employee needs in order to perform their job. The challenge in mapping knowledge is to capture its complexity and to keep it up-dated. The latter carries great significance since knowledge is volatile and changeable. Further, *dynamic modelling* is a loose concept embracing many ways of approaching knowledge-organisation in a number of situations. Models are often used in order to understand as well as increase the understanding of certain operations and it might target different encounters in the organisation (Davenport & Prusak, 1998).

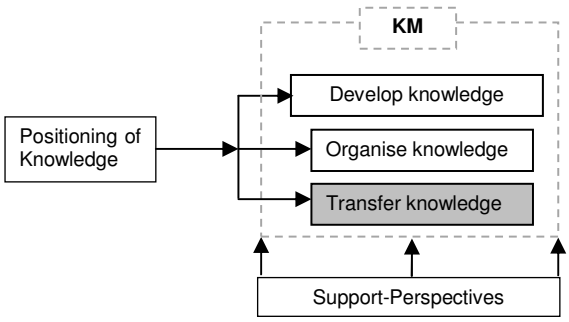
When it comes to the capturing and codification of tacit knowledge it might prove demanding but the fact that tacit knowledge is rich, deep and insightful provides benefits mostly make it worth it. It is especially essential to retain knowledge in cases when there is a risk that the employees, the knowledge-carriers, might leave the organisation. It is essential that companies have strategies and plans on how to keep tacit knowledge within the organisation. Some of these strategies are mentorships and apprenticeships but also plans on how to keep key knowledge workers. Further, over time knowledge inevitably becomes embedded in products and processes, which in effect is the extraction of tacit and explicit knowledge from an individual and turning it into concrete and physical forms. By embedding highly complex knowledge, the reliance on keeping key workers within the organisation is reduced. Much emphasis should still be placed on keeping the person holding the needed tacit knowledge since it is difficult to know whether all knowledge has been made explicit or not (Davenport & Prusak, 1998).

According to Nonaka (2007) a powerful tool to make knowledge more forward and open, is the use of figurative language. In support to this, Davenport and Prusak (1998) argue that the most effective vehicle to distribute knowledge has proven to be the use of stories. They further claim that especially tacit knowledge is beneficial to communicate, inevitably also the organisation of it, in this manner. Learning is essential to companies acting in today's knowledge economy and the use of stories is the most efficient way to learn and make sense of something that is generally difficult to understand. Further, it is easier if these narrative communicative manners relates to the setting in which they are applied, i.e. they need to be situation-specific to make sense to the learner.

Davenport and Prusak (1998) argue that stories and figurative language is not only a way to understand, create and organise knowledge but also a way of communicating it, however, a certain amount of sophistication must guide the act, which is put forward in the following discussion.

2.3.3 Transfer knowledge

According to Albino, Garavelli and Schiuma (1998) knowledge represents the main resource through which competitive advantage is created and the transfer of knowledge is, by nature, a very important strategic issue for the firm's ability to compete. Knowledge is difficult to transfer to another person. The process is viewed as a communication



process with information processing activities. In this process, the knowledge possessed by an organisation or individual can be transferred to another actor by information flows transmitted through appropriate channels. Knowledge transfer can also be seen as an inter-relationship between units by defining it as;

> *'The process through which one unit (e.g., group, department, or division) is affected by the experience of another'.* (Argote & Ingram, 2000, p.151)

The above dependency-view is also applicable for people. Bender and Fish (2000) however, have another view of how knowledge should be transferred. They argue that, knowledge-able members in the organisation can educate employees by spreading their knowledge in meetings, making presentations and by demonstrating how things should be done. It is further argued that even though knowledge is what is communicated, the receiver gets the knowledge in the form of data. The process of creating knowledge starts again as the receiver of the data attach meaning to change the data into information with this person's personal values and beliefs and subsequently constructing his or her own knowledge. As a consequence, people can transfer data or information but the knowledge itself has to be shaped in the mind of the individual. This implies that if knowledge needs to be transferred in an organisation, they claim that people need to be transferred.

In order to trace the ability to achieve knowledge transfer by examining the organisational processes that may encourage or discourage learning Gilbert and Cordey-Hayes (1996) have identified four stages. The stages follow the process of knowledge as it might be transferred in an organisation and lead to the development of routines which can be observed in the behaviour and practices pursued by the members in the organisation. These practices and behaviour becomes an element of the core routines so that learning occurs. The first step is *acquisition* which implies that before the knowledge can be transferred it needs to be acquired. The knowledge can be obtained in many ways, by previous experience, by doing, by borrowing, by acquiring individuals with new knowledge or in other ways searching. The second step in the model concerns the *communication,* written or verbal, of knowledge after it has been acquired. It is vital that the organisation is alert to the dispersion of information if it wants to encourage knowledge transfer. Thirdly, the knowledge that have been acquired and communicated should then be applied in order to be maintained. The result of the *application* of the knowledge enables the organisation to learn. The fourth and last step in the process is the *assimilation* of the results and the effects of using the new knowledge.

Since the individual is the one possessing the knowledge within organisations, it is vital that the individual share it so that the organisation can benefit from it. According to Davenport and Prusak (1998) the most efficient way of sharing knowledge is to acquire knowledge through highly knowledgeable persons and then make them communicate to others what they know. The communication process however, is difficult to force upon anyone. Knowledge is inevitably exchanged within an organisation, whether routines are in place or not. The informal and unstructured knowledge-exchange is, although vital for knowledge exchange, confined to a narrow set of other people around oneself and is also rather fragmented. Also, when in need of information, people do not look for the most knowledge-able person in the organisation as a whole but only in its immediate surroundings and therefore the quality of it suffers. This lack of quality is highly individual as well as department specific; some circumstances provides for logical and useful exchange between people or departments whereas some do not.

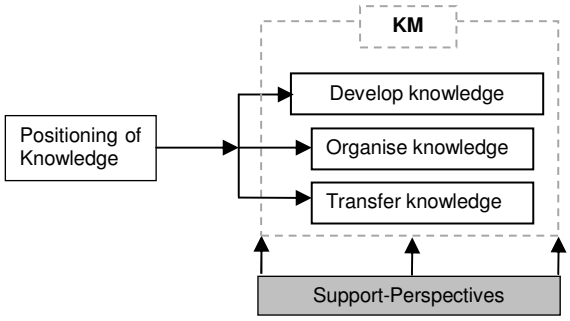
According to Davenport and Prusak (1998) structured and intentional transfer of knowledge is not merely the documentation of knowledge and its subsequent spreading, but also activities, such as the reallocation of employees, the knowledge incubators. This carries benefits since it provides for communication of tacit and ambiguous knowledge, which is merely transferred through relationships due to its complex nature. Further, today knowledge is a cornerstone in the economy which has consequences on communication that needs to be viewed in a new way. Traditionally, informal talk has been seen as an excuse not to work but today *talk is actually to work*. Without communication, formal as well as informal, the individual will not contribute to the organisational knowledge base to a full extent. Many companies have special chat rooms where no organised information exchanges, such as meetings, are to take place. Other common rooms, such as cafeterias, are also arenas for knowledge exchange and problem-solving. Both perception of communication and the channels it makes use of is changing and it is important for companies to create both the *place* and the *opportunity* for knowledge to be communicated. These two ways of transferring knowledge has become less challenging lately due to the electronic exchange that is ever increasing in value (Davenport & Prusak, 1998). One should however beware of any downsides stemming from technology, as is put forward here;

> *'As a general rule, though, the more rich and tacit knowledge is, the more technology should be used to enable people to share that knowledge directly. It is not a good idea to try to contain or represent the knowledge itself using technology.'* (Davenport & Prusak, 1998, p. 96)

In conclusion, both informal and formal communication of knowledge is needed. The manner in which knowledge is transferred is however highly dependent of organisation specific issues such as the type of culture (Davenport & Prusak, 1998).

2.4 Knowledge support through structure and culture

When being an innovative and creative entity within a large corporation, the degree of formality and structure is a determinant of the innovation-process. This is not to say that a structured organisation will have greater innovative power, nor is it to say that it is not. It is merely to say that it should be taken into consideration since it is a means to assist in the sharing of information and knowledge. Also, whether culture contribute beneficially or conflict with knowledge activities are important to consider (Burns, 2005).



It is generally agreed upon that there is no universally best way of structuring an organisation, but that the mere purpose of it and the situation the organisation reside in matters. Contextual factors such as structure matters. It is further stressed that the importance of having an organisation that promotes and supports knowledge-creation and its very source, the individuals. This internal perspective on creating a sound and constructive environment puts emphasis on interactions within the organisation, overlapping levels and boundaries. In essence, the organisation is supposed to absorb the knowledge from the individuals,

strengthen and magnify it and then diffuse it into the organisational construct (Nonaka & Takeuchi, 1995).

Research by Brockman and Morgan (2003) suggest that that in order to use existing knowledge in a useful manner, some formal structural support is needed, even for innovative endeavours. Slater and Narver (1995) however, stress the importance of having an organic and open structure with decentralised planning in order to provide for information sharing, innovative information creation and organisational learning. Sabri, (2005) argues that having a company structure and culture that fit together and overlap each other is important as a good foundation for organisational knowledge work and its management. Some organisations may base their operations on bureaucratic structures and power cultures that neither promote nor provide for information-sharing. Since information is a basis of knowledge, it will suffer. If however, the structure and culture is there to support knowledge creation and sharing, one example being a support oriented organic structure, knowledge creation is easier conducted. These organisations share features such as informal and adaptive in nature, internally work-interdependent and have an open information-processing channel.

The handling of knowledge, and in particular in Nonaka's (2007) case the creation of knowledge, is dependent upon, as well as affects, the manner through which the organisation supports the knowledge-context, that is how management is conducted, how responsibilities are assigned and how the overall organisation is constructed. He is also of the opinion that for an organisation to be structured to support the above three steps there is an overall need for structural 'redundancy', touched upon earlier. He views the concept of 'redundancy' as a deliberate effort of overlapping information, activities and management responsibilities**,** which provides the opportunity for knowledge to be produced. 'Redundancy' facilitates knowledge-creation due to the fact that these overlapping interests provides for regular communication contributing to the creation of a widespread cognitive perception which in turn makes the transmitting and spreading of the knowledge smoother. He further argues that no specific group is to be solely responsible for knowledge-creation but the effort should be shared by all levels and individuals. However, different positions within an organisation may make different contributions to this creation. Frontline-employees contributes with specific and detailed knowledge of daily business, even though they may be inadequate to communicate this knowledge they contribute to new knowledge by translating, adapting, changing knowledge into something that is comprehensible by them, i.e. new knowledge is created. Hence, confusion may actually be a source of new knowledge, this is however only true if management knows how to push its employees to challenge their every-day reality. Management's main function in this process is to guide the organisation and its knowledge-creation towards a meaningful end. Finally, senior management's main job is to provide an overall sense of direction for the future knowledge, through metaphors and concepts (Nonaka, 2007).

In addition to structure, but also in combination to it, culture can have an immense impact on the knowledge creation, either through promoting or challenging it. Much of the cultural development relies on the openness of sharing and learning. Also, informal relationships are influential to a greater extent than formal structures (Burns, 2005). In creating a knowledge supportive environment in an innovative context, a number of aspects are to be considered through the discussion below.

It has been put forward that organisational knowledge resides in an organisational context. It is part of a bigger picture and therefore it is important to realise that it can not be treated as separate from other organisational influential factors but need to be dealt with in combination to these. It is further put forward that today, organisations need to engage in new

ways of managing knowledge. Knowledge is to be treated and supported through organisational aspects, some of which are rooted in culture. A knowledge creating culture might be the foundation upon which knowledge is subsequently developed (Sabri, 2005).

The most effective input to knowledge creation is often viewed in terms of culture. Since culture is influential in organisational values, beliefs and systems it is highly influential in how the employees within an organisation view knowledge. It is further argued that the best performing management strategies are focusing on culture by making them knowledge-focused. The culture of a company is a source of competitiveness, different ways of acting can be nourished and shaped by the internal features of a company. Seeing as throughout this research, knowledge is looked upon as a competitive asset, the culture is one of the influential features of how knowledge is managed. Knowledge sharing is essential for a company in order to fully exploit its knowledge basis and culture has a great influence on *how much* of the knowledge is shared and *in what ways*. In order to share knowledge, the culture should facilitate things such as learning, mentoring, collaboration, sharing of ideas and stories (Janz & Prasarnphanich, 2003).

Organisational culture is however deceitful since it can be a positive contributor to the management of knowledge, but it can equally likely have a negative impact. Davenport and Prusak (1998) strengthens Leonard-Barton's (1992) argument of rigidities stemming from cultural aspects, such as values and norms, and specifies some particular cultural problem areas, especially when it comes to knowledge transfer;

- Lack of Trust
- Differing culture, vocabularies and frames of reference
- Lack of time and meeting places
- Status and rewards go to knowledge owners
- Little absorption capacity of recipient
- Belief that knowledge is prerogative of particular groups, not-invented-here-syndrome
- Intolerance for mistakes or need for help

These areas of concern are either promoted or worked against, through the culture within the company. They also stress relations and connections that need to be constructive and provide for both straightforward *giving* of knowledge as well as straightforward *receiving* of it. Mutuality is vital. Davenport and Prusak (1998) further argue that trust is the foundation of relationships and since knowledge is largely dependent on relationships, it also becomes dependent on trust. When there is no trust little sharing and creation of knowledge will occur which can relate back to Nonaka's (2007) 'redundancy principle', where overlapping activities create arenas for relationship and trust building. Also, overlapping activities also enhances shared cultural views of employees. Lack of time and meeting places are rather straightforward problems whereas the status and rewards are more complicated issues. When knowledge is communicated, independently of the actual information or data flow conveyed, it is given different status due to who is giving it away. The recipient will treat knowledge differently depending on what perception the recipient has of the giver and what status he or she owns within an organisation. Also, the recipient needs to have the ability to receive the knowledge. This emphasises that actions of knowledge sharing is not only depended upon the giver but also of the receiver and their relationship, that is, knowledge transfer consists of both giving and receiving. Also, the way things are put forward have implications on how it is received. Further, organisations need to create acceptance

for mistakes and assistance and rather than punishing failed attempts, accept creative attempts and reward successful ones. Finally, collective owning is essential when it comes to the effects organisational knowledge has on culture. One way of providing a sense of collective owning and hence affect cultural climate positively, is as simple as codifying knowledge (Davenport & Prusak, 1998).

2.5 Theoretical summary

Knowledge is crucial. Knowledge is being competent. Knowledge is competitive strength. Due to this, there is a need to ensure and secure knowledge within companies. This is in fact becoming ever more pronounced as it is realised that it is one of the most important assets a company can be in possession of, therefore management of knowledge is becoming ever more prominent. This management perspective consists of; knowledge development, knowledge organisation and knowledge transfer. All parts are in reality continually mixed and are part of a continuous spiral that pushes for the mere creation of knowledge.

Knowledge ultimately comes from *individuals* and in order for organisations to benefit from it, it needs to construct situations where the organisation and its members can learn from individuals. This can have take on formal or informal shapes and obtain input from external as well as internal sources. Further, knowledge per se is an abstract concept and consists of both tacit and implicit elements, which requires different treatment when organising and transferring it.

Support to knowledge creation can be found in both structure and culture and often these two constitute opposing forces. Both of them inevitably influence how knowledge is perceived as well as handled and therefore the two concepts need to be adjusted to specific contexts as well as harmonised with one another in order to provide a common knowledge ground.

3 Research design

He who chooses the beginning of the road chooses the place it leads to.
It is the means that determines the end.
H. E. Fosdick

This section provides an overview of how the research has been conducted. It presents the methodical decisions taken during the process and also critically reflects upon them.

A research design is *'a logical plan for getting from here to there'* (Yin, 2003, p. 20), which represents the plan on how the initial research purpose is fulfilled. Further, it provides a detailed description of how the research is conducted and acts as support in making the research systematic and organised. It is a tool that the research uses and that provides a foundation for controllability of the research output, as well as representative to reality. Also, it is important for the sake of explaining decisions made during the research process (Holme & Solvang, 1997). Moreover, in order to construct an appropriate foundation for research studies, a number of criteria need to be taken into consideration before making a choice; type of procedure, problem discussion, researchers' resources and requirements, traits of the researched object and the researchers' stance towards the specific source of data (Halvorsen, 1992).

Further, Ghauri and Grønhaug (2005) claim that the method used in a study should be selected in the light of the research problem and purpose, which in this study focuses on the notion of knowledge and more specifically on the mere creation of it. The research was therefore conducted with main focus on a project group within Husqvarna, Robotic Mowers. In order to provide useful managerial inputs, data was also gathered from two other project groups within SAAB Avitronics (SAAB) and Litium Affärskommunikation (Litium).

3.1 Choice of method

There are two fundamentally different ways of reasoning when conducting a study, one qualitative and one quantitative. Quantitative research methods are often used when the research relies on numerical or standardised measures that need to be analysed in order to reach the purpose of the study. To adopt a quantitative approach conveys advantages given that it provides a broad set of findings that can be generalised relatively easy. However, the main drawback of using a quantitative method is that there is a risk that, due to inflexibility, the data gathered is not relevant for the research purpose. Qualitative research on the other hand, is more flexible by nature and the research can be adjusted during the process (Holme & Solvang, 1997). Also, it allows the researcher to study chosen issues in-depth and subsequently produce highly detailed information (Patton, 1990). Qualitative approaches aims at understanding the social reality of individuals and groups by exploring their behaviour, perspectives and experiences (Holloway, 1997). The purpose of this study is to;

> *'Examine how knowledge is created and subsequently managed within an environment characterized by progress and innovation, and to identify the most problematic areas in knowledge creation processes and suggest improvements.'*

This research purpose is explanatory in nature and therefore a qualitative approach has been adopted. The concept of knowledge is a complex phenomenon that can be perceived as abstract and therefore it can not easily be quantified or standardised. Miles and Huberman (1994) argue that the main advantage of using qualitative data is that its richness provides large potential of explaining a complex reality. The objective of this study was to analyse how knowledge was created and subsequently managed in a knowledge-intensive unit. When studying social realities, qualitative reasoning is preferable (Holloway, 1997; Miles & Huberman, 1994). In this study it contributed to an in-dept understanding of knowledge creation in project groups.

Holme and Solvang (1996) argue that qualitative and quantitative approaches can create additional value when used in combination. Although this study is conducted in a qualitative manner, one minor quantitative tool, the use of a Likert scale, has been used merely as a guide for inputs to the qualitative discussion (section 3.4.1).

3.2 Research approach

In combination to deciding upon a qualitative or quantitative approach there are also decisions to make on how to handle the collected data, in relation to theoretical views. There are two approaches that determine how the collected data is handled, an inductive and a deductive approach. The inductive approach implies that one starts with a specific case and move to a broader generalisation about the studied subject. In effect, this means that the theoretical structure is developed after the data collection. However, the research is still influenced by, and conveys, theoretical considerations. Due to the fact that the inductive approach is only to a small extent constrained by a pre-determined theoretical discussion, it leaves the research area rather open to a variety of options. The deductive approach on the other hand, implies moving from a universal principle to the understanding of a particular case. This means that the research starts with a belief or view that is founded on a specific theoretical basis, which is then applied on reality, i.e. data collection is conducted after the construction of the theoretical foundation (Depoy & Gitlin, 2005).

This research relies on an extensive literary and theoretical foundation, built upon recognised theorists' collective views, which provided a foundation for the empirical investigation and subsequent analytical discussion. This starting point is deductive in nature owing to the fact that it is founded on well-known theories. However, during the course of action, recommendations and analytical models have been developed, which entails inductive reasoning. Hence, both deductive and inductive processes have been employed and as a consequence, one can not claim that a completely inductive or deductive approach has been used. Brett-Davies (2007) describes this combination of deductive and inductive approach as abductive. The benefit of using the abductive approach is that the theory and the data collection can be done interchangeably and the theory can be formed in accordance with what the field experience reflects (Brett-Davies, 2007).

3.3 Research strategy

Having decided the cornerstones upon which this research relies, a qualitative abductive research approach, a strategy on how to make the research process and its findings to an-

swering the purpose, was considered. In order to concretise the intent of this particular research, a case study approach was used. A case study is an entity which is examined as a single unit and it implies learning from an individual, group, organisational, social or related phenomena. It is argued that when researching contemporary events, such as the intent of this research, case studies are useful (Yin, 2003).

This study critically investigates one focus case that is representative to the research purpose and problem. Further, to triangulate the problem two support cases were used. *Hence, there is one case in which the problem lies and two cases that are used to assist the construction of the managerial implications* (figure 7).

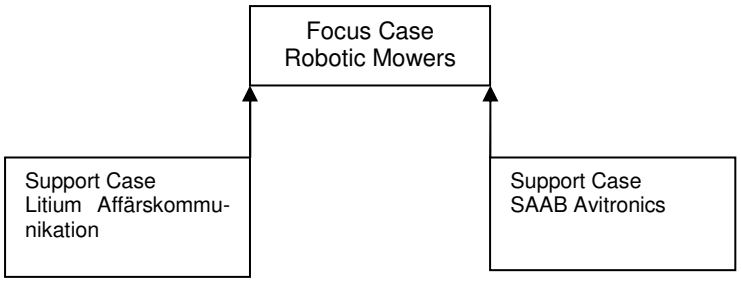


Figure 7 Relation between main and focus cases

Using multiple cases enables the researcher to understand how they are influenced by local conditions, hence developing more thorough descriptions and powerful analyses (Miles & Huberman, 1994). The objective of this study was to examine how knowledge is created, managed and how it can be improved. The two supporting cases, both involved in product development activities within environments similar to that of the focus case, provided input on how these aspects could be improved. The findings from these supporting cases were used in order to provide insights into how knowledge can be created and managed in innovative project groups and consequently these findings was used to provide suggestions to the focus case. The reasoning behind the choice of adopting a multiple case study is that it offers an attractive way of using several research approaches in order to portray an identified issue (Brett-Davies, 2007).

Further, a case study approach is applied when the research concerns a specific empirical investigation with a wide range of sources of information, such as in the case of this study (Robson, 2002). As have been elaborated on, the main purpose of this study is to examine how knowledge is created and subsequently managed within an innovative environment. Considering the exploratory nature of this purpose, using a case study approach is supported by Yin (2003), who states that using this approach is beneficial when the goal is to examine a phenomenon that needs to be looked at in-debt. Flyvbjerg (2006) further claims that in order to understand complex issues, research based on case-studies is preferred.

In summary, the purpose and the research questions needed to be confronted from a variety of angles, favouring the use of a case study. This provided for an in-depth study of the complex concept of knowledge through using a two-level case-study. The first level is represented by the focus case of Robotic Mowers and the second level was that of SAAB and Litium.

3.3.1 Selecting the case

The selection of what input to use for research is imperative for its outcome. Any selection, be it sampled element, when and where interaction is done, about what and for what purpose, has implications of the research later on. It is crucial to realise that it is impossible to look into each and every element that might contribute to the research and therefore a choice has to be made (Miles & Huberman, 1994). Further, when initiating a selection phase for research purposes, one need to make sure that the investigated object has the ability to fulfil the purpose of the research. Due to the objectives behind qualitative case studies, it is often argued that the case selection should be made based upon purposive sampling rather than representative case selection (Lincoln & Guba, 1985). The following steps have been undertaken in order to make an appropriate selection;

When initiating the process of this knowledge and innovatively focused investigation, a discussion on these particular areas was done with Mike Danilovich (personal communication, 2008-03-08), who has research experience within the area of organisational knowledge. The discussion concerned knowledge, core competencies and theoretical departures. Also, three different companies were distinguished as suitable research objects.

In order to make a choice on what company to approach, a think-tank session on selection criteria was conducted, in which suggestions on selection criteria was put forward and written down. After summarising the criteria, the listed items were evaluated and the seemingly non-significant alternatives were removed. The remaining criteria for the selection of case were;

a) It has branches (preferable manufacturing units) geographically close to Jönköping
b) It is an actor within a perceived competitive environment
c) It engages in innovative product development
d) It has recently experienced changes in the product structure

All criteria reflected two underlying conditions; *location* and *change in knowledge base*. Criteria (a), that the companies should preferably be located in the Jönköping region, were considered important since it would be easier to establish contact with companies well aware of Jönköping International Business School. Moreover, a geographical closeness provides for easier communication with the company, which hopefully could provide a deeper insight into the problematic nature of knowledge. Criterion (b), with focus on competition, was chosen since this was believed to provide a context in which the external demands of progress should be rather high and subsequently affect the product and force it to constantly evolve. Criterion (c) and (d), innovative product-development and changes in product structure, were required since it provides development of underlying knowledge-requirements which would provide knowledge activities to investigate.

When selecting a case, these criteria led to that the research could only take the direction of a purposive sample selection. Silverman (2000) clarifies that purposive sampling allows the researcher to choose a case since it represents interesting processes or features for the study. By using the criteria above, the three suggested companies were looked into by using information put on their respective homepages. One of the three companies, Husqvarna and more specifically the unit Robotic Mowers, was believed to fulfil the criteria and was in the process of launching a new version of an innovative product. Therefore a choice to approach Robotic Mowers was done based on Silverman's (2000) argument of purposive sampling.

A change of focus was done after an initial meeting with Stefan Axelsson (personal communication, 2008-04-21) at Robotic Mowers, and two major changes to the research was conducted. Firstly, the production criteria needed to be overlooked since they did not have production in Huskvarna. Prior to this, the research purpose was to some extent connected to production perspectives. Secondly, it was discovered that Robotic Mowers did not share core competencies with Husqvarna. The initial research focus assumed that the product development was highly connected to the core competencies of Husqvarna and therefore this also needed to be considered. Prior to this, the research was intended to look into knowledge and how it was managed with a production-focus and also to see knowledge changes in relation to core competencies. After some consideration the focus was changed. The research was still to use Robotic Mowers but even more emphasis was put of the *creation* of knowledge.

Due to this new direction, new ways to fulfil the focus was considered. It was concluded that it would be beneficial to examine how companies possessing the same core competencies as Robotic Mowers manage their knowledge creation. The two core competencies of the Robotic Mowers were articulated by Stefan Axelsson (personal communication, 2008-04-21) to be; *software* and *electronics*. By using the same selection criteria as for Husqvarna, two other companies were selected, one in each competence area. In order to create an understanding on how the knowledge was developed, organised and transferred, a product manager within a project group at each company was interviewed. The companies that were chosen were also selected using a purposive sampling method.

3.4 Data collection

When engaging in qualitative research studies there are different approaches to use in order to gather empirical data, such as questionnaires, interviews and observations. This study essentially relies on primary data from interviews. Secondary data has only been used to provide a theoretical foundation, to support primary data and provide a general picture of the specific cases, further discussed in section 3.4.4 (Ghauri & Grønhaug, 2005).

The main benefit with using *primary* data is that it is gathered specifically with the current research in mind. Although, there are disadvantages with using primary data such as a low degree of control as well as high cost and time requirements, it does provide great benefits since the gathered data is closely related to the research problem (Ghauri & Grønhaug, 2005).

Data was collected through a case study approach using in-depth interviews with employees at Robotic Mowers, SAAB and Litium. The disadvantages have been overcome by ensuring access to key persons and creating the interview questions in a suitable manner, only the issue of time has been experienced as a drawback of this research. In some cases there have been difficulties in setting up interviews due to the respondent's lack of time, which has delayed the research process.

3.4.1 Interview method

When conducting qualitative studies, a common way of extracting relevant information is to conduct interviews. In research there are three types of interviews that can be used; structured, semi structured and unstructured interviews (Ghauri & Grønhaug, 2005). When interviews are intended to provide answers specific to the research and equivalent information from different respondents, it requires that the same set of questions is asked in a

comparable manner for each interview, that is, a structured manner is required (Halvorsen, 1989).

Further, interview questions can be designed in two different ways; open-ended and closed-ended. When engaging in a qualitative case study, it is often beneficial to challenge the case from a number of angles in order to thoroughly scrutinise it (Brett-Davies, 2007). Also, it is beneficial to combine open and closed-end questions in order to triangulate a problem and to gain depth in the research (Halvorsen, 1989). The interviews conducted at Robotic Mowers, SAAB and Litium have mostly been based on open-ended questions but also, one closed-ended question has been included.

Closed-ended questions are beneficial since they facilitate the coding as well as the understanding of a question in that it provides examples. They further make it easier to compare answers from different respondents and help the respondent to remember the available alternatives. There was merely one closed-ended question asked during the interviews and it was included only in order to save time since it quickly provided information that subsequently served as a foundation for other open-ended questions. The closed-ended questions were asked using a Likert-scale format which is the most common tool when using these types of questions. It presents the item as a sentence and is followed by answer options that indicate the level of agreement (DeVellis, 2003). Different ways of creating knowledge were suggested and the respondents were asked to assign each activity a level of importance. Five values were used since it is a comprehensible amount of alternatives which gives the respondents the opportunity to value the alternatives and thereby provide a clear set of data. The interval was ranging from one to five on each activity, one being perceived as weak, three moderate and five as very high (appendix 3) When making use of this kind of questions, it is important to include all possible answers (DeVellis, 2003). In order to fulfil this requirement an 'other' alternative has been included in the list of alternatives. Further, the alternatives in the Likert-scale question were placed in a random order. This was done because otherwise the respondents might be influenced by the order in which the alternatives were placed. The randomisation was conducted by numbering each alternative and making a draw in order to decide the position in the list.

The remaining interview questions were open-ended that, according to Creswell (2002), is the most widely used way when using a qualitative research approach. Further, the main advantages with using open-ended questions is that it provides the possibility to reveal lacking knowledge, it does not suggest answers to the questions and it does not force difficult terms upon the respondent (Halvorsen, 1989). In this research, open-ended questions were used to a great extent since the nature of the purpose demands thorough explanations and sometimes also clarifications. The open-ended questions acted as a guide and when necessary, follow-up questions were asked in order to clarify or receive more information about interesting issues. By the use of open-ended questions, the respondents' answers provided a deeper insight with individual opinions. This was of importance since when it comes to knowledge, it is interpreted differently by different individuals. Hence, by using open-ended questions the researchers could capture valuable information that would have been missed if only closed-ended questions were used.

3.4.2 Pilot test

A pilot test is beneficial for case-study research since it helps in developing appropriate questions for the real case (Yin, 2003). There were two major reasons to why a pilot test was conducted in this research. One reason was that a practice interview was beneficial for

the interviewers since they could learn how to act together and towards a respondent. The second and most important reason however, was the difficult nature of the knowledge concept. Due to the complexity of the subject, one needed to see whether the respondent understood the questions and also it needed to be tested if the researchers had become blind to their own research and hence specified questions on a too abstract level.

The pilot test was conducted with a product manager at Fläkt Wooods, a company unrelated to the other cases. Both the choice of company and the choice of respondent were selected based on Yin's (2003) selection criteria for pilot cases which are; *access*, *convenience* and *geographic proximity*.

Prior to the interview, the objective of the research was expressed and also clarified that the interview was merely conducted as a test. Subsequently, an initial set of questions was asked in equivalent manner, as was planned for in the focus case of Robotic Mowers. This was done in order to ensure that the questions would not be misinterpreted and also to examine the approximate length of the interview.

During the interview, it became evident that the respondent did not differentiate between a few questions. After the interview, the questions were evaluated on which to remove. In addition, due to the fact that knowledge is an abstract subject, it was needed to reformulate some questions in order to make them more practical and hence easier understood by the respondent. The pilot interview indicated the difficulty of remembering and distinguishing the different knowledge-creation activities and therefore it was decided to include a closed-ended question.

3.4.3 Conducting the interviews

The interviews were conducted face-to-face in undisturbed conference rooms or respondent's offices. The main advantage with conducting face-to-face interviews is that the research situation is similar to an every-day conversation, which implies that this is the type of method where the researcher practices the least control of the persons under study (Holme & Solvang, 1996). In the initial phase, an interview was conducted with Stefan Axelsson, business manager at Robotic Mowers. This interview was mainly conducted in order to become familiar with the organisation and to get a general picture of the technology and required knowledge.

Further, two different sets of questions have been used, one for the introductory interview of the business manager (appendix 1) and one for the remaining interviews (appendix 2). The additional respondents were chosen from an organisational chart provided by Stefan and all persons but one, were selected based on the fact that they possess management positions within Robotic Mowers. There are two levels of management within the group, one high level with little connection to every day work and one middle level which is highly involved in everyday work. All managers on the middle level were interviewed. The reason for choosing to interview the managers was that this study focused on knowledge creation from a management perspective. The last person interviewed was included due to his position as a software engineer employee and findings extracted from him were, to some extent, used in order to support or contradict the views of the managers. This was perceived important due to the fact that managers might otherwise give a different picture compared to what is actually experienced by the co-workers (figure 8).

Unit	*Position*	*Date*	*Interview*	*Employment*
Robotic Mowers				
Stefan Axelsson	Business Manager	2008-04-21	90 min	3 years
Olle Markusson	Product Manager	2008-04-28	40 min	10 years
Christer Gustavsson	Product Development	2008-05-08	40 min	2 months
Patrik Jägenstedt	Primary Development	2008-05-08	40 min	7 years
Jonas Bergström	Software Engineer	2008-05-08	35 min	2 years
Litium				
Jonas Beskow	Development Manager	2008-04-28	30 min	1 year
SAAB				
Anita Karlsson	Line Manager	2008-05-16	40 min	1 year

Figure 8 Interview cases

Prior to the interviews, the respondents were provided with the questions and was asked to read them through, which gave them time to reflect on the questions in order to make the actual interview more efficient and informative. The length of the interviews varied, the introductory interview lasted for 90 minutes whereas the rest lasted for 30-40 minutes. For each interview, two interviewers have been present in order to minimise loss of valuable information. This was also ensured through recording all interviews and to listen to them again at a later stage. Also, by being two interviewers one person was responsible for asking the questions and the other for asking follow-up questions and taking notes.

The language used at the interviews was Swedish due to the fact that all the respondents were Swedish. However, one experienced problem was that the language and expressions of engineers are highly specific. Consequently, there is a risk that the respondents adjusted the answers to a level they perceived as appropriate for outsiders, which might have resulted in that important information has been excluded. This limitation was overcome by asking several follow-up questions and initially to formulate the questions to correspond to their way of thinking. Further, the innovative characteristics of the companies under study and the implication of the fear of confidential information to be misused might have implied limitations that have influenced the information gathered. However, to minimise this restraint, much effort has been spent on creating a good relationship with the respondents. Further, to receive as rich data as possible, the respondents were given the opportunity to comment on our interpretation of the answers. The draft from the interpretation of the interviews was sent to the respondents and they were encouraged to send their comments.

3.4.4 Secondary data

Secondary data is a source of data that has been collected and documented for other reasons than the research in progress. Research often makes use of both primary and secondary data, where the latter carries advantages in that it saves time and money since is has already been collected and processed. This does however also convey disadvantages since the purpose of its previous collection is different from the purpose of the current research (Halvorsen, 1989).

Secondary data in this research has been kept at a low level in an attempt to reduce external influences and biases. The secondary data used has, in declining extent, been; scientific articles, books written for academic purposes, documentation from the companies, the inter-

net and other published theses. The literature sources have been used in order to create a well-founded theoretical framework. They have all been published and before choosing what sources to make use of, much time and effort was spent on evaluating the sources. This was done in order to make a proper choice and use recognised theorists and their opinions. Other secondary data used for the empirical findings are information documents on the companies and their products. Finally, sources of secondary data that have been used for research purposes but not specifically as inputs to this thesis are the internet and other published theses. The internet provided background information of Husqvarna whereas the other published theses provided input to the writing process of this thesis.

3.5 Data presentation and analysis

The data presentation follows a structure guided by the main areas from the theoretical framework and a distinction has also been made between the three project groups, which has been done in order to facilitate the understanding and make the empirical investigation coherent with the theoretical part. Due to the fact that the data collected had to be translated, the translation of the interviews and the quotations might imply a small bias considering that there is a possibility that the exact translation is not given. However, this has been overcome by letting respondents read through the draft of the empirical data.

After a qualitative study has been conducted it is followed by an extensive amount of additional work. The aim is to generate an overall picture of the research. Analysis can be conducted by adopting three general strategies; *relying on theoretical propositions*, which means that the researcher should analyse the empirical evidence with a theoretical base, *thinking about rival explanations*, which implies that the researcher should be critical when analysing the empirical data and the last strategy, *developing a case description*, which implies that the researcher should have a plan when analysing the empirical findings (Yin, 2003). The strategy adopted was the *relying on theoretical propositions*, where the empirical findings was looked at from a theoretical perspective through creating an analytical model.

3.6 Trustworthiness of the study

Lincoln and Guba (1985) emphasise that when it comes to qualitative research the major issue to consider is how the researcher can persuade the readers that the findings of an investigation are worth taking account of. In order to ensure trustworthiness, they argue that the following four aspects should be considered; credibility, transferability, dependability and confirmability. The steps are well recognised as suitable means to measure trustworthiness in qualitative studies according to Healy and Perry (2000).

One way to ensure *credibility* of empirical findings and the interpretation of them can be achieved through persistent observation and spending a long period of time on the research. Another way to certify credibility is to use peer debriefing, which is a method where pilot tests are used to check assumptions that might not have been observed otherwise and might have influenced the research in a negative way. Credibility of this study has been supported by conducting a pilot test prior to the interviews and having the respondents read the drafts on the empirical findings and being encouraged to give comments. Also, the recordings from the interviews have been listened to over again in order to ensure that the data was not misinterpreted. Further, *transferability* concerns the extent to which the findings can be used in other times and contexts. The responsibility of ensuring transferability is placed on the person that wishes to use the research in other settings. However, the researcher can assist by providing a thorough description in order to enable someone that is

interested in transferring the study to another setting to evaluate if this is possible. This study is ensuring a possibility for others to transfer the research to another context by describing the empirical work process in detail. *Dependability* is intertwined with the concept of credibility and it is not possible to achieve dependability if the research is not credible. Dependability incurs the stability of data over time and concerns changes in the process. In this study, the research process has been thoroughly explained. When a change of focus was undertaken this has been explained in the methodology section in order to enhance dependability. Also, the fact that the research is conducted in a credible manner entails that dependability can be assumed. Lastly, *confirmability* entails that the views of the researcher will influence the research, and it serves as a means of maintaining objectivity throughout the study. Confirmability can be ensured by letting other people questioning and criticising the collected data (Lincoln & Guba 1985). This has been done by not using anonymous sources so that the data can be traced to its source and also by letting people read the research drafts and discuss the chosen method.

Further, Yin (2003) suggests that the researcher should use *multiple sources of data* in order to ensure high trustworthiness of the study. In this research, this has been obtained by conducting several interviews as well as using secondary data from different sources. Also, the perspective of the managers has been questioned by interviewing a co-worker.

3.7 Ethical implications

Ethics are the underlying principles and values that researchers base the research on, it implies that the researchers have moral obligations to explain and answer the question under study in an accurate and honest manner (Ghauri & Grønhaug, 2005). This study has fulfilled this requirement by not only emphasising the positive aspects of the method but also being clear and honest with the potential limitations and weaknesses. In addition, it have been ensured that the data collection have been conducted in a way that have not embarrassed or put the respondents in an awkward situation. This has been achieved by being clear about the purpose of the study and giving them the possibility to read the report before it was published. Also, the respondents were asked beforehand if the interview could be recorded, which was done in order to respect their potential fear of the recordings being misused.

4 Knowledge creation in product development units

If knowledge can create problems, it is not through ignorance that we can solve them.
Isaac Asimov

This section presents the empirical data concerning knowledge creation and its management. The findings from Robotic Mowers are presented in accordance to the theoretical framework, followed by corresponding findings from SAAB and Litium.

4.1 Interviews

The following findings are extracted from interviews that have been conducted with managers and one co-worker from Husqvarna, SAAB and Litium (figure 8). The findings from Husqvarna are based on the groups' collective answers. However, when specific contribution has been made the name of the respondent has been stated. Interviews have been conducted with Stefan Axelsson 2008-04-21, Olle Markusson 2008-04-28, Patrik Jägenstedt, Christer Gustavsson and Jonas Bergström 2008-05-08. Further, the findings from SAAB are based on an interview conducted with Anita Karlsson 2008-16-05 and the findings from Litium originate from an interview that was conducted with Jonas Beskow 2008-04-28.

4.2 Robotic Mowers' situation

Husqvarna AB is a Swedish industrial company with a strong history in its three business areas; Construction, Lawn and Garden, and Forestry. They are global leaders in the latter two business areas and their products are exported to over a hundred countries throughout the world (Husqvarna, 2008). Robotic Mowers is a product development group within the Lawn and Garden area and is the one focused upon in this study. The group was formed in 1992 in order to set out on a new business venture and try to exploit a new idea. In effect, they bought the idea of a solar-driven mower and the already developed technology in the form of a prototype, from an outside inventor. Initially, the group consisted of merely two employees from the Husqvarna organisation whose main job was to work out how the product functioned, what competencies that were needed to produce it and how to make commercial production possible. After that, product development took off and in 1995 the first generation of the Automower was launched, Solaris, which was purely driven by solar power. This was followed by the second generation, in 1998, which was powered by a rechargeable battery. This generation worked well, having learnt much from the previous generation, but one had taken a step away from the initial environmental focus. Therefore a Hybrid is to be launched in 2008. This model combines the two previous models by taking the power from the sun when possible and using the rechargeable battery when the sun is absent. In addition to these generation shifts, there are also yearly improvements of the product. Over the years, and during the Mower's development process, flaws have been discovered, solutions proposed and knowledge has been accumulated.

Even though Robotic Mowers is a department within the organisation of Husqvarna and the fact that they use Husqvarna's internally provided services and pools of expertise, they to some extent see themselves as separated to them. When it comes to competence ex-

changes between Robotic Mowers and Husqvarna, Olle explains the relationship in the following way;

> *'The relationship between Husqvarna and Robotic Mowers is good, but we do not think that we have much to benefit from the exchange with them.'* (O. Markusson, personal communication, 2008-04-28)

Patrik also state that the group is not much influenced by Husqvarna but instead, the Robotic Mowers has a strong identity of their own;

> *'We don't have a direct feeling for Husqvarna but I feel that our identity as Automower people is very strong on the individual level, people enjoy their work and are proud to be with Robotic Mowers.'* (P. Jägenstedt, personal communication, 2008-05-08)

The fact that they do not benefit much from Husqvarna's competencies depends on that their products are highly different from Husqvarna's product portfolio, which mainly consists of mechanical products. It has also been expressed that the feeling of separation from Husqvarna is dependent on the mentality at the Robotic Mowers, which is described as 'innovative and forward', whereas Husqvarna's is described as an 'old industrial' mentality. In addition, Robotic Mowers' building is separated from those of Husqvarna's headquarters.

4.3 Knowledge and competence composition

It is important to realise that the Robotic Mowers group is focused on product development and not production, which is situated in England. The group has so far founded their three generations of mowers on two main competencies; *software* and *electronics*. The importance of software competence is due to the fact that each garden is unique and therefore, to create a mower that can operate in every situation is complex.

The other main competence, electronics, lies as the foundation in making those intended moving behaviours real. Over the years, the product and its required competencies have changed, as put forward by Patrik;

> *'We have gone from mechanics to electronics, software and also testing. The group composition has changed accordingly.'* (P. Jägenstedt, personal communication, 2008-05-08)

This emphasises that the group, and the personal competencies connected to it, have evolved. These are however, not the only ones to have changed, also the understanding of the product itself has evolved. Due to the complex nature of the product, it has taken many years in order to get it to function properly and especially in the initial stages of development, problems occurred. Even though the three generations are rather different in how they are powered, the competence-differences between the models are perceived as small and the learning from previous errors has been applicable to the succeeding generations and the acquired competencies could be re-used. This is represented by the following statement;

> *'There have been a number of so called child-diseases throughout the years, now it is more stable. [...] Electronically, we have learnt to choose the right components that can survive the hard conditions. Software however, that's where the largest difference lies. Software is what develops all the tim.e'* (S. Axelsson, personal communication, 2008-04-21)

Over the years, Robotic Mowers has been characterised by an innovative and creative atmosphere with somewhat disorganised practices and routines. It still is today, but as the group has grown to 15 people and is believed to continue to grow, it has been realised that there is a need to improve its organisation and its structure. In early 2008, a step in this direction was taken and a small-scale re-organisation was conducted, through which more people were employed, a new work-role was created and reallocation of one person was done. This meant that the former development manager, who had been within the group for seven years, was re-allocated to work with 'primary development' with a long-term perspective on future technologies. The development manager position was then appointed to external party that was recruited through the use of personal networks, who was partly employed for his experience and knowledge in creating structure. One of his challenges is to organise and structure current and future operations at Robotic Mowers, as well as to ensure that the group manages an up-coming expansion.

4.4 Knowledge creating activities at Robotic Mowers

The creation of knowledge in Robotic Mowers originates both from external and external sources. The below presentation is founded on the rating of knowledge-sources done by members of the development group and the subsequent discussion of the most important external and internal sources. The importance of type of source and what kind of information that is extracted from where is also elaborated on.

4.4.1 External sources of knowledge

This study's objective is focused upon knowledge creation and this section presents Robotic Mowers knowledge creating activities in order of importance.

Suppliers and consultants are important sources of new information and learning for the Robotic Mowers, and especially when it comes to the development of new components, which Christer emphasise by stating that;

> *'The suppliers develop components which they then recommend to us. We have developed a good and stabile network so we can take advantage of the developments that the suppliers make.'* (C. Gustavsson, personal communication, 2008-05-08)

It has further been expressed that within this network of suppliers, it is crucial to distinguish key people, i.e. highly knowledgeable people, in order to extract as much vital information as possible.

Information on components have been mentioned as one way of learning from suppliers but within Robotic Mowers, *consultants are also seen as suppliers* and they generate a larger amount of learning into the group than what the component-suppliers do. Consultants are commonly used and currently, Robotic Mowers have five consultants working within different areas. Further, they use two different types of consultants; *expert* consultants and *resource* consultants. The expert consultants are used for very specific purposes and problems requiring competencies that the group does not possess. The resource consultants possess competencies similar to the group members and generally, Robotic Mowers has around 2-3 of these consultants working within different areas. However, the group tries to perform the tasks within the core competence areas and only use consultants for less crucial areas. Although consultants are not seen as an ultimate way to keep operations going, the expansion phase that Robotic Mowers presently is in makes the demand for different types of

competencies difficult to foresee and therefore the best short-term solution is thought to be the use of consultants.

Another particularly important source of retrieving knowledge is the information and experiences extracted from the opposite side of the value chain, Robotic Mower's *retailers*. In Husqvarna's case these are located in different geographical markets. Olle emphasises that in order to learn from the retailers, similar to the learning from suppliers, there is a need to find competent sales persons within their organisations that have both the product knowledge needed and the ability to communicate it;

> *'The thing is to find the right persons that really possess the knowledge, so that you not only find sales staff that simply can sell 'by the book' , and not how it works in reality. It is difficult to find persons that are both social and have knowledge about the details, either you have a salesperson that can give the simple answers that everything is easy, easy, easy. At the other end you have the person that should provide support and that takes care of the details […] it is difficult to find one person that possesses both of these traits.'* (O. Markusson, personal communication, 2008-04-28)

Robotic Mowers do believe that they have been able to identify these competent people within their retail-network. From them, knowledge and information is extracted through visiting the retailers in Sweden and elsewhere, communication through telephone and asking them for advice in specific issues. The retailers are generally visited two times per year in order to strengthen their communication and distinguish the 'competent individuals' that have the ability to provide valuable input to development. These individuals are then gathered at meetings where they are encouraged to share their customers' positive and negative experiences with Robotic Mowers and also to test new ideas and act as a sounding board. The meetings with the retailers work as brainstorming sessions and result in technical specifications for next year's model of the mower. If the changes concern a new product platform, i.e. a new product generation, specific documentation on what characteristics it should have is done, however most often the meetings only provide inputs to incremental changes between the different models. Additionally, from communication with retailers, the product manager creates a so called 'wish-list' on suggested improvements. These suggestions are subsequently rated by retailers in different geographical areas. After this, these suggestions are treated in the following manner;

> *'They are then delivered to the development department and the top ten wishes are aimed at being improved for next year. If the development department experience difficulties with some suggestions, they might have to be removed from the list. A compromise is made and other wishes are fulfilled instead of the unfeasible ones.'* (O. Markusson, personal communication, 2008-04-28)

These suggestions from the retailers and the learning that Robotic Mowers have gained by listening to their feedback, results in improvements of the product.

Also, Robotic Mowers has a phone line, a so called hot-line, that customers and retailers use and through which feedback is injected into the project group. The hot line is open 24 hours a day and is directly connected to one of the 15 members of the project group, who can solve their problem, answer their questions and listen to their feedback. Although calls do come from end-customers, most of them come from the retailers. Through this, the retailers act as a middle-hand and communicate their own customers' problems. This external involvement contributes with direct and hands-on feedback to Robotic Mowers, which subsequently guides the development group towards problematic areas.

Benchmarking is also an important source of gaining new knowledge. That is, robot mowers from the main competitors are tested and looked into in order to learn about their functionality and underlying construction. To a small extent, this benchmarking provides Robotic Mowers with business intelligence on new technologies that competitors posses and that they need. If this is the case, they purchase the licence and use it in their product. Although it is generally thought to be important to learn from competitors, only one respondent expressed a problem with how it s done today;

> *'We are doing it too little I think, because it is very useful to do. Often the time is scarce, and you do not have the resources that are needed to be able to make a detailed analysis on a competing product. It results in that you purchase a product and make a superficial analysis on it and then you leave it at that.'* (C. Gustavsson, personal communication, 2008-05-08)

Hereby, Christer stresses that there is a need to use benchmarking to a greater extent than what is currently done. Robotic Mowers however, have a great advantage in owning a number of patents on technologies that are needed in order to construct a robot mower. Therefore, competitors have to buy a licence to use this technology from them and due to this they can keep track of competitors. Further, *partner projects with other companies* also provide useful inputs into the product development and most of these partnerships are done with direct competitors. Sometimes the different products affect and disturb each other and therefore they are more or less required to co-operate with competitors in order to construct functional products.

Finally, the group also acquires knowledge by *recruiting* new competent people. Due to the fact that Husqvarna does not have the required competencies, internal recruitments are not done. Upon hiring new employees, personal networks have often imperative;

> *'To hire the right person can lift an entire department. It is better to hire a person that someone knows is good than taking a chance. Sometime one has to take a chance though, and might end up with someone that contributes even more.'* (P. Jägenstedt, personal communication, 2008-05-08)

Today, the group consists of 15 employees, out of which five possess management positions. One of these group members has been involved from the start. The group is generally believed to continue to grow.

Figure 9 concludes the discussion above and presents specific information and its external source, in order of importance;

Knowledge creating activity & source	*Type of information*
• Consultants/Suppliers	assignment-specific
• Retailers	functionality issues originating from end-customers
• Partner projects	overt intelligence on competitors' products
• Benchmarking	covert intelligence on competitors' products
• Recruitments	new ideas and perspectives

Figure 9 Summary of external knowledge creation activities

4.4.2 Internal sources of knowledge

This section will follow the same structure as the above by presenting Robotic Mowers' most important sources of knowledge, only here the sources are of internal character.

When it comes to internal knowledge sources, *tests* are the most important way of creating knowledge within Robotic Mowers. Tests are used in order to experiment with new constructions, techniques and components that may be used. Tests provide reliable data and are therefore extremely important for the product development process, they are however rather time consuming. Until recently, Robotic Mowers' products were tested in real-world settings and whenever a product change was done, the effect of it was tested in a real garden. Soon a virtual way of testing will be introduced which means that tests can be conducted in different garden settings without actually having to move outside the office, which speeds up the testing process. The benefits with this virtual test world are further argued for since one can conduct tests on a continual basis, all year round. It has been further, stated that the tests made in the virtual world will create more thorough and deeper knowledge compared to the more superficial real world ones. Real world tests will still be conducted in parallel to the virtual one, although to a lesser extent.

Meetings are seen as good ways to share information and subsequently create knowledge. At Robotic Mowers, there are two types of meetings; *general* and *specific*. General meetings are a part of the knowledge sharing and decision-making process when developing a new product. In general, projects are divided into separate phases and the meetings ensure that everyone is working in the same direction in addition to generating ideas. These meetings are also where current problems are dealt with and solutions suggested. Only the members that are directly involved in the problem that needs to be discussed are participating in the meetings but if the meeting involves strategic issues, the entire project group participates. It has been stated that meetings are good forums to generate ideas for future use. These kinds of meetings can be dedicated for specific aims, such as brainstorming meetings, and are perceived as important.

Informal talk carries great significance for sharing knowledge. Much time is spent on talking through issues with others, in smaller and bigger groups, in conference rooms or in the corridor. Also, one stated major benefit of informal communication is that time is saved since one knows who possesses certain pieces of knowledge, expressed by Jonas;

> *'For example when someone has done some tests and uploaded a thick report, you might not want to read the whole report, but rather get the core idea from it. This sort of knowledge is*

> *communicated during coffee breaks etc. Also, if you are not a member of certain projects and thereby not attend those meetings you will have to look for this information by yourself. This kind of knowledge is spread in the corridor.'* (J. Bergström, personal communication, 2008-05-08)

This statement put forward the importance of informal communication as a way of learning from others within the group and also that the time-saving aspect is important. Figure 10 concludes the discussion above, specific information and its internal source are, in order of importance;

Knowledge creating activity & source	*Type of information*
• Tests	rich and specific information on functionality
• General meetings	general current information on what is happening in project
• Specific brainstorming meetings	improvements and problem-solving
• Informal talk	all types on unstructured information

Figure 10 Summary of internal knowledge creation activities

4.5 Support and obstacles to knowledge creation

The culture in the project group encourages creative thinking rather than feeling trapped by old working ways. Moreover, the environment in the group is expressed to be curious and the people are eager to find new solutions. It is stated that everyone in the team is striving to improve and become as good as possible through being open minded to new things.

On a group level, the way the group works and its residing culture is not seen as influenced by Husqvarna's old industrial mentality, nor is it seen as in any way inhibiting to be a part of this organisation. It is however expressed that it is not easy to know to what extent one is affected by old knowledge due to that they are coloured by what they already know. On the individual level however, it has been expressed that situations occur where members get stuck in old habits and have problems to think differently than before. Jonas stresses this with reference to his own competence area, software;

> *'Like it is now, we are building everything based upon the same platform as earlier and therefore we are limited to develop totally new products.'* (J. Bergström, personal communication, 2008-05-08)

Patrik further explains the challenge as a manager to prevent this phenomenon from occurring;

> *'Sometimes it feels like when we do some things, we are doing them the way we always have. If you want to change this as a manager, much energy is demanded from you and it is a rather strenuous process. But I do believe that we are gradually moving away from this.'* (P. Jägenstedt, personal communication, 2008-05-08)

In order to avoid getting stuck in old working habits, at one occasion, a consultant was hired during the launch of the second generation of the mower. The consultant's task was to challenge the product-structure and make an unbiased evaluation of the basic mechanical concept.

In opposition to the negative issues raised about old knowledge, Jonas finds that old knowledge can serve as a positive factor in new product development when claiming that;

> *'History plays a large role, the largest mistakes is known by everyone and are incorporated into stories. Much of the problems that we had in the beginning can occur again in new projects if we do not think twice.' (J.* Bergström, personal communication, 2008-05-08)

Through this statement he means that senior people that have been involved in old projects should share their experiences in the new project in order to avoid making the same mistakes.

4.6 Organising knowledge

There are several ways to organise knowledge and at Robotic Mowers *responsibility areas*, such as job specifications and project responsibilities, are not written down or documented in any other way since these kinds of routines are viewed with scepticism by the group, much represented in Christer's and Patrik's statements;

> *'There are different opinions about the question, some people wish to have it but at the same time then you specify exactly what the person should do so the result might be that the person only does what's in the description, nothing else.'* (C. Gustavsson, personal communication, 2008-05-08)

> *'Personally I have problems with those types of descriptions, because either it needs to be very, very broad and formulated in an unclear manner so that it does not really mean anything, or it should be so extremely detailed that the size is infinite and as soon as one little task is changed, the whole document needs to be changed.'* (P. Jägenstedt, personal communication, 2008-05-08)

However, it is expressed that with future requirements in mind and the believed growth in group size, the members will become more specialised and job specifications might be needed.

Although responsibility areas are currently not written down, they are communicated verbally since it is expressed that if a task is not assigned a certain person, it will not get done. However, since it is a small project group the responsibility areas are not very strict and they often overlap. Also, the flexibility needed for this working ways is communicated through Olle's statement; *'we are a small group, flexibility is A and O'* (O. Markusson, personal communication, 2008-04-28). Although there are only a few persons working with a particular problem, there is always one person who is the outer most responsible. Moreover, responsibility areas in the group are, to a small extent, varying from one project to another.

The requirement to *document* as much as possible only comes from within the group. Information from several sources is documented but the most significant documentation involves the test results. Christer expresses that;

> *'Yes, we document when it comes to things that we test in the field so that we know what we have done. In two years time we might have forgotten what we've done today.'* (C. Gustavsson, personal communication, 2008-05-08)

This statement indicates that most of the knowledge documentation is done at the development department that conducts a multitude of tests. The many tests result in detailed reports that are used later in the development process. The Robotic Mowers has a few

documentation routines. The main tools used are simple computer tools such as excel tables, where for example listings are done and features are rated. Most of the information and outcomes from general meetings is documented in the form of protocols, meeting minutes and stored presentations. The various reports are written individually by different members of the project group and placed into systems. However, time is constantly scarce and sometimes one may not always have the time to look for information and get it from everyone. Also, there is much knowledge that is undocumented and remains only within the head of specific individuals of the group, which is communicated through;

> *'Much of it is, despite all, related to persons. It is in the head of many [group members] that has been around for a while and knows.'* (O. Markusson, personal communication, 2008-04-28)

As this statement indicates, the problem with a lack of documentation routines has been recognised and therefore more formal procedures are planned for. This is also done due to the fact that the group is expanding, the product range is increasing and the organisation is successively becoming more mature, moving from being a rather unstructured and inventor-oriented group towards a more formally structured one. One step in becoming more structured has been to employ the new development manager, who is intended to improve the current procedures and routines. This is not believed to harm the overall innovativeness but rather to improve the previous flaws in the documentation. A step in this process has been to more thoroughly document the changes made to the Automower, which was previously not done at all.

Ideas that arise but are not applicable at the moment can be reported by anyone in the group through a computer system called *Change Request,* i.e. ideas today are saved for the future. These requests can originate from anywhere, externally or internally, and can concern anything around the Automower. There are established routines on how the requests should be handled but they are not followed. When the routine is followed, a meeting is arranged with concerned parties and it is decided what priority each request should be assigned and if they should be carried out or not. The group that is assembled on these meetings are different depending on what competence areas the request involves. How often these meetings are held varies and according to Patrik;

> *'It depends on which phase we are in, if we are in a new development phase like now, the procedure is not followed. But if we are in a phase of product care, the meetings are held rather often. Generally however, it varies, sometimes [the meetings are held] every week and sometimes twice a year. The goal is to have one Change Request meeting every month.'* (P. Jägenstedt, personal communication, 2008-05-08)

Even if ideas are rejected they are saved in the system and it is possible to view them again, and the requests are considered when making the next generation of the Automower. As stated below, not all ideas enter the system;

> *'The thought is that new ideas should be placed in the Change Request but this is often neglected instead the ideas are discussed with other group members and then you try to make the idea into some kind of specification, but it should have been placed in the Change Request.'* (P. Jägenstedt, personal communication, 2008-05-08)

This statement stresses that today, ideas are largely spread informally. In addition to this, many of the new ideas that are actually documented are kept in the group members' hard drives.

4.7 Transfer knowledge

Overall, information and knowledge within Robotic Mowers is reflected in both written and verbal manners. Due to weak routines, the responsibility to access data is placed on the individual who need it. The most important ways of sharing knowledge is embedded in the daily operations and includes *informal talk* and different forms of *structured meetings*. The unstructured communication of knowledge is easily done by being situated close to each other and sharing common room. Also, information is easily communicated between hierarchical levels, due to the flat structure. Further, meetings are another arena for knowledge and information spreading where people are encouraged to inform and teach each other. The frequency of meeting varies but generally; department meetings are normally held on a monthly basis where the general information is disseminated to everyone in the group, project-specific meetings are frequently held and other, highly issue-specific meetings are held when needed.

When it comes to the computer *platforms and portals* where the members can retrieve and share information, several ones are used. Some of them are very specific to the group and exist in order to register product changes, follow-ups, check activities and make updates. Others are rather general. Firstly, the internet and the intranet communicate information to employees internal to the organisation. Another place where information is shared is through the use of structured data systems and data bases that preserves project specific information and other documents. The limitation with this, however, is that people simply search for and read a particular report rather than learning more about the issue, i.e. information that is not directly related to the issue but may still contribute useful input, is ignored.

All information however, is not spread in the group. It is stated that there are individuals in the group that are knowledgeable within certain areas and that it is hard to know what knowledge they possess. Knowledge within the group is often very specific and is therefore often captured within individuals;

> *'We are working within very different areas, people are involved in different projects and doesn't everyone need to know what is happening in all projects. For example, the person that is working with the mechanics does not have to know in detail what is happening with the steering system that is an electromagnetic story.'* (P. Jägenstedt, personal communication, 2008-05-08)

This statement puts forward that sometimes, it can be allowed to let knowledge be uncommunicated and that all knowledge does not need to be spread. To some extent, Christer agrees that everyone does not always need to know everything;

> *'Everyone cannot have deep and specific knowledge but we always try to have a backup, we have at least two persons that can perform the same tasks.'* (C. Gustavsson, personal communication, 2008-05-08)

These statements stress that all knowledge does not need to be shared all the time. Contrary to this however, Olle argues that knowledge should always be shared since the one possessing key knowledge might leave the group. When members leaves the group, one tries to keep the knowledge within the group through letting the new employee work side-by-side, with the one leaving, for a while. These periods, however, are often rather short and therefore concern about today's lack of documentation routines has been expressed. If

a member leaves the group without spreading the knowledge, much of what that person knew would be lost.

4.8 Knowledge creation at SAAB Avitronics

SAAB are developing products for the airplane industry and the group focused upon is one consisting of 15 persons with core competencies within the electronics area. The industry in which they operate puts pressure on the company to deliver the most recent technology and in order to create the ability to achieve this, several tools, external as well as internal, are used for gaining information and knowledge. The first part of the discussion below deals with SAAB's most important external sources (figure 11).

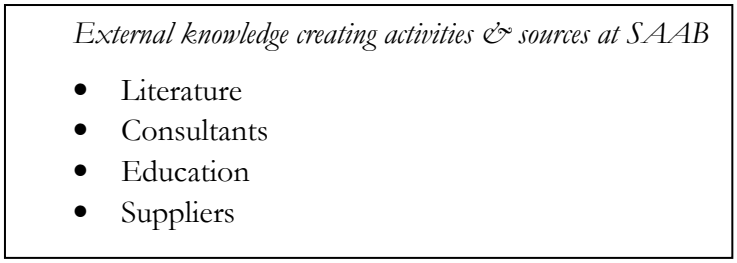


Figure 11 SAAB's most important external knowledge creation activities

As can be observed in figure 11, the most important source of acquiring new knowledge into the group is that of *literature* that is used to learn how to develop and construct the products. It is used as a constant source that group members return to when problems occur. Everyone does not need to read the literature however, but knowledge is also spread when group members help each other. Also, *consultants* are used when the workload is too large and time is scarce. This is a short-term perspective that can be developed into a long-term one if the consultant proves to be competent and is therefore hired. Another important way to gain knowledge in the long-term is through different forms of *education*. The importance of technology that is updated is emphasised and also that the members constantly need to develop their skills in accordance to this requirement. The frequency of the different types of education is varying from 2-8 courses yearly for each group member. One of the reason to why the group is in need of a high amount of education is that several tools that are used in the development process are often changed and therefore much effort is put into educating people so that they can perform their every-day work efficiently. In addition, another important input of information is when *suppliers* present their new product solutions to the group, usually a few times a year.

In addition to the knowledge that is acquired from the external environment, the group is also dependant on knowledge generation activities *within* the group. The below figure indicates the most important internal sources (figure 12).

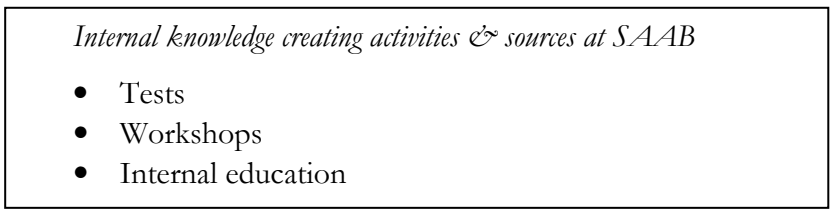


Figure 12 SAAB's most important internal knowledge creation activities

When it comes to internal sources of learning, the most important method is through the use of *tests* conducted on the products. The testing procedures are highly structured. Initially, a test plan is formulated, in which it is stated what one will test and how it will be done. After conducting the tests, the results are put into detailed reports. The reports are finally stored in a database from which it can be acquired by all the members in the group. Documentation of projects is thorough, and strictly controlled, which is a requirement of their customers.

The group uses a tool called '*lessons learned*', which is built around a *workshop* where all project members are gathered. Here it is discussed what has been learnt during a project and what conclusions that can be drawn from it. All members in the group are encouraged to express their opinions and ideas and the result of these meetings is summarised into a report. Another important source of learning is by *internally led education*. The advantage with this way of educating the members is that it is possible to choose exactly what specific theme that will be covered.

In order to keep the competence up-dated, the project group has one person that is responsible for facilitating the creation of new knowledge in the group. The person is not responsible for the actual creation but rather for making it possible, through pushing for education. This responsibility lies on the technical manager that distinguishes the need for competence development and therefore proactively searches for different kinds of education. Sometimes however, suggestions for courses to attend and other learning activities originate from the group members themselves, which is appreciated and encouraged, as stated;

> *'We place a large amount of responsibility on the individual, that they should be responsible for their competence development needed in order to perform their job.'* (A. Karlsson, personal communication 2008-16-05)

This view of having the individual carry much responsibility to develop is incorporated into their policy where it is clearly stated that individuals need to work actively to develop their competencies. However, it is the line manager that is the outmost responsible to ensure that the workers have the needed knowledge.

Knowledge sharing is encouraged in many ways. Firstly, a *formal appointment of one specialist within each competence area* is conducted. Contact details are placed on the intranet to make sure that the competence specialist can be contacted and hence support the knowledge sharing. Secondly, a so called *competence portal* has been launched, in which members of the group write what competencies they possess and what courses they have taken. This personal competence archive is used partly to keep a personal record of what has been done but also as a tool for the company when recruiting. Finally, mail groups are to be initiated for the members to more easily take advantage of each others experiences and knowledge.

4.9 Knowledge creation at Litium Affärskommunikation

Litium is a relatively young Swedish company that offers a product range including development, adjustments and sales of web- and mobile applications. The group focused upon is one consisting of six persons and their core competence is within the software area. In the software industry, knowledge quickly becomes outdated and obsolete. Therefore, knowledge needs to be constantly up to date and novel ideas need to be taken advantage of.

Figure 13, shows the main external tools that are used in order to obtain new knowledge input into the group.

External knowledge creating activities & sources at Litium

- Literature
- Education
- Seminars
- Suppliers

Figure 13 Litium's most important external knowledge creation activities

The most common way of incorporating new information and knowledge into the project group is by the use of *literature*. In the everyday work there is often some sort of knowledge threshold to overcome, for example if a certificate is needed by individuals. In order to learn what is required to overcome this, literature is the most common tool. Further, it is not only used when certain certificates are needed but also when there is a general lack of knowledge. However, in many cases the knowledge that is needed is not yet available in hard copy literature. When this occurs, internet sources are used in order to find information to solve a particular problem. Further, Litium experiences many advantages with *educating* the employees. Especially, externally led courses are perceived to provide high value. Education is seen as beneficial in that individuals have the potential to create new value to the company through bringing in novel ideas and information to their co-workers but also so that individuals can become specialists in certain areas. Further, by providing education to the employees, this may become a personal motivation to learn even more. The aim is that each employee should attend at least one external course per year. Also, in order for all members to benefit from the knowledge that the particular individuals have acquired on a course it is shared with the members of the group when the person returns to the office. The co-worker is assigned time on a meeting to share what they have learnt during the course. By doing this, the acquired knowledge is not only beneficial for the person that attends the course but it should also contribute with something to the entire group. Another important source of learning is through the use of *seminars* with *suppliers*. These seminars are held in order to educate the members of the group about the latest software applications.

The group also acquire knowledge from within the organisation. The most important sources are illustrated in figure 14 below;

Internal knowledge creating activities & sources at Litium

- General meetings
- Tests
- Specific brainstorming meetings
- Informal talk

Figure 14 Litium's most important internal knowledge creation activities

As can be seen, *general meetings* are seen as the most important internal knowledge-creation arena. Here, one spreads the information that in some way has been incorporated into the organisation for example the mentioned briefing that follows when someone has been edu-

cated. Although meetings are seen as the major way of spreading knowledge, a few other activities are also perceived as important. These include t*ests* in which the company benefits greatly by new employees, since they are often more prone to experiment with new and unorthodox programming manners. Further, *specific brainstorming meetings* are also valued as rather high since these represents the accumulation of knowledge from a number of employees. Finally, *informal talk* is perceived as a major vehicle of knowledge sharing.

Within the group, responsibility areas are not formally specified. Which is due to the constant overlapping of activities and that the members rotate to some degree. The documentation of information in projects within the group is conducted around products, rather than people. However, one exception is that they are using a project history portal where it can be seen which project the members of the group have been involved in. When it comes to documentation on products, the main tool is an interface in which articles concerning products and their use, written by group members, are stored. Further, the programming codes are accompanied with simple explanations of how it was done is placed into the system. When it comes to long-term planning however, all projects are documented with established goals for a few versions ahead. The purpose with having far reaching goals when working with the present version of the program is that it works as a guide for the present version. The group has a 'request function' where new suggested functions, not possible to be used presently, can be stored. These functions are then evaluated in terms of time and resources needed to be carried out.

4.10 Empirical summary

Robotic Mowers is a product development unit within Husqvarna. Their main competencies are software and electronics, both of which are developing quickly and result in the need to strengthen old, and create new, competencies in order to keep internal and external pressures aligned.

Knowledge creation at Robotic Mowers comes from external as well as internal sources. The most important external sources and activities to create knowledge are; suppliers, consultants, retailers, other markets, partnerships with other companies, benchmarking, recruitments. The most important internal sources are; tests, general meetings, specific brainstorming meetings and informal talk. These also provide source-specific knowledge in addition to what can be extracted from other sources.

Previously, much effort has not been put into communicating and documenting knowledge which has largely been due to lack of time. Lately however steps in order to organise knowledge work and create more formal structures have been taken, much in order to provide stable ground in the assumed group increase. The action that are so far taken in this direction is the appointment of a new product development manager, who is to evaluate the current situation and based on this, establish new routines in order to bring order to the knowledge creation and how it is managed. The group is further perceived as innovative, creative, sharing and open by nature. The group admits that to some extent its knowledge creation is inhibited by old habits and therefore at one point, it has hired an external party merely to challenge how their product is constructed. External pressures also reveal when a change in the group's competence composition is needed.

SAAB builds their business offer upon competencies within electronics and Litium builds theirs on software competencies. SAAB most important external knowledge sources and

subsequent activities are; literature, suppliers, consultants and education. Their internal ones are; tests, workshops, internally managed courses, internally managed education and informal talk. Litium's most important external knowledge sources and subsequent activities are; literature, education and courses, seminars, suppliers and recruitments. The internal ones are; general meetings, tests, specific brainstorming meetings, internal education and informal talk.

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5 Discussion of Robotic Mowers' knowledge creation

Curiosity begins as an act of tearing to pieces or analysis.
Samuel Alexander

This section provides an analysis which is founded on the combination of two broad theoretical models through which empirical findings is discussed in combination with theory.

The model below (figure 15) is the analytical framework that will be followed and represents three levels of scrutiny. On the most basic level, Nonaka and Teece's (2001) knowledge creation model will provide a map on what knowledge-creation process that is discussed as well as what direction and intention it has. Leonard-Barton's (1992) competence distinguishing model is then merged with this in order to attain a higher analytical level, as well as depth, to the discussion. Each *conversion mode* will consequently be discussed in terms of; *skills & knowledge base, technical system, managerial systems and values & norms*, through direct connections as well as contextual perspectives. Additionally, strengthening as well as opposing theoretical reasoning is used within the constructed framework in order to create a dynamic discussion. Finally, a summary of the main points is presented at the end of this section.

Within these three levels, the group and individual perspectives are used in parallel to each other and separated only when such a differentiation is needed. Further, the four sections present a different amount of analytical material which simply reflects the importance the specific process have at Robotic Mowers. Finally many issues are considered in the light of the upcoming growth.

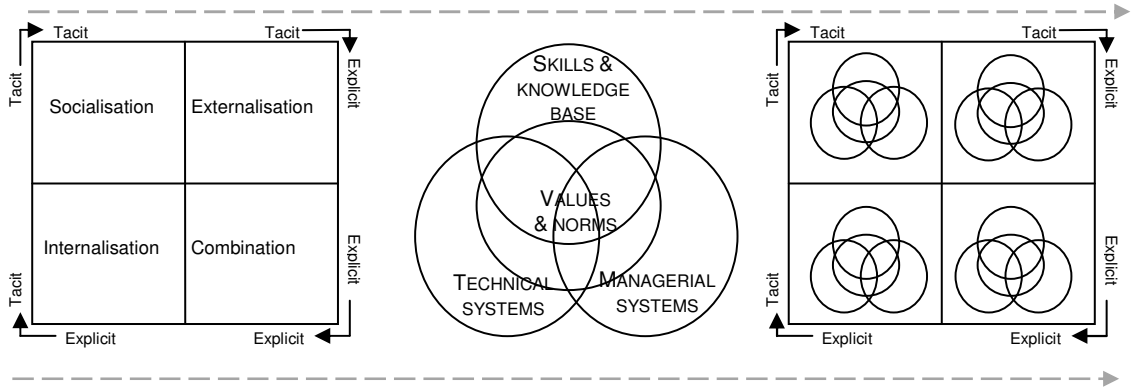

Figure 15 Analytical model

5.1 Externalisation

Externalisation is the mode in which tacit knowledge is turned into explicit, when this happens, tacit knowledge is in a sense turned into concrete forms and it is communicable to others around the knowledge carrier.

Skills and knowledge base

When individuals, the knowledge sources, engage in turning tacit knowledge explicit they contribute to the group's accumulated knowledge base. As a consequence, the foundation upon which individuals build their own knowledge is increased, meaning there is dependency between the two parties as well as a full-circle learning process (Nonaka, 2007; Cohen and Levinthal, 1990; Davenport & Prusak, 1998). In Robotic Mowers, new knowledge-creation is of essence and therefore there is a need to *continuously enhance the group's knowledge* base. The question is, if enough knowledge is concretised, organised, shared and absorbed in order to fully benefit from specific individual's knowledge, i.e. is there a symbiotic transfer between group and individuals that provide for both giving and taking and thereby increasing the both parties' knowledge bases. Communication of individual's tacit knowledge and thus making it explicit, is vital for this.

The skill and knowledge base within Robotic Mowers is largely reliant on the fact that the context in which the group exists is dependent on sharing knowledge, much due to the fact that it relies on only one product. The product as such is a representation of a multitude of highly specialised competencies and it is the outcome of the group's accumulated knowledge. It further represents knowledge-interdependency since every product component is reliant on all the others (Argote & Ingram, 2000). This means that co-ordination and working together is essential, i.e. work needs to be orchestrated in order to keep the same pace and direction of development. Due to the environment where the product development takes place, which is innovative and changeable and where there is a high knowledge-intensity and knowledge-need that is set accordingly, this *pace and direction perspective is important in order to create coherence and stability* in Robotic Mower's work. In order to achieve this, *communication of knowledge is crucial* (Albino et al., 1998). This need to communicate knowledge has been recognised in Litium where group members are given room to share what they have learnt at courses, in meetings that are held for the entire group. This is a way to share knowledge in an informal yet efficient way that lead to that the group's knowledge base directly benefit from an individual's. Also, it stresses the importance of communication, something that is also of importance in Robotic Mower since the group state that much of their knowledge resides within their heads;

> *'Much of it is, despite all, related to persons. It is in the head of many [group members] that has been around for a while and knows.'* (O. Markusson, personal communication, 2008-04-28)

One can assume that if all group members carry a large proportion of their individual knowledge base within their head, it needs to be pushed to be communicated and thereby contributing to the group's knowledge base. Also, if it is not communicated, then it is plausible to think that the tacit knowledge will never be recognised as knowledge at all and the visible knowledge level is therefore smaller than its potential level. One way to increase this visible knowledge may be to use consultants, a person that enters the group untainted by history and with new perspectives, to questions the current knowledge. This might also be a way for the group members to question their own ability to communicate knowledge and to discover whether they are influenced by old manners or not. Therefore, in accordance to Leonard-Barton's (1992) argument that individuals can create inhibiting forces to development, consultants can be Robotic Mowers way to overcome this.

Davenport and Prusak (1998) agues for the crucial need to share knowledge, which in a sense is to communicate it, which at Robotic Mowers can be inhibited by narrow *specialisa-*

tion. Due to the fact that all group members are specialised in their respective areas there is a possibility that they unconsciously do not see the full benefit of sharing since knowledge is specific to each area. There is a risk that some individuals keep their knowledge to themselves, hence limiting the knowledge they share with other and that others can absorb. It is however put forward, that to some extent, everyone does not need to know everything which makes the communication issue a little less important;

> *'We are working within very different areas, people are involved in different projects and doesn't everyone need to know what is happening in all projects. For example, the person that is working with the mechanics does not have to know in detail what is happening with the steering system that is an electromagnetic story.'* (P. Jägenstedt, personal communication, 2008-05-08)

Although Huber (1991) favours sharing of knowledge, he contrasts Davenport and Prusak's opinion to some extent in agreeing with the statement above. He accepts that an individual can learn something new without communicating it to others, since it still contributes to an increase in the organisational knowledge base.

Prahalad and Hamel (1990) claims that a long-term focus is essential in developing competencies, which is reflected in Robotic Mowers through the existence of a small sub-group that works with future technologies. This is intended to investigate what technologies that are needed a few years in advance. Business intelligence that is collected from the external environment is informally translated into an idea on what competencies the group should develop in the long run. This can affect the main competencies within the group and inevitably has effects on resource acquisitions, e.g. there may be new criteria on what competencies new recruitments need to possess, and hence *knowledge-needs need to be turned explicit*.

Technical systems

Technical systems are a means to store and organise, but also to share information and knowledge. In storing, one creates the ability to re-use knowledge, use it in new ways, for new purposes and share it with new group members, which can contribute beneficially in the case of Robotic Mowers. This storing of knowledge also facilitates the building of a stable knowledge base that can lead to new knowledge additions, i.e. stressing the prevalent path-dependency (Leonard-Barton, 1992; Davenport & Prusak, 1998).

At Robotic Mowers, one group member is normally responsible for entering data into the systems, hence only one person's perspectives comes through in the input process. Also when data and information is retrieved from systems it is subjected to individuals' personal constraints, which are dependent on how that particular individual perceives the data's status and subsequently treats it accordingly (Davenport & Prusak, 1998). Hence, *both input and output is limited by individuals*. Slater and Narver (1995) argue for incorporating a variety of views when engaging in knowledge creation, in order to learn as much as possible and hence create a greater knowledge basis. This is a mind-set seen at SAAB in their 'lessons learnt' routine where an effort is made in order to get everyone's knowledge, explicit and tacit, documented in reports.

Data and information that resides in technical systems at Robotic Mowers consist of test data, reports and change requests. In addition to being subjected to individuals' preferences, these are constrained and limited to a particular purpose when retrieved and there is no time for other possibly useful pieces of data and information to be considered. Hence

information that could be beneficial, if turned into knowledge, is often neglected and organisational learning is further restricted by technical systems through time and inability to see potential new uses. Day (1994) stresses that sharing is a mere necessity for organisational learning and in Robotic Mower's case this suffers when processing systems are used. The use of systems implies that since input is reflecting only one person's view and the output data is limited to another person and purpose, *the knowledge creation is limited both when entering and extracted from a system, making it rather narrow*. Also, views resulting from varying views and interpretations are lost (Slater & Narver, 1995; Huber, 1991).

Rigidities stemming from knowledge have been discussed by Leonard-Barton (1992) and there is a possibility that the systems that Robotic Mowers uses are restraining knowledge creation by its very nature, since they exist for specific purposes and that there may be other purposes that are not accounted for in these systems. However, in accordance to Leonard and Insch (2005), tacit knowledge often makes itself visible through 'know-how' and at Robotic Mowers, group members often have gut-feelings on product behaviour, which is based on their tacit knowledge gained from past experiences, and without explicitly stating what needs to be tested, they proceed with experiments. SAAB on the other hand, has a well developed routine when it comes to tests, which provides for consistency. Cohen and Levinthal (1990) strongly stress the importance of having procedures and routines in order to capture knowledge, whereas Davenport and Prusak (1998) only argue for a proper balance in codifying knowledge in order to enable creative processes. Hence, by forcing data into structured technical systems, important attributes such as dynamism and creativeness can be lost. They state that *too much structure can eliminate or decrease knowledge contributions*. At Robotic Mowers, the lack of routines or structured plans on what to test, leads to that flexible experiments can be conducted which might result in more valuable and rich results.

The knowledge-based rigidities elaborated on by Leonard-Barton (1992) can originate from structured codification manners and therefore, by keeping some data separated and outside of systems, one can gain innovative strength. At Robotic Mowers there is a great need for knowledge to be constantly up-dated and therefore *it is plausible that codification can, to some extent, influence negatively* as well as prove expensive (Davenport & Prusak, 1998). Further, this is partly because codification takes time, which the group state that they lack, but also since everyday work is dependent on a large amount of tacit knowledge. Today however, much data and information is fragmented and isolated from others and in addition to that, much of it is never put into general systems but exist only on personal hard drives. One way to solve the issues of time, being constantly updated and cost, can be the use of dynamic models, argued by Davenport and Prusak (1998) that can enable information spreading. One example of this is to use communities that are open for anyone to add input to e.g. a wiki site. These can be placed on the intranet or a network that is specific to the group. However, being such a small unit today, information sharing does not seem to require these means yet, however they can be kept in mind for future use.

Further, as was argued by Nonaka and Takeuchi (1995), the communication of knowledge builds on trust and relationships. In Robotic Mowers' case, the strong relationships and subsequently open informal communication of knowledge may conflict with or serve as a complement to data systems. The importance of using data systems however has been reduced since it has been stated that everyone does not necessarily need to know everything. Albino et al. (1998) argue for the appropriateness of each communication channel, meaning how well it is adjusted for its purpose. Here, one may assume that the individuals sup-

posed to use the systems do not see them as appropriate for making tacit knowledge into explicit forms, and therefore they do not use them for this. *Hence, balance between codified and uncodified knowledge is needed* when spreading knowledge.

Managerial systems

Managerial systems are vital in order to create some degree of control and structure in the knowledge creation. These systems have great influence on the extent to which knowledge is shared and how it is carried out. Today, the group consist of 15 people out of which five possess management positions. Hierarchical levels within the group are perceived as diffuse and communication between the levels is said to be unaffected by what parties that are involved. This means that communication is done in the same manner despite who is involved, which facilitates the vertical transfer of knowledge as well as the transfer of different types of knowledge, argued by Nonaka and Takeuchi (1995) to favour knowledge creation.

In the past, the group's management has not placed much emphasis on knowledge structure and control, therefore knowledge creation has been rather unsystematic, however guided by a common goal and strong cultural influences. Also, the group has been relatively small making this acceptable and there was no general need to systemise their knowledge work. Over the years, the group has grown and today *a need to adjust to new circumstances and provide a common ground through structure has been realised*, a decision which in itself indicates a proactive attempt to overcome possible inertia and rigidities stemming from the lack of structure. A step in this direction was to extend the management group through creating a new management role, primary development, and move the former product development manager to this position. Through moving him to a new position, Robotic Mowers could ensure to keep his knowledge within the group and subsequently avoid a knowledge gap. This is in accordance with Bender and Fish's argument (2000) that data and information is easily disseminated in an organisation but knowledge per se, only exist *within* individuals and therefore one needs to reallocate people in order to transfer knowledge. The product development position was appointed an external recruitment, who has a great amount of experience in how to structure and optimise work. This change was based on the belief that structure is needed for the up-coming group increase. By coming from the external environment he can challenge and criticise current operation, without being hindered by old knowledge. One might assume that innovativeness and structure do not go hand in hand and since management claims that the there is an innovative spirit within the group, they might not have realised the need for creating control systems until recently. These systems however can *convert the knowledge possessed by the individuals in the group from short-term benefits into long-term benefits*, through storing knowledge and making it possible to turn into other forms and useable by others.

When initiating the work on using more structured documentation procedures, one should realise the importance of including the members of the team in the process. This is critical since they are the ones who know what knowledge that is relevant to codify, and what is not. Davenport and Prusak (1998) argue that *relevance in codification* is secured by deciding what the purpose of it is, including different input sources, assure its suitability to serve the purpose and finally codify and share it through appropriate channels. By incorporating all the group members' views into how the documentation routines will be conducted, in addition to creating relevance, generate a feeling of empowerment and involvement, which contributes to the desire of the group members to follow the new routines.

When it comes to the *mapping of knowledge*, the group's individuals are the ones to be mapped since they are the sources of knowledge. They represent different and specialised knowledge functions which are represented in the organisational chart. In this, each person's area of expertise is specified and also what relations different group members have to one another. This is however, only a superficial map on where to find shallow person-specific knowledge in the group and does not contribute much to Robotic Mowers' knowledge creation since the group is small and group members know where to find person specific knowledge (Davenport & Prusak, 1998). Seeing as the group is continuously growing, a more thorough description of what knowledge each position requires may however, be considered in order to know where to find highly specific knowledge. Albino et al (1998) argues for the importance of transferring knowledge in order for the organisation to remain competitive and by having a map on where to find specific pieces of knowledge, sharing can be encouraged. Further, it can contribute to that old, as well as new, members to a greater extent turn to more knowledgeable members and thereby increase their individual learning.

A competence description can also be used as SAAB uses the so called 'competence portal'. This is mostly for the personal use in order to keep track of what knowledge is possessed, but also for helping the human resource department when new employees are recruited. The stated competencies serve as a description on what is required to know in order to fill a specific position. Litium also documents competencies but whereas SAAB mostly focus on pure education, Litium documents what kind of projects co-workers have been involved in. This facilitates and saves time in allocating members to new projects since one can easily construct a balanced mix between experienced and inexperienced members as well as different competence areas. At Robotic Mowers however, any competence description is seen with scepticism. Davenport and Prusak (1998) argue that much effort needs to be put into *capturing complexity* when documentation is done, which the group to some extent agrees to. They argue that if competence descriptions should be made, they need to be either infinitely detailed, or vague enough to not really mean anything. When documenting responsibilities like these, the negative aspects may be larger than the positive ones for Robotic Mowers since they have to nurture their innovative capability.

Values and norms

Values and norms are likely to be affected by codification of knowledge. Davenport and Prusak (1998) argue for the positive impact that *collective owning* of knowledge has on the group. It further affects the group-specific culture through the members' attitudes towards each other and their perception of the group. This collective owning can be achieved through using systems to document and spread knowledge. In Robotic Mowers, the culture is stated to be open and people like to share with one another. It has been put forward that due to pride in one's individual work as well as in the group-work, sharing is enhanced. This however is contradicted by not making full use of systems and routines such as the Change Request programme, which is a sharing mechanism. Much emphasis is however put on the informal manner in which one spreads and shares knowledge, which makes the importance of codification lessened since in Robotic Mowers knowledge is shared without explicitly documenting it. The *informal sharing of tacit knowledge* only provides benefits in the short run since it is only the directly involved people that gain from it and therefore access to it is restricted to others (Davenport & Prusak, 1998). Further, it needs to be considered that *small changes can quickly change the group's sharing culture*. If for example the group looses some members abruptly and needs to replace them with new people, then it will be difficult

to maintain the same balanced culture. Also, the group is currently growing and one can question if there is enough time to make them a part of the culture and share the same world-view.

Finally, it is extremely important to think about what actions that is taken today since it has a huge impact on future work. Due to path-dependency and the individual's bounded rationality, that can provide obstacles, one needs to constantly think of what effects today's action have on the future (Leonard-Barton, 1992; Davenport & Prusak, 1998). This is what Robotic Mowers' are doing right now, which is expressed in the intent to create more structure around its work.

5.2 Combination

The combination mode is when explicit knowledge is turned into new explicit knowledge. It is often done through new external inputs or new combinations of explicit knowledge that already exists within the organisation.

Skills and knowledge base

Over the years, knowledge has been used in the different product generations. These products are a in a sense a symbol of the knowledge that has turned explicit and is put into the product (Nonaka, 2007). Also, the knowledge has become embedded in the product, as argued by Davenport and Prusak (1998) and it has become the ultimate concretisation of the group's knowledge, that is, *knowledge has turned fully explicit*. By investigating the mower, group members learn visible features, e.g. how it is constructed, and from one generation to another the explicit knowledge has been re-used and applied again, only in different formats. In similar manner and if looking from a group-perspective, *individuals are in a way overt and explicit pieces of knowledge* or symbols of it, e.g. job titles explicitly communicate what knowledge people possess, which provides a basis for Robotic Mowers to easily create new explicit combinations of knowledge.

The skill and knowledge base at Robotic Mowers has recently been altered through hiring new employees possessing different sets of competencies to what the group already had. This has created a new knowledge combination of the group. The priorities given to strengthen some areas and leave others unchanged is dependent on what direction product development will take on, in the future. Slater and Narver (1995) discuss the positive implications that varying perspectives and different experiences have on knowledge creation and consequently, it is crucial that people with different backgrounds are brought into Robotic Mowers. If the new members are only found within the networks of the manager that is recruiting, which is how it has been done today, it might be the case that the recruited person has similar explicit knowledge base to what already exists in the group. Therefore, contributions of varying explicit combinations are lost, which according to Huber (1991) limits the behaviour of the group. This is furthered by the fact that the group is relatively small, hence one person constitutes a large portion of the overall composition and can therefore also represent a large possible loss.

Further, it has been argued that the individual is the source of knowledge and Drucker (2003), put this importance in relation to its responsibilities through stating that;

> '*Knowledge is always embodied in a person; applied by a person; taught and passed on by a person; used or misused by a person.'* (Drucker 2003. p. 287)

Seeing as a great amount of responsibility of how knowledge is treated in organisations, is placed on individuals it is crucial to incorporate appropriate people into the group, which in Robotic Mowers' case has been to employ people whose knowledge and skills are already known by some people in the group, i.e. through personal networks. New explicit knowledge is however not only incorporated through new employees but also through dedication of resources for specific developmental aims, that is consultants. Whereas the resource consultants may not contribute to the explicit knowledge base more than any other group member, the expert consultants do. The explicit knowledge contributions they provide are mostly depending on the expert consultants that conduct specific tasks and then report back to the group. *This ability to capture, store and distribute explicit knowledge makes it relatively easy to secure the consultant's contribution and tying it to the group.*

Cohen and Levinthal (1990) argue for the importance of looking outside the organisation to acquire knowledge. This is partly done when Robotic Mowers recruits people, upon doing this however, the external contributions and connections this person has become less and less important as they become more acclimatised into the group. There is however other parties that the group extracts overt information from and that remains in the external environment, e.g. suppliers, customers and retailers. When it comes to generating knowledge from sources further down in the value chain, e.g. from retailers, Robotic Mowers' actions support Nonaka's (2007) redundancy view and provide *valuable insights and feedback through a set of parallel channels* such as; visits, direct contact and the hot line. The explicit information gathered is then organised and combined into new explicit forms. The activities further fulfil similar needs in the information they provide, which also *ensures relevance that is further enhanced by identifying key knowledge carriers* within the retail network that has been created over time (Bierly et al. 2000).

Further, when combining different sources of explicit knowledge, stories play a major role at Robotic Mowers. Information and old knowledge appears to be embedded in communicated stories;

> *'History plays a large role, the largest mistakes is known by everyone and are incorporated into stories. Much of the problems that we had in the beginning can occur again in new projects if we do not think twice.'* (J. Bergström, personal communication, 2008-05-08)

This shows that old explicit *knowledge survives through stories and that it can be put into new explicit contexts* (Nonaka, 2007; Davenport & Prusak, 1998). Story-telling as such, and knowledge generated from it, is enhanced by still having one of the initial two group members within the group. This person is a source of historical knowledge but, due to the rapid evolvement of competencies it may also represent inertia, which hinders Robotic Mowers in their knowledge creation process, elaborated on by Leonard-Barton (1992).

Technical systems

When it comes to using technical systems for turning explicit knowledge into new explicit knowledge at Robotic Mowers the routines are rather basic, reports are combining different sets of knowledge into new sets which will convey new meanings. Diverging perspectives and differing knowledge sets, that are brought together in order to create a more valuable meaning is argued for by both Slater and Narver (1995) and Bender and Fish (2000), and is prevalent in Robotic Mowers' grouping of reports where new combinations are created. Here, *significance is given to knowledge through structured* documentation and the analysis

and descriptions in them. A larger number of people can benefit and learn from reports, than from unprocessed and unstructured knowledge that is not combined. Further, status is important as argued by Leonard-Barton (1992) this is highly prevalent in technical systems. When Change Requests are extracted from databases in order to be discussed during evaluations meetings, they are given priorities and hence they take on new meanings to people which will affect their work.

Davenport and Prusak (1998) argue that co-ordination and grouping of knowledge is inevitably a part of any codification effort in turning explicit knowledge into new explicit forms. In Robotic Mowers' technical systems this co-ordination of input e.g. how data and information are grouped together in reports, impacts how a person that retrieves information perceives it. Nonaka (2007) argues for the importance of symbolism in order to perceive and absorb information, consequently turning it into knowledge. This grouping of explicit knowledge is in a sense *symbolic* since it conveys meaning through how pieces of information are related to other information. This affects the perception that the group member retrieving the information will have. Therefore *it is essential for Robotic Mowers to codify and group knowledge inputs in ways that convey importance.*

The newly constructed virtual test world is to be utilised in parallel to real-world tests, resulting in two different data flows into the technical systems, two different reports and consequently two different explicit knowledge sets. Nonaka (2007) pushes for the benefits in knowledge creation through having redundant procedures, much like these test-routines that to some extent will overlap in order to create valuable knowledge. The two tests are conducted in parallel with the pure intention to create credibility to the result. The real-world tests are used to observe superficial characteristics such as weather conditions whereas the virtual world provides time efficiency and hence a more thorough examination, creating deeper data. The two data flows are combined and to create richer knowledge.

Robotic Mowers' development work is highly reliant on proposed changes, however the Change Request program is not used to its full potential. Firstly, this is due to inadequate explicit input from group members. Ideas are kept on personal computers and only a part of all change ideas are put into the actual programme, i.e. there are gaps in the explicit input data. Secondly, the change requests are not scrutinised and worked through on the regular basis that they are supposed to. This is due to *lack of time* and that *focus seems to be put on the short-term* situation rather than the long-term. This irregular routine and short-term focus can have consequences on the organisational memory that Huber (1991) argues for as a basis for future learning and consequently on future operations. One may question what happens when new people enter the group and most of the new ideas are not overtly made available to them. This is something that all group members should consider since the group has expanded lately and one believes that it will continue to grow, hence long-term focus in knowledge communication is especially important and technical systems is a major vehicle for this. By contradicting this view, Leonard-Barton (1992) argues that although an organisational memory can provide a foundation to build extended knowledge upon, it is relevant to consider what knowledge one does not need any longer, i.e. to unlearn knowledge in order to overcome rigidity, essential in such a changeable context that Robotic Mowers operates in. As competitive forces increase, competencies need to develop quickly and therefore internal systems also need to be up-dated in order to provide support. One might assume that Robotic Mower either ensures updated systems or allows for some explicit knowledge to be kept outside of the system in order to avoid rigidities.

Managerial systems

When it comes to turning explicit knowledge into new explicit knowledge, managerial systems and the group's formal control are not obvious in the group setting, much due to the open attitude of the group and lack of formal levels. There is however a few managerial routines that represent the formal structure argued by Brockman and Morgan (2003) to promote support to knowledge creation. These come forward through the handling of information extraction. When engaging in information collection that is dependent on networks, such as when information on wanted improvements, new features and their respective ratings, are gathered from retailers, the information is handled by the management level. Only when they have organised and processed it, is it distributed to group members. This represents the control of the development direction; suggestions originate from the retailers but are *shaped, structured and controlled by the management level* that combines them into a list that is then to be executed by the co-workers. There is a clear chain of command and it stresses the importance of having some *structured processes in order to fully benefit from explicit knowledge*.

Values and norms

The most pronounced effect on values and norms in knowledge creation through explicit to explicit combinations is the effect new group members have. One can question whether they have a strengthening or weakening effect. One point that should be emphasised is that if many new members are brought into the group during a short period of time, there might be a risk that the culture of the group is changed or weakened. Both explicit and tacit knowledge creation have traditionally been controlled through culture. If the culture is weakened, dealing with explicit knowledge is affected since new members will have their *own preferences of how to engage in explicit knowledge work*. Therefore, if the group need to keep their old routines or intentionally create new ones, they need to overtly communicate this and not rely on control through culture and informal working manners.

5.3 Internalisation

In the internalisation mode, explicit knowledge is turned into tacit knowledge. Although not all knowledge creation activities conducted at Robotic Mowers lead to explicit knowledge, they do however *always* contribute to new tacit knowledge. When looking to the group's external knowledge sources and activities, the ones perceived most important are; suppliers/consultants, retailers, other markets, partner projects, benchmarking and recruitments. Further, the internal sources of knowledge creation are, in order of importance; tests, general meetings, specific meetings and informal talk.

Skills and knowledge base

When increasing the skill and knowledge base in a situation of turning explicit knowledge into tacit knowledge, it is a rather practice-oriented approach in Robotic Mowers. Their actions follow Sinkula's (1994) argument for *learning from direct experiences* in addition to Backler's (1995) reasoning, that knowledge is created in a dialogue with others. Robotic Mowers absorbs tacit knowledge from each and every concrete activity they perform but also through keeping a constant dialogue with key individuals, both of which are stemming from internal as well as external sources. Webster (1992) stresses the strategic importance of who one is working with. This is also something Robotic Mowers stress when key individuals are located in networks of retailers and suppliers, and partnerships with direct com-

petitors are conducted in order for the product development to benefit. Consequently, they absorb tacit knowledge from a variety of sources and contexts

Seeing as the individuals are the knowledge-carriers in the organisation, attention should be given to their specific individual knowledge. If the individual's knowledge is increased, so is the organisation's. In order to enhance the individual's knowledge base, there is a need for the group to internalise explicit knowledge from both external and internal sources and thereby enhance people's tacit knowledge. As was the case when strengthening individual's explicit knowledge, the *tacit knowledge has implications on individuals own ability to keep learning* and see more opportunities, as argued by Davenport and Prusak (1998). They state that individuals are bounded by rationality, however, if that rationality is expanded then more knowledge can be accumulated. Hence, Robotic Mowers' group members are all part of a learning spiral, meaning that if they learn more they will know more, and if they know more they have the ability to learn more. One can assume that one of the most efficient ways to enhance group member's ability to know more, is through internalising explicit knowledge into tacit, e.g. through education. What one knows and what one can learn are mutually dependent. Therefore, limits posed by individuals, affect the organisation's accumulated knowledge base and therefore, at SAAB one has realised the need to make individual learning possible. This has resulted in that they have appointed one person within the group to be responsible for making knowledge creation possible for others. This does not mean that this person is responsible for holding courses or similar activities, but rather to identify a knowledge need and to make group members fill it. This is supposed to ensure that the individual's knowledge is up to date and that the individuals may expand their capacity to learn. A similar approach to identifying knowledge needs and pushing group members to fill them might be valuable for Robotic Mowers. Also, the group should consider where the responsibility for increasing the competence base lies, on management or on the individual, since responsibility is not assigned anyone today. In similar manner as to SAAB, it might be appropriate to assign this responsibility to the individual since today, it is presumed to be their responsibility but, it is not specifically stated.

Technical systems

When it comes to turning explicit knowledge into tacit, technical systems do not play a major role in Robotic Mowers, *the lack of it does however*. This lack is most pronounced when it comes to test data that is not processed further, i.e. it remains in the form of raw data and is not turned into information or knowledge. Sinkula (1994) argues for learning through explorative actions and for Robotic Mowers, explorative actions, such as tests, are a significant part of the development process and are a direct source of experience and tacit knowledge. However, Robotic Mowers does not turn all test results into reports, *hence tacit knowledge can not be gained by people that was not present at the testing,* which could have been done if the systems were in place.

Bierly et al. (2000) stress that knowledge needs to be relevant and suitable for its purpose. When combining this view with Drucker's (2003) point that the individual carries much responsibility in knowledge creation, it is a logical step to assume that it is up to the individual to make judgements on relevance and what knowledge to put into technical systems, in order to create a state of organisational learning. This makes Robotic Mower's knowledge creation highly subjective since, what knowledge that is perceived as relevant or not, is up to the group member. Individual's further look for data in technical systems with a specific purpose in mind and therefore other data that is not directly connected to this purpose is neglected. This means that possible knowledge absorption from peripheral issues is

not done, hence knowledge creation is restricted even further (Davenport & Prusak, 1998; Bierly et el., 2000). Hence, since the individual in the knowledge transfer *mechanism when it comes to tacit knowledge, it is highly restricted by individual's preferences.*

Managerial system

The informal managerial structure at Robotic Mowers has effects on its tacit knowledge creation. This agrees with Burns (2005), who argues for *valuing informal relationships above formal structures* when creating a knowledge supportive environment. Informal and unstructured communication is one of the most important ways of spreading and creating tacit knowledge within the group. This is highly individual and relationship based, also it has been stated that the culture in Robotic Mowers enhances the way and the amount of tacit knowledge that is transferred among each other. People are communicating knowledge openly to one another, also when crossing hierarchical levels, and tacit knowledge is absorbed from everyone. Receiving and absorbing tacit knowledge therefore does not seem to be an issue. This however, contradicts Cohen and Levinthal's (1990) opinion on the importance of having established routines to capture as much knowledge, tacit and explicit, as possible. For Robotic Mowers, the informal management could possible make the retrieving and creation of new knowledge irregular and consequently result in an unfocused and fragmented knowledge path. However, the currently small size of the group as well as the strong relations within it offsets this, although this may only be a short-term solution.

By not having satisfactory routines on how to capture explicit knowledge, and the fact that the ones they do have, are not followed, can be seen as a strategic approach. This might be a strategic choice by management since it *forces the members of the group to communicate* their knowledge with each other. This is beneficial since it is not possible to conduct one's own work without the input from others, and through communication people can internalise other's knowledge.

The way the group is run and controlled is done in a highly informal manner. The management level and the co-workers work together, side by side, in everyday work. The climate is highly informal, which affects how people behave towards each other and treat their respective knowledge, meaning that no distinction is made between the explicit knowledge that is communicated from management level and that which originates from co-workers. Therefore, absorption of knowledge from these two levels carries the same importance at Robotic Mowers. This however can convey problem since, as argued by Nonaka (2007), management is in possession of different information than lower organisational levels and, as Davenport and Prusak (1998) argue, information is absorbed differently depending on the status of the giver; the higher the status of the giver, the more likely it is for the recipient to view it as valuable. *Hence, if information is not treated with the respect of the management level then some important tacit knowledge creation may be overlooked.*

Values and normes

The physical conditions, that is, that the group is situated geographically separated from other employees at Husqvarna and that they have common rooms where they meet at least twice a day, have provided the opportunity for the group to keep and nurture a sharing culture, which enhances the absorption and understanding of others group member's knowledge.

The informal knowledge structure and the weak control of it, creates a feeling of empowerment which serves as a *motivation* for group members to extend their knowledge base (Leonard-Barton, 1992). Further, education as such can be used as a means of motivation, which was observed at Litium. The desire to be knowledgeable and to be around others with the same desire, which seems to be the case in Robotic Mowers, result in a sharing environment where members *learn from each other's knowledge*. However, the organisation around the group does not provide structured support for learning, which Nonaka and Takeuchi (1995) state is essential for acquiring new knowledge. One can assume that the management of Robotic Mowers have not yet realised the importance of individual's learning for the outcome of the group. SAAB on the other hand, has discovered this and therefore they invest heavily in educating their employees. Although SAAB's employees are expected to carry the responsibility for their own competence building, they are also pushed through formal and structured directives to actively act in this way. This is contrasted to Robotic Mowers where the employees are neither formally or informally encouraged to further educate themselves. They are however not discouraged either.
In the long-run it can be assumed that the group would need to adopt a more structured approach to knowledge creation through education. Also, to build a more supportive structure by the use of a common formal vision on competence building. However, the culture is expressed to be 'curious' and the members of the group are eager to both share and receive information. Therefore, it can be assumed that these characteristics of the core *values in the group currently compensate for the weak support from structure*.

5.4 Socialisation

In the socialisation mode, tacit knowledge is turned into new tacit knowledge. Tacit knowledge can not be documented and therefore there is a need to be physically present in order to learn from other persons' tacit knowledge. Also, it is abstract, subjective, action-based and difficult to realise, therefore it is also difficult to share and communicate. Due to the inability to communicate it, a large part of the analysis can only be based on what the group member's state, which is that much knowledge is indeed tacit and that it remains that way.

Skills and knowledge base

The group state that much of their knowledge is kept within individuals without explicitly communicating them, which implies that there is a great tacit knowledge base. The fact it has not been communicated signifies that the group do not see the long-term benefits of doing that. Bender and Fish (2000) argue that in order to transfer tacit knowledge, the employees themselves must be transferred and socialised with new people. At Robotic Mowers however, this is not feasible due to the *specialised job requirements which subsequently limits tacit sharing*. Nonaka's (2007) redundancy-principle on the other hand is in accordance to Robotic Mowers' present procedures to ensure the spread of tacit knowledge since they always have at least two persons working with the same activities. Due to different experiences and different perceptions their tacit knowledge is consciously, and unconsciously, shared. Consequently, their overlapping knowledge base that, to a large extent, is tacit is increased by working closely together in order to learn from each other. In addition it creates a shared interpretation that is crucial for effective organisational learning (Huber, 1991; Day 1994; Sinkula 1994). This socialisation is however restricted to the two individual's knowledge and not extended to incorporate other group member's knowledge. The group-wide sharing is done through working together in projects and the *interdependency between competence areas that forces individuals to communicate and to co-operate, hence also sharing tacit knowledge*.

Technical systems

When it comes to a discussion on *technical systems* in this tacit to tacit conversion mode, any application is pointless in the case of Robotic Mowers. Robotic Mowers do not in any way encourage tacit to tacit knowledge creation activities, e.g. rotation of people, *based on technical intents*.

Managerial systems

When it comes to managerial systems however, there are ways to encourage and promote socialisation so that the full benefits can be experienced from the tacit knowledge. Slater and Narver (1995) argue for varying perspectives, meaning that in order for the creation of knowledge to be optimised, the managers need to ensure that individuals with both external and internal perspectives are combined. Cohen and Levinthal (1990) agree on the importance of using external sources to gain innovative organisational abilities. Since Robotic Mowers perceive themselves as highly innovative, it is important that they do not overestimate their internal ability to remain that way and thereby neglect the importance of receiving external input. It can be assumed that it is difficult to remain innovative if only using internal capabilities. *Socialisation with external parties should not be underestimated.* To avoid a plateau where opinions reach a consensus and new learning is not easy to come over, the group uses external inputs through mechanisms such as consultants and networks. In the latter, individuals are located that they keep a constant dialogue with. Consultants however, are rather special since they actually enter the group, and therefore they can exit the group with knowledge that is vital for the group to keep. Therefore, these are used for areas that are not directly connected to their core competencies since by letting tacit knowledge on this escape the organisation is risky (Prahalad & Hamel, 1990). It has been argued by Davenport and Prusak (1998) that external arenas for knowledge communication, such as fairs, provide an open and unconditional setting where tacit knowledge can be extracted and new views can be gained. Today, however, external communication arenas like these are valued low by the group.

Culture, rather that structure, has been the mechanism on how to control knowledge creation but when new employees enter the group, the lack of structured knowledge work becomes evident since they are not familiar with the culture. The lack of documentation of job duties and responsibly areas contributes to the necessity of *learning job requirements through tacit sharing*. At Robotic Mowers they solve this by letting the new employee work side by side with an already socialised group member for a period of time. However, it has been stated that the learning period is often short and intense, which may lead to insufficient transfer of tacit knowledge. Hence, valuable knowledge disappears from the group which according to Leonard and Barton (1992) is difficult to regain and that creates a knowledge gap. To minimise this *tacit gap of knowledge*, management needs to establish routines for internal and personal education and that builds on co-operation with already socialised group members. Another way to minimise the problem with the knowledge gap when a person leaves the group is that another, preferably the other person within the same competence area step in as a mentor and bridges the knowledge gap.

In addition, management can encourage socialisation by *creating more time and place for interactions within the group*, which Davenport and Prusak (1998) argue is important for fusion of different pieces of tacit knowledge and thereby new knowledge combinations are created. This can take on an informal and unstructured set of actions such as activities outside the

office i.e. by allowing people to spend time together, a common foundation can be created in the group and knowledge sharing occurs unconsciously. Although indirect, this can also work as an incentive to share.

Values and norms

The values and norms are aligned with the group's culture and are rooted in the common language and frame of reference that have been shaped. Slater and Narver (1995) argue that to enhance the knowledge learning and sharing, there is a need for an open and organic structure. Moreover, Burns (2005) agrees and states that *informal relations are more important than formal*, which is highly prevalent at Robotic Mowers. Whether the sharing is successful or not depends on the openness of the group and the trusting relationships that individuals are able to form (Nonaka 2007; Davenport & Prusak, 1998). One may assume that in Robotic Mowers they have been able to create supporting relationships since informal relationships are perceived to be important. Further, a shared interpretation can be enhanced by a sense of belongingness and a common feeling that everyone voluntarily collaborate without the influence by managers (Janz & Prasarnphanich, 2003). It can be understood that the sharing and open culture in Robotic Mowers originates from individuals that have become knowledgeable due to their curiosity and interest. Initially, the product was of breakthrough character and the level of uncertainty was high. Also, it was a new business venture that probably created a strong connection between the individuals since they shaped their own context and subsequently also their culture. This initial nature still influences the atmosphere in the group and when working in the same environment, the members have developed a common sense of how to behave and solve problems which is the foundation for the extended sharing attitude.

5.5 Summary of Robotic Mowers' problem areas

Figure 16 is a summary of the above discussion but it focuses on Robotic Mowers' problem areas. The conversion modes are illustrated on the vertical axis and competence areas on the horizontal axis. For each intersection, the main discussion areas are summarised into bullet points and subsequently coded into one of the following three categories;

(P) Problem, meaning that there may be a problem today, or that a problem may arise in the future.

(S) Solution, meaning that the group is working with that solution today.

(N) Need, meaning that there is a need to fix a problem and that a solution is not worked on today.

The stated problems, solutions and needs are however not always related to each other in the figure. Also, areas that have many problems or needs but not as many implemented solutions are shadowed.

Competence area / Mode of Conversion	Skills & knowledge base	Technical systems	Managerial systems	Values & norms
Externalisation *(tacit to explicit)*	(P) Inability to see sharing need due to specialisation. (P) Much knowledge kept in group members' heads. (N) Realise the need to communicate; to create more explicit knowledge & to create coordination of work.	(P) Loss of knowledge; inadequate input in systems & restricted when retrieved. (N) Make input more rich through using more people in the process. (N) Need to see L/T benefit of documentation. (S) Allow some tacit knowledge to be uncodified in order to avoid rigidity.	(P) Clash between informal work manners and the up-coming structuring. (N) Involve group members when deciding what to codify; create relevance & empowerment of individuals.	(P) Lose the collective owning of knowledge when expanding due to little explicit knowledge. (N) Increase collective owning by better input into systems; managerial & technical.
Combination *(explicit to explicit)*	(P) They hire people from personal network to ensure appropriateness but looses contributions from varying explicit knowledge. (N) Hire consultants first and make sure that there is a fit between them and the group, then make them employees. (S) Ensure relevance from explicit activities through redundant actions and identification of key individuals.	(P) Inadequate input in to systems and inadequate use of them leads to problems for new employees since knowledge is not available to them. (N) Increase routines for input to systems to create long-term benefit.	(P) Lack of routines. (S) Increase routines.	(P) More group members may inflict on the informal handling of explicit knowledge. (N) Overtly communicate how explicit knowledge is to be dealt with.
Internalisation *(explicit to tacit)*	(P) Responsibility to create is not specifically put on either management or individual (P) Individuals are subject by 'bounded rationality' (N) Make the individual responsible for its own competence building in a forma manner. (N) Create support and provide opportunities for the individual to act on this.	(P) Insufficient data input makes tacit knowledge creation restricted to people directly involved in a specific activity. (P) Tacit knowledge creation is restricted to individuals responsible for the input into the systems. (N) Make data & information necessary to put into systems in comprehensible groupings.	(P) Weak managerial systems lead to fragmented tacit knowledge (P) Short-tem view. (P) No differentiation in who communicates knowledge; management or co-worker. (S) Informal relations and culture ensures that knowledge is turned into tacit forms (S) Informal managerial control pushes individuals to communicate.	(S) Culture compensate for structure (S) Allow much tacit knowledge since it pushes for increased communication and co-operation, which create a united culture. Also, individuals feel empowered and responsible when possessing tacit knowledge.
Socialisation *(tacit to tacit)*	(P) A large tacit knowledge base. The need to go further in the process and turn this into explicit forms, is not realised. (P) Limited tacit sharing due to specialisation. (S) Co-operative working manners, overlapping and mutually dependent.	*Not applicable*	(P) Inadequate managerial control leads to insufficient time to transfer tacit knowledge from old to new employee. This creates a knowledge gap. (S) Create routines building on co-operation and overlapping activities. (S) Create time and place for socialisation to occur, externally & internally.	(N) Encourage informal relationships, common langue and strengthen a common frame of reference.

Figure16 shows the intersections of conversion modes and competence areas. For each intersection, perspectives on problems, solutions and needs are put forward. The intersections that represent particular problematic areas are shadowed and as one can observe, the majority of them are within the *externalization* and *socialization* modes (horizontally), as well as within the *skills & knowledge base* (vertically).

As can be seen, it is plausible that the *externalization* mode experiences great knowledge losses simply because, in general, little externalization is done for each and every competence area. Overall, the problem seems to lie in the *inability to see future benefits* from making tacit knowledge into explicit knowledge. In the knowledge and skill base, this is seen through having a perceived large tacit knowledge base, the lack of co-ordination of highly specialized individuals, hence they do not realize that they need to communicate the knowledge they possess. Also, in the use of technical and managerial systems there is an obvious lack in the knowledge creation mode. In technical systems, both input and output are inadequate. In the managerial systems there is mostly a future problem in that they seem to lose focus of the individual when structuring. The group's work is further highly dependent upon culture and therefore a major problem is that if knowledge is not communicated, the collective owning will affect the culture. It seems like group members have become content with having a large tacit knowledge base since they believe that they can access the knowledge they need through their informal working procedures and unstructured communication. This stage seems to be a content one, where little effort is made in order to change and therefore streams of knowledge creation processes are hindered here and they do not have the chance to continue to the next stage in the creation process. This may be acceptable when the group is stable, but it should be questioned when the group is growing.

Socialization is the mode that precedes the externalization and therefore, the problems in these may be connected. In this mode, the problems within the skills and knowledge base, is represented by *letting tacit knowledge remain tacit*. The need to go further in the process, into the externalisation stage, is not realised. Sharing as such, is further limited by having a high degree of specialisation. Within managerial systems, there is again a danger when new group members enter the group since there is not enough time to transfer the tacit knowledge to new employees. Finally, in the values and norms perspective, an increasing group size can pose problems since work today relies much on culture. However, as the group becomes more formal and mature the culture may be weakened. Hence one needs to actively encourage informal relationships, common language and frames of references, which is normally done by the culture.

Within the *skills and knowledge base,* most issues are already discussed in terms of the modes above. There is however some problems in its intersection with *internalisation,* where responsibility is a major issue due to the fact that the management has not specifically put responsibility on the group members, nor have they taken on the responsibility themselves. In effect, this hinders the individual's development and enhances their 'bounded rationality', subsequently it may affect the organisational knowledge base.

6 Concluding remarks and suggestions

Great is the art of beginning,
but greater is the art of ending.
H. W. Longfellow

The following section presents the main points from the previous analytic discussion and fulfils the research purpose. Also, implications in term of theory, method and management are stated.

The purpose of this study was to examine how knowledge is created how that process is managed in an environment characterised by progress and innovation, to identify the most problematic areas in these processes and suggest improvements. Below, this study's research questions are answered, the research question concerning improvements is however presented in the managerial implication section.

At Robotic Mowers, knowledge is created from different sources, the most crucial internal source is tests, whereas the most crucial external source is consultant/supplier. For each knowledge-creating activity, the individual is at the heart of it, thereby making the individual it's the creator. The group's knowledge creation is dependent on informal and unstructured interaction among group members and to external parties, making the explicit knowledge creation possible through communication and tacit knowledge creation possible through relations and overlapping activities.

Management has left most knowledge creation uncontrolled and therefore it is weakly managed without proper routines and formal encouragement. The explicit knowledge, is managed and supported through creating time and place for communication. The tacit knowledge on the other hand is left largely unmanaged and support is provided mainly through making use of parallel activities. Further, by being an innovative unit, tacit knowledge has intentionally been left unmanaged in order for the knowledge not to loose creative aspects. Overall, low managerial control is exercised, whereby the group has developed a strong culture that enhances the informal way of how the knowledge is treated, subsequently lowering the necessity of a formal knowledge structure. This unbalanced culture-structure relationship works well due to the small size of the group and close relationships between the members.

The main distinguished problem in the knowledge creation process is that the *group fails to realise the need for a long-term perspective*, which is revealed through inadequate efforts in trying to turn tacit knowledge into explicit knowledge. The need to establish routines and procedures for knowledge creation is neglected, or simply not realised, which is due to a perceived scarcity of time. Hence, knowledge access is restricted, which hinders the knowledge creation since group members cannot benefit from other members' knowledge, therefore the overall organisational learning suffers. Also, the knowledge that is shared is irregular and since it is not controlled by management, there is no continuity. Consequently, there is a discrepancy between the existing knowledge level and the potential level. Hence, failing to convert tacit knowledge into explicit forms hinders the knowledge creation.

Further there is a conflict in *who carries the responsibility of acquiring knowledge*, since it is not articulated by the management. This results in management placing the responsibility on the individuals without them being aware of it. Group members however, assume that management is the responsible party. The fact that the responsibility is not assigned either individuals or management, implies that leaning is hindered and that the group is not reaching its full knowledge potential.

Finally, another conflict lies in the *relationship between culture and structure*. This problem will be revealed when the group grows since the need to implement more structure will probably be inhibited by the management's strongly rooted reliance on culture. Hence, the structure needs to be given more space and reliance on and culture needs to be decreased. However, when increasing knowledge structure it is important not to loose focus on the individual since the group members are deeply rooted in its culture, therefore the balance between structure and culture needs to be adjusted in a delicate manner.

6.1 Implications

When conducting an in-depth study, there are a number of implications to consider. Upon founding the research on a theoretical basis, it is clear that the research outcome has implications of this sort. Another foundation of the research is the way it is carried out, methodologically. The manners, in which the study has been executed infers on the result and therefore it is imperative to discuss. Finally, the research has resulted in tangible outcomes for the management of Robotic Mowers, which are presented as managerial implications where suggestions for improvements in key areas are made. The three types of implications, theoretical, methodological and managerial, are discussed below.

6.1.1 Theoretical implications

Knowledge creation is a theoretical area that is given ever more attention, stressing the increasing importance of managing knowledge in appropriate manners. Therefore the theoretical discussion is to a large extent founded on recent research. Knowledge creation needs to be put in a management context through organising and sharing it. Also, the need to secure and support knowledge through culture and structure is stressed. These may be opposing forces or be aligned, and they may convey support or inertia, this is however the main area where theories diverge. At Robotic Mowers, this structure-culture issue is something that has been given more attention lately. Even though there are diverging theoretical opinions within knowledge creation, there is a clear reliance on individuals. The situation of Robotic Mowers' knowledge creation strengthens most of the theoretical set outs, but more importantly, there are a few areas where misalignments have been observed.

The theories considered in this study dealt with knowledge creation within organisations. Although Robotic Mowers reside within an organisation, they to some extent see themselves as separated from it, which may conflict with the theoretical stance. However, most theories put the individual at the heart of knowledge creation, which implies that an individual-perspective is already taken and therefore they are applicable to the case of Robotic Mowers. Further, knowledge creation as a concept is theoretically positioned in a managerial context. When it comes to Robotic Mowers however, it is interesting to point out that the knowledge acquirement is unstructured and its responsibility unassigned, which implies that knowledge creation is only to a small extent managed. Instead it is founded on informal relations and communication.

6.1.2 Methodological implications

When looking back at the process it is easy to question whether or not the right research decisions were taken. However the methodological choices have provided for the fulfilment of this study's purpose. Overall, time is the major constraint. Considering the complex nature of knowledge it might have been beneficial to conduct follow-up interviews with the respondents in order to get even richer answers. However, the interviews were conducted with all middle-managers, who provided valuable answers due to the use of mostly qualitative, but also to small extent quantitative measures. Although the research has a management perspective, it was valuable to include views from both managers and co-workers. However, this perspective could have been enhanced by firstly conducting a quantitative pre-study on the co-workers, which could have served as discussion material when interviewing the managers. In addition, although adjustments of questions were made and follow-up questions were asked, one potential constraint that might still affect the research outcome is that the respondents and interviewers do not have the same frame of reference, therefore the communication between the two parties may have been restricted. A major strength of this study is the fact that knowledge creation has also been examined at SAAB and Litium, which has provided substance to the managerial implications. Considering that their contributions are applied in similar contexts it is likely that they will be useful for Robotic Mowers.

Finally, Robotic Mowers proved to be interesting when it comes to knowledge creation due to their ongoing knowledge efforts. One suggestion for further research is to make a longitudinal study and examine the process before and after an increased structure has been implemented. Another suggestion is that the knowledge creation of the entire organisation of Husqvarna could be examined and compared to that of the Robotic Mowers. This could be interesting in order to see if this small and innovative unit can contribute with input to the large industrial organisation.

6.1.3 Managerial implications

It is imperative to keep competences within the group and since much of the knowledge is individual, importance lies on keeping the members. The following actions can contribute to locking members to the group and to develop them.

Firstly, the group members should to be encouraged to increase their skills and competencies through education. Management needs to reflect a positive attitude towards education and it should be highly valued on employee evaluations and salary negotiations to have attended courses. To further enhance that it is crucial to keep the members knowledge base up to date, incentives can be used as a form of motivation. Another way to communicate the importance of education is to include it in the group policy. By doing this, it will be stated in a clear formal way that the responsibility of increasing the members competencies lies on themselves.

Further, a mentorship program for new employees should be initiated. Firstly, if a member leaves the group, this member needs to act as a mentor for a new employee during a long period of time before it leaves. Secondly, even if no one exists the group a mentor should be assigned to the new employee. This is an effective way to transfer the knowledge since the knowledge is kept within the individuals and shared through the strong informal culture as well as also to acclimatise the new members into the group culture.

Also, despite the fact that the main knowledge responsibility is placed on the members it would be beneficial to assign one particular person the responsibility for making knowledge creation possible in the group, for example through identifying knowledge needs and search for relevant ways to fill it. This will create a continuity and control over the knowledge creation and people will feel encouraged to educate themselves. In addition, when the group members have been involved in learning experiences, this particular person should be given a time and place to, informally, share what has been learnt. This provides a convenient opportunity to increase the overall organisational learning.

In addition, sessions should be arranged where all the group members are gathered and encouraged to express their experiences and opinion from a certain project. These are subsequently documented and is carried out in order create richer learning experiences that can be used for future projects.

Further, a knowledge plan on what future competencies the group needs can be developed. Since this is a long-term plan it will assist in the recruitment planning to avoid the extensive use of consultants and to estimate what knowledge that needs to be developed in accordance with the direction the product is taking. This plan should further be connected to a competence portal placed on the intranet, where the members of the group document their past experience, possessed competencies, courses taken and projects involved in. This portal would serve two purposes; 1) to facilitate for the group members as they can both follow their own learning history and see who to ask in specific issues by looking at the others' competence profiles 2) it can be used as a tool when making the knowledge plan since the management gets an overview of what knowledge that already exists in the group.

Finally, consultants should be used for specific purposes. It is an effective way to examine if the group is influenced by old knowledge or not, and also to gain expertise within a certain field. The consultants should be encouraged to share their knowledge by hosting internal education with the members in the group.

The above discussion can be summarised in the following recommendations:

1. Encourage education through giving them responsibility
2. Mentorship for new group members
3. Assign one person to be overall responsible for identifying knowledge needs
4. Create place and opportunity for sharing of knowledge after education
5. Create opportunity to gather different perspectives
6. Develop a knowledge plan
7. Create a competence portal
8. Use consultants for specific purposes

These suggestions can assist Robotic Mowers in moving towards a long-term perspective, through increasing the competencies in the group. To some extent these suggestions are based on input from SAAB and Litium.

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Appendix 1 Interview guide

Introductory interview at Robotic Mowers

Introduction

1. What is your position?
2. How many years have you had this position?

Generally about competencies

3. What are the perceived core competencies of Robotic Mowers?
4. What are Husqvarna's core competencies?

To develop knowledge; to create, learn new and spread

5. To what extent are you using/ have used the following ways of creating knowledge (Appendix 3)? The knowledge should be specific to the Automower.
6. What are the main advantages with the highest ranked activities?
7. Generally, is there a requirement to systematically document information?
8. Are responsibility areas documented in any way?
9. What are you doing to ensure that knowledge that is documented, reflects a number of views? I.e. not only the one doing the actual documentation.
10. If ideas come up that can not currently be applied on the product but might be useful in a later stage, how are these ideas stored?
11. How are you trying to keep knowledge that might only be kept within someone's head? How are you trying to document it?
12. Do you have specifications on what knowledge each job position demands? Why/why not?
13. Are responsibility areas and activities overlapping or are they strict?
14. Are responsibilities rotating to any extent? Also, does one person have the same responsibilities from one project to another, or does it change?
15. Is there any person that is responsible for creating new knowledge within the group? Or any such person at Husqvarna that you benefit from?
16. Do you feel that old knowledge have in any way hindered the development of new knowledge, or new ways of working?

Appendix 2 Interview guide

Focus case & support cases

Introduction

1. What is your position?
2. How many years have you had this position?
3. How has the group composition developed? (How many were you from the start, how many have entered and how many have left)

Generally about core competencies

4. What are the perceived core competencies of Robotic Mowers?
5. What are Husqvarna's core competencies?
6. What specific patents does Robotic Mower possess?

To develop knowledge; to create, learn new and spread

7. To what extent are you using/ have used the following ways of creating knowledge (Appendix 3)? The knowledge should be specific to the Automower.
8. What are the main advantages with the highest ranked activities?
9. What routines do Robotic Mowers have in order to encourage learning?
10. How will the results from the tests based on the virtual test world be documented and used?
11. Generally, is there a requirement to systematically document information?
12. Are individual responsibility areas documented in any way?
13. What are you doing to ensure that knowledge that is documented, reflects a number of views? I.e. not only the one doing the actual documentation.
14. How are the 'change requests' managed?
15. If ideas come up that can not currently be applied on the product but might be useful in a later stage, how are these ideas stored?
16. How are you trying to keep knowledge that might only be kept within someone's head? How are you trying to document it?
17. Looking at the knowledge creating activities that you have specified, how is this knowledge shared? What channels are used?
18. How are you working with restructuring the group at the moment?
19. How is the communication working between you and the factory in England? How can product-specific problems be solved here and communicated to them?
20. Do you have specifications on what knowledge each job position demands? Why/why not?
21. Are responsibility areas and activities overlapping or are they strict?
22. Are responsibilities rotating to any extent? Also, does one person have the same responsibilities from one project to another, or does it change?
23. Is there any person that is responsible for creating new knowledge within the group? Or any such person at Husqvarna that you benefit from?
24. How do you ensure that specific knowledge is spread? If for example tests are done that reveals something special, how is this information spread?
25. Do you feel that old knowledge have in any way hindered the development of new knowledge, or new ways of working?

(All but the following questions were asked to SAAB or Litum; 3, 6, 9, 13, 17, 18, 23)

Appendix 3 Knowledge creating activities

External knowledge creating activities	*Rate (1-5)*
Retailers	
Seminars	
Suppliers	
Literature	
Consultants	
Education	
Co-operations with universities	
Partner projects	
Aquisitions	
Externally managed courses	
Exhibitions	
Other	

Internal knowledge creating activities	*Rate (1-5)*
Tests	
Workshops	
Internally managed courses	
Other departments within Husqvarna/Litium/SAAB	
General meetings	
Specific brainstorming meetings	
Internally managed seminars	
Informal talk	
Computer systems	
Other	