How does an individual who absorbs external knowledge affect the organizational learning in an inter-organizational cooperation?

A qualitative study of Volvo Trucks knowledge acquisition in the CERC cooperation.

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Graduate School
Master Degree Project Submitted on June 7th 2020
Master of Science in Innovation and Industrial Management
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Acknowledgements

I would like to start by thanking all the people at Volvo Trucks that I had the immense pleasure to interview in order to get their view of the CERC cooperation from a company perspective. Their participation was of course vital for the thesis as it is built on their knowledgeable insights and extensive experience. So, thank you all from the bottom of my heart!

Furthermore, I would like to thank my supervisor Daniel Hemberg for very fruitful advice and utmost valuable guidance. Especially as I have not had a co-worker to bounce the issues with the concrete feedback from Daniel has been of utmost value. I also thank my opponents for valuable feedback regarding what I needed to clarify.

Gothenburg, June 7th 2020

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Abstract

Background & Purpose:

As the technology landscape of today is very complex there are many technological fields that cannot be covered by one single company. Instead joint cooperation's between different stakeholders is needed to solve the complex technological challenges facing us. One type of joint cooperation that is aiming at building up technological knowledge is governmental or EU subsidized cooperation's between the university and the industry.

The Combustion Engine Research Center (CERC) is one of these cooperation's and it is a cooperation between Chalmers University of Technology and three Swedish automotive companies, namely Volvo Car Cooperation, Scania and Volvo Trucks. As this research is pursued as a master thesis the time frame is limited and therefore the author chose to only include Volvo Trucks in the study.

The purpose of this research has been to gain a deeper understanding regarding how a cooperation between the industry and the university can strengthen knowledge build-up and foster innovation in the technological field. This has been done through a qualitative study where employees at Volvo Trucks has been interviewed in a semi-structured way.

Methodology

As there were not any prior literature in this specific case the author chose a qualitative study approach. The study is built on semi-structured interviews and the interviewees were chosen by purposive sampling. Originally eleven interviews were scheduled but due to the Corona virus close down of Volvo Trucks it was not possible to perform them all. Instead the nine semi-structured interviews that were conducted before the close-down is used as base for this master thesis and according to Bell, Bryman & Hartley (2019) this is sufficient in order to perform a qualitative study. A literature review was performed in a systematic manner. The analysis work was performed as a thematic analysis with constant iteration between empirical data and theory.

Empirical findings & Conclusions

The empirical findings and data analyses found three different ways that the individual position of an individual that absorbs external knowledge is affecting the internal learning of an organisation. Those three were:

Hierarchical position, organisational position and physical position. The hierarchical position affects the information that is absorbed and thereby the internal learning, the organisation position affects how the knowledge is spread within the organisation and how much external knowledge that is absorbed and finally the physical position affects the knowledge acquisition and the spread of the knowledge.

The analyses also found two organisational routines patterns in which the individual that absorbed external knowledge affected higher level entities. Those two were the overarching organisational routines that affect the knowledge build-up strategy and the internal Volvo Truck advance engineering routine which affect the technological strategy.

Key Words:
Absorptive Capacity, Organisational Routines

Abbreviations & Definitions

AC	Absorptive Capacity
AE	Advanced Engineering
CERC	Combustion Engine Research Center
FtF	Face to Face
PhD	“Doctor of Philosophy”, Licentiate
MSc	Master of Science
R&D	Research and Development
OR	Organisational Routines
VTEC	Volvo Technology Corporation

List of Tables

List of Figures

TABLE OF CONTENTS

1. Introduction

The introduction chapter will provide the background and the overview of this Master Thesis.

1.1 Background

The overall aim of this master thesis is to gain a deeper understanding regarding how cooperation between the industry and the university can strengthen knowledge build-up and foster innovation capacity. In order to investigate this topic deeper the CERC cooperation between Chalmers University of Technology and three Swedish automotive companies was chosen. CERC stands for the Combustion Engine Research Center. Its vision is:

> "*to generate knowledge and methods required by the combustion engine-related industry to develop highly efficient, ultra-clean internal combustion engines and exhaust aftertreatment systems that utilize renewable/fossil-free fuels and meet requirements of modern electrified powertrains, thereby contributing to sustainable propulsion technology, through high-quality research and education.*".
>
> (Chalmers 2020).

CERC was formally established in 1995 and in 2020 it is still up and running. The responsible parties and stakeholders have varied through the years but as of 2020 it is the Swedish Energy Agency that is subsidizing part from the government side, Chalmers University of Technology that is the university stakeholder and the participating automotive companies are Scania, Volvo Car Corporation and Volvo Truck Corporation. There are also various suppliers of components and measuring equipment that is tied to the cooperation depending of the current projects (Chalmers, 2020). In order to limit the scope to fit within a Master Thesis time frame this study is focusing on the knowledge build-up and innovation capacity that is built through the cooperation between one of the automotive companies, Volvo Truck Corporation and Chalmers University of Technology.

Knowledge build-up and innovation capacity are very broad topics and it is not realistic to completely cover this vast research area in a single Master Thesis. The scope therefore had to be limited and two theoretical constructs that the author recognized as being of particular interest to the innovation process was chosen. The first construct Absorptive Capacity was chosen due to the fact that CERC is a cooperation with an external partner seen from Volvo Truck´s perspective. The Absorptive Capacity construct was defined in 1990 by Wesley Cohen and David Leventhal as:

> "*the firm's ability to identify, assimilate and exploit knowledge from the environment*"
>
> (Cohen & Levinthal, 1990)

As CERC is about retrieving external knowledge in order to come up with innovative products this construct was considered to be of utmost interest. As seen from the definition, the construct is divided into three phases, the identification, assimilation and exploit phase. The first phase recognises Volvo Trucks ability to identify external knowledge, the second phase the ability to assimilate this knowledge within the company and the last phase is about exploiting the knowledge into innovative products.

The second construct that the author found applicable was the organisational routines construct which highlight the routines that forms the backbone of an organisation. This construct is very broad and is to be found within the company on many different levels. Feldman and Pentland defined the construct in 2003 as:

> "*an organizational routine is defined as a repetitive, recognizable pattern of interdependent actions, involving multiple actors.*
>
> *(Feldman & Pentland)*

The organisational routines build capabilities within the firm that possibly affect the absorptive or learning capacity of the company and therefor using those two constructs might give us new insight in the knowledge and innovation process that is attached to the cooperation between the industry and the university.

1.2 Problem Discussion

The technological challenges facing most industries today are complex and multifaceted and there is a general feeling that the technological landscape is getting more and more complex. This trend will most probably drive demand for more cooperation between different stakeholders. The automotive industry has been subject to complex technological change for decades since there has been severe emission legislation starting already in US in the 70´s (EPA, 2020) and these requirements have been a driving force for innovation within the automotive powertrain technology field since then. As the internal combustion engine is a complex product there has been a need to cooperate with different stakeholders all along the development.

This paper will contribute to the field by giving some insight in how the position of an individual who absorbs external knowledge affects the knowledge build up within the company and how organisational routines affect higher-level entities such as knowledge build-up strategies and innovation concepts.

1.3 Purpose

The purpose of this thesis is to obtain a greater understanding of how Volvo Truck is using the CERC cooperation in order to foster innovation and exploit knowledge into new innovative products. This chosen cooperation is a rather complex cooperation as it has a multitude of stakeholders with various goals. It mainly comprises of Chalmers University of Technology and the three competitive automotive companies Volvo Car Corporation, Scania and Volvo Truck Corporation. Adding to the complexity is that suppliers of various components and measuring equipment is also participating from time to time.

Hopefully the insight coming from this study can be used in order to address cooperation in other complex technological fields such as for example electrification, biofuels, autonomous vehicles or artificial intelligence for example.

The purpose of this master thesis will be fulfilled by conducting interviews with stakeholders that have been participating in the CERC cooperation from Volvo Truck, especially focusing on how knowledge is identified, assimilated and exploited as well as focusing on the organizational routines that exist within Volvo Truck to take care of the external knowledge and exploit it.

1.4 Research Questions

The main research question for this master thesis is:

How does an individual who absorbs external knowledge affect the organizational learning in an inter-organizational cooperation?

As this is a very broad subject and multiple factors influence how an individual affect the learning within the organisation and this master thesis time frame is limited this main question needed to be narrowed down. This was done by focusing on two research questions that was covering the same topic but that was more specific. The research questions were suggestions from the literature review regarding what could be relevant to research on.

The first question is based on a bibliometric analysis of the absorptive capacity concept performed by Aprilyanti and Alon in 2017.

How does the organizational position of an individual who absorbs external knowledge affect internal learning in their organization?

The second question is suggested by Salvato and Rerup in their research article "*Beyond Collective Entities: Multilevel Research on Organisational Routines and Capabilities*" from 2011.

> *How are organizational routines an engine of change of higher-level organizational entities*

As the individual who absorbs external knowledge is a part of the organisational routines that affect the internal learning process in the organisation this question is considered to be of interest. Those organisational routines also affect the higher-level strategies of the company.

1.5 Contribution

This master thesis will contribute with deeper understanding regarding how the position of an individual who absorbs external knowledge affects the internal learning and knowledge build-up within a company. Specifically, it looks into the cooperation between CERC and the engineers and specialists at Volvo Trucks.

It will also look into how organisational routines that the person who absorbs external knowledge are subjected to affect the higher-level strategies of the company. Especially the knowledge build-up process.

1.6 Delimitation

The study will only include interviewees that is or has been working at Volvo Trucks and who has been involved in the CERC cooperation during a considerate amount of time in their career. This has been secured as the sampling has been purposive with a snowball approach (Bell, Bryman and Hartley, 2019). The first person who was interviewed was found in the 2019 CERC report where he was listed as Volvo Truck´s representative (Chalmers 2019). This person proposed new interviewees that he thought had made significant impact in the cooperation and the second interviewee suggested yet some other names and so on.

The study includes participants from different hierarchical levels in order to single out if there are any differences in the perception of the cooperation between people at different hierarchical positions within the company. This will also give a richer understanding of the cooperation as it will be viewed from different hierarchical positions.

2. Theoretical Framework

This chapter is focusing on the systematic literature review that was performed for this thesis. It is covering the two focused constructs Absorptive Capacity and Organisational Routines.

2.1 What is Absorptive Capacity?

Firms of today are operating in a very complex and fast changing environment and therefore they need to constantly reinvent the way they are working and adapt in accordance to new requests. That is, they need to innovate in order to stay ahead of the competition and provide their customers with new valuable goods and services.

A firm's ability to innovate is necessary for a firm to stay in business. In this context Cohen and Levinthal started to research on the role that R&D played in the knowledge creation and innovation of a firm. They stated that "*economists conventionally think of R&D as generating one product: new information"* (Cohen & Levinthal, 1989) and they elaborated on this by proposing that R&D also had another second role. In 1989 they published an article "Innovation and Learning: the two faces of R&D" where they argued that "*R&D not only generates new information but also enhances the firm's ability to assimilate and exploit existing information*" (Cohen & Levinthal, 1989). They also broaden the thinking by noticing that researchers interested in technological change have observed that firms are also investing in R&D in order to be able to utilise information that is available externally. One of the examples that they refer to is a study of the semiconductor industry performed by Tilton in 1971. Tilton made the following observation:

> "*an R&D effort provided an in-house technical capability that could keep these firms abreast of the latest developments in semiconductor developments and facilitate the assimilation of new technology developed elsewhere*"
>
> (Tilton, 1971)

Cohen and Levinthal also argue that "*while R&D obviously generates innovations, it also develops the firm's ability to identify, assimilate and exploit knowledge from the environment-what we call a firm's "learning" or "absorptive" capacity*." (Cohen & Levinthal, 1989). With this argumentation they introduced a new construct to the research community "Absorptive Capacity" and they tied this new construct to a firm´s learning process. They state that:

> "*Learning-by-doing typically refers to the automatic process by which the firm becomes more practiced, and, hence more efficient at doing what is it already doing. In contrast, with absorptive capacity a firm may acquire outside knowledge that will permit it to do something quite different*".
>
> (Cohen & Levinthal, 1989)

In 1990 Cohen and Levinthal published a second paper in the same subject with the title "Absorptive Capacity: A new perspective on learning and innovation". In this paper they define Absorptive Capacity as

> "*a firm´s ability to recognize the value of new external information, assimilate it, and apply it to commercial ends*"
>
> (Cohen & Levinthal, 1990)

and they also argue that this capacity is critical to a firm´s innovative capabilities. They also suggest that the absorptive capacity largely is a function of the firm´s level of prior knowledge in the related area and that it therefore is a path-dependent or cumulative concept. They argue that

> "*the organisation needs prior related knowledge to assimilate and use new knowledge*". They state" *at the most elemental level, this prior knowledge includes basic skills or even a shared language but may also include knowledge of the most recent scientific or technological developments in a given field*"
>
> (Cohen & Levinthal, 1990).

In this paper they also look into the organisational aspect of absorptive capacity and they say, "*a firm´s absorptive capacity is not, however, simply the sum of the absorptive capacities of its employees*" (Cohen & Levinthal,1990). This means that there is an organisational element that affects the sum of the individual's knowledge and this organisational element is possible to influence. They write

> "*to understand the sources of a firm´s absorptive capacity, we focus on the structure of communication between the external environment and the organisation, as well as among the subunits of the organisation, and also on the character and distribution of expertise within the organisation". To develop an effective absorptive capacity, whether it be for general knowledge or problem-solving or learning skills, it is insufficient merely to expose an individual briefly to the relevant prior knowledge. Intensity of effort is critical."*
>
> (Cohen & Levinthal, 1990)

Cohen and Levinthal's definition of Absorptive Capacity is the most widely cited definition (Zahra & George, 2002) and it is built up of three dimensions of how to retrieve external knowledge namely the identification, assimilation and exploitation of knowledge (Cohen & Levinthal, 1990). Lane et al argue that these three dimensions encompass the ability to imitate other firms´ products and processes as well as the ability to exploit less commercially focused knowledge, such as scientific research. (Lane et al, 2006).

In 1994 Cohen and Levinthal published a third article in the subject with the interesting title "*Fortune favors the prepared firm*". In this article they develop an analytical structure and suggest that *"a firm's Absorptive Capacity-not only permits firms to exploit new, valuable developments, but also to envision better their emergence*" or to "*predict more accurately the nature of future technological advances*" (Cohen & Levinthal, 1994).

The above is a rather thorough walkthrough of Cohen and Levinthal's definition of absorptive capacity as a construct. The main reason for this is that, as will be described later on, the concept has since its definition been cited and used in more than 1000 research articles but that there is doubt regarding if the concept really has been used to build new research on or just been used as a general reference material (Lane et al, 2006, Volberta, 2010).

To sum up this first section Cohen and Levinthal defined Absorptive Capacity as a" *firms' ability to recognize value of new information, assimilate it and apply it to commercial ends*". They tied R&D to learning and innovation, they stated that absorptive capacity is path dependent and cumulative and that the absorptive capacity of an organisation is not the sum of the individual's absorptive capacity. An organisations absorptive capacity is dependent on how the individual knowledge is used and spread through the organisation. Last but not least absorptive capacity also enables assumptions about the future (Cohen & Levinthal, 1994).

In the beginning of 2000 Shaker Zahra and Gerard George noted that the absorptive capacity research stream was using different levels of analyses and that the field was scattered (Zahra & George, 2002). They therefore recognized a need to reconceptualize the various dimensions of the concept and clearly define each of them in order to reunite the research. They redefined AC as

> "*a set of organisational routines and processes by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organisational capability*".
>
> (Zahra & George, 2002)

They thereby connected AC to the dynamic capability concept which was defined by David Teece, Gary Pisano and Amy Shuen" in their 1997 paper "Dynamic Capabilities and Strategic Management. A dynamic capability is defined as

> "*the firm´s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments.*"
>
> (Teece et al, 1997).

Zahra and George categorized four capabilities to describe the refined AC concept. Those four were knowledge acquisition, assimilation, transformation and exploitation capabilities. They divided those into two categories which they defined as "Potential AC" and "Realized AC". The first category Potential AC" consists of a firm's knowledge acquisition and assimilation capacity. That is its capacity to identify and acquire external knowledge (knowledge acquisition) and the firm´s routines & processes that allow it to analyse, process, interpret and understand the information obtained from external information (assimilation capacity). The second category is a firm's "Realized AC" which consist of its transformation and exploitation capability. Zahra and George denote transformation as

> "*a firm's capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge*".
>
> (Zahra & George, 2002)

and exploitation as a capability that is based on:

> "*the routines that allow firms to refine, extend and leverage existing competencies or to create new ones by incorporating acquired and transformed knowledge into operations. The primary emphasis is on the routines that allow firms to exploit knowledge.".*
>
> *(Zahra & George, 2002)*

AC as a dynamic capability (Zahra and George,2002)			
Potential AC		Realized AC	
Knowledge Acquisition	Assimilation Capability	Transformation Capability	Exploitation Capability
A firm's capability to identify and acquire externally generated knowledge that is critical to its operations.	*The firm's routines and processes that allow it to analyse, process, interpret and understand the information obtained from external sources*	*A firm's capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge*	*The routines that allow firms to refine, extend and leverage existing competencies or to create new ones by incorporating acquired and transformed knowledge into operations*

Table 1: AC as a dynamic capability

In 2006 Lane, Koka and Pathak conducted a detailed analysis in order to look into how the AC construct had developed since the original definition by Cohen and Levinthal. The authors performed a thematic analysis on research papers from 1991 to 2002. The analysis included 289 papers that were published in 14 major peer-reviewed management journals. First, they analysed how the construct had been used by the researchers. That is, had they used it as a core topic or only as a minor citation. Secondly, they studied the cohesiveness of the construct by looking at citations between the research papers. In this respect a tight linked community is considered a sign that the construct is true to its original research field.

The results from their study was somewhat surprising. Only 22 percent (64) of the 289 papers made more than minor use of the construct and only 4 of the papers (1,4%) extend or redefine the construct according to their method of analyses. (Lane et al, 2006). They comment on their findings by saying

> "*when a construct is perceived as very important to a field because of high citation frequency and when the vast majority of the citations turn out to be ritual, then the true importance of the construct [..] and its contributions to a field are overstated*".
>
> (Lane et al, 2006)

Due to this result Lane et al state that there has been what they call a reification of the concept and they further state that "*the reified use of a construct may produce some useful insights, but the insights can be idiosyncratic, since few researcher understand the assumptions and definition of the construct they think they are using*". (Lane et al, 2006)

The four papers that extended the concept according to the analyses of Lane et al (2006) were Dyer & Singh (1998), Lane & Lubatkin (1998), Van den Bosch, Volberda & De Boer (1999) and Zahra & George (2002). See table 2.

Authors	Paper	Citations
Dyer & Singh (1998)	The relational view: Cooperative strategy and sources of interorganisational advantages	"*We offer a view that suggests that a firm's critical resources may span firm boundaries and may be embedded in interfirm resources and routines. We argue that an increasingly important unit of analyses for understanding competitive advantage is the relationships between firms and identify four potential sources of interorganisational competitive advantage: (1) relation specific assets, (2) knowledge sharing routines, (3) complementary resources/capabilities, and (4) effective governance."* "*We have argued that collaborating firms can generate relational rents through relation-specific assets, knowledge sharing routines, complementary resource endowments and effective governance."*
Lane & Lubatkin (1998)	Relative absorptive capacity and interorganisational learning"	"*This study examined the role that partner characteristics play in the success of interorganisational learning. We reconceptualized Cohen & Levinthal's firm-level construct- AC- as a learning dyad construct."*
Van den Bosch, Volberda & De Boer (1999)	Coevolution of firm absorptive capacity and knowledge environment: Organizational forms and combinative capabilities	*"Cohen & Levinthal (1990) have considered the level of prior related knowledge as the determinant of AC. We suggest however that two specific organizational determinants of absorptive capacity should also be considered: organisations forms and combinative capabilities (systems, coordination, socialization)."*
Zahra & George (2002)	Absorptive capacity: A review, reconceptualization and extension.	[..] offer a reconceptualization of this construct. Building upon the dynamic capabilities view of the firm we distinguish between a firm's potential and realized capability.

Table 2: Four papers extending the AC concept

In 2007 Todorova and Durisin studied Zahra and George's (2002) AC definition and they proposed that extended knowledge in innovation theory refuted their definition from 2002. Todorova and Durisin´s article "Absorptive Capacity: valuing a reconceptualization" redirects the attention back to Cohen and Levinthal's original work. Todora and Durisin (2007) argue that the sequential order of assimilation and transformation cannot be valid. Instead they see transformation as an alternative process to assimilation. This breaks apart Zahra and George's (2002) proposed concept of Potential and Realized AC. (Todorova & Durisin, 2007)

In 2017 Apriliyanti and Alon performed a bibiliometrical study through systematically reviewing co-citations and bibliometric cartography of the Absorptive Capacity concept from 1990-2015 arguing that the major bulk of literature has been released since 2005. Their extensive study resulted in a categorisation of the AC research into 5 different categories. Intraorganizational learning, interorganisational learning, knowledge transfer, dynamic capability and micro-foundations and based on the existing literature they proposed future research questions within those categories that could be of interest to build on. The first Research Question was chosen from this list as it coincided with the overall main question that the author was investigating namely, *how does an individual who absorbs external knowledge affect the organizational learning in an inter-organizational cooperation?* (Apriliyanti & Alon, 2017)

2.2 What are Organisational Routines?

Organisational routines as a concept has a long history, dating back to the "Carnegie School" which was an economics movement that focused their attention to organisational behaviour in the 1950-1960. It was led by Herbert Simon, James March and Richard Cyert from the Carnegie Mellon University (Salvato & Rerup, 2011).

A highly influential work in the field was Nelson and Winters book "An Evolutionary Theory of Economic Change" (1982) where the authors highlighted the concept of routines as being crucial for organisational change. (Becker, 2004). Nelson and Winter stated that routines store knowledge in the organization and thus can be seen as key repository of knowledge in the firm (Nelson & Winter, 1982). In the same perspective Levitt and March ties organizational routines to organisational learning and states that "organizations are seen as learning by encoding inferences from history into routines that guide behaviour". And thus, routines are seen as a sort or memory that capsules the past experiences. (Levitt & March, 1988).

As organisational routines are multidimensional complex patterns of interaction, they are not very easy to grasp and there has been a wide debate regarding what an organisational routine really is. Some people only see the routines that are actually written down, but the concept of organisational routines is much wider than that. Levitt and March include "*the forms, rules, procedures, conventions, strategies and technologies around which organizations are constructed and through which they operate*" (Lewitt & March, 1988) in the routine term. One of the most active debates has been whether organisational routines form stability and inertia in the organisation or if it also can be a part of an organisations ability to foster change. In 2003 Feldman and Pentland challenged the earlier notion that organizational routines were creating inertia in the organization and built a model that explained routines as a source of change as well as stability. And they divided the concept of a routine in an ostensive and a performative part (Feldman & Pentland, 2003).

The ostensive part is described as the structure of the routine and the performative part as the specific actions performed by specific persons at specific times and places. They argue that "*the ostensive aspect enables people to guide, account for, and refer to specific performances of a routine, and the performative aspect creates, maintains, and modifies the ostensive aspect of the routine*." (Feldman & Pentland, 2003).

This interaction between the ostensive structure and the performative actions foster both stability and change. They formulate a process view through which organisational routines and capabilities emerge and evolve and they define an organisational routine: "*as a repetitive, recognizable pattern of interdependent actions, involving multiple actors*. "(Feldman & Pentland, 2003).

Yet, another debate has been regarding if a routine is a mindless or an effortful endeavour. In this debate Feldman and Pentland state that routines are interdependent actions and that actions are supposedly effortful (Feldman & Pentland, 2003). Pentland and Reuter (1994) used the phrase "*effortful accomplishments*" to describe the way in which participants construct routines from a repertoire of possibilities. They state that: "*an organisational routine is not a single pattern but instead a set of possible patterns that is enabled and constrained by a variety of organizational, social, physical and cognitive structures*" (Pentland & Reuter", 1994). The organisational members choose which patterns to enact and to a greater or lesser extent each activity is the effortful accomplishment of the participants.

As organizational routines as a construct is broad and the literature covering the concept is vast there is a constant need to systematically review the literature. One of the major systematic reviews was made by Markus Becker in 2004. He wanted to address what routines are and what affect they have on organisations. In the paper "Organisational Routines: a review of literature" Becker summarized the literature regarding what a routine is in nine characteristics of routines that will be described below (Becker, 2004).

The first characteristic "*patterns*" is a concept "*that grasps the regularity of the routine*". The second characteristic is "*recurrence"* and Becker states "*one would be hard pressed to call something happening only once a routine" (Becker, 2004)*. The third characteristic is the "*collective nature of routines*" where he includes that routines involve multiple actors (Feldman & Pentland, 2003). Fourthly he includes the debate regarding whether routines are "mindless or effortful" accomplishment. According to Becker the empirical research argues for organisational routines as effortful accomplishments. The fifth characteristic is the "*processual nature of routines*", something which is tightly coupled to organisational change according to Becker (2004) and he continues "*a routine is a process, even despite the conceptual complication that a recurrent pattern of interaction) as Feldman and Pentland defines a routine is a somewhat stable sequence of interactions*". (Becker, 2004). Sixthly organisational routines are stated to be "*context dependent, embedded and specific*". Becker states that "routines are embedded in an organisation and its structures and are specific to the context. The seventh characteristic is "*path dependence*", that is the routines are shaped by history in a path dependent manner and due to this there is a risk to get stuck on a path. Lastly the routines are subjected to "*triggers*" and there are two types of triggers. A routine can be triggered by actors or external cues. (Becker, 2004)

In the same paper Becker (2004) also categorized the effects that routines have on the organisation. Starting with "*Coordination and Control*" where he found that routines enhance interactions which have a positive impact on performance and that routinized behaviour is easier to monitor and measure than non-routinized. He then goes on to categorize routines as a "*truce*" between those giving and those executing orders. The truce concept helps the organisation to work smoothly despite diverse interests and opinions (Becker, 2004). Becker also found that routines has a capacity to "*reduce uncertainty*" by fixating certain parameters and thereby also free limited cognitive resources for more complex work. He also found much research done in respect of routines and "*stability"*. This research stream however states that even though routines gives stability they are not inert but change incrementally and thereby contribute to both stability and change. Lastly routines also play a vital role in the "*storage of knowledge*" and they are credited with being able to store tacit knowledge as well as non-tacit documented knowledge that is written down. This comprises both individual as well as organisational knowledge (Becker, 2004).

In 2011 Carlo Salvato and Claus Rerup wrote an article "Beyond Collective Entities: Multilevel Research on Organisational Routines" where they collected current literature and wanted to rethink organisational routines and capabilities as assemblages or networks of heterogenous parts rather than as collective entities (Salvato & Rerup, 2011). They state that comparing interrelationships at different levels of the organisation will yield a deeper understanding of the concept of routines. They divide the analyses into lower level analysis, which is individual skills, habits and managerial competencies and higher-level analysis which is dynamic capabilities and strategies. They argue that routines are multilevel entities and that it is interesting to study those:

> "*by further specifying how routines can be broken down into their ostensive and performative components and how their interactions can be studied, our perspective provides a deeper understanding of the role that routines might be playing in shaping higher -level organizational entities*."
>
> (Salvato & Rerup, 2011)

The levels that Salvato and Rerup (2011) refers to goes from lower to higher level entities. Listed from the bottom and up they are individual competencies, routines, capabilities, dynamic capabilities and firm strategy and the authors argues that it would be interesting to study how the different levels affect each other:

> *"we believe that our approach holds the potential to more precisely identify the internal functioning of routines and capabilities, their evolution, and their impact on higher and lower-level organizational entities".*
>
> (Salvato & Rerup, 2011)

Salvato and Rerup (2011) proposes several research questions that they think should be interesting to research on further and that has not been scrutinized before. The second research question was chosen from these:

> *How are organizational routines an engine of change of higher-level organizational entities?*
>
> (Salvato & Rerup, 2011)

This research question was chosen as it could tie the organizational routines affecting an individual who absorbs external knowledge to the firm's strategy regarding learning and innovation. This in line with the min question. *How does an individual who absorbs external knowledge affect the organizational learning in an inter-organizational cooperation?*

2.3 Summary

The literature review regarding Absorptive Capacity and Organisational Routines has been performed in a systematic manner. Both concepts are complex and very broad. There is also extensive literature covering both concepts, but this literature is not coherent as it points in many different directions and there are many research papers using the constructs differently. The most widely used definitions of the two concepts follows below.

Absorptive Capacity is:

> "*a firm´s ability to recognize the value of new external information, assimilate it, and apply it to commercial ends*"
>
> (Cohen & Levinthal, 1990)

An Organisational Routine is:

> "*as a repetitive, recognizable pattern of interdependent actions, involving multiple actors*. "
>
> (Feldman & Pentland, 2003).

In the CERC case an individual that absorbs external knowledge must first identify the knowledge and then secure that it is assimilated and further exploit it into new products and services. The same person is during the absorption process subjected to a myriad of organisational routines that affects the outcome and also affects the firm's ability to be efficient in its absorptive capacity.

3. Methodology

In order to ensure the transparency of the results of the study the research methodology is described in detail in the following chapters. Starting with describing the purpose of the research as that is the very reason that the research is undertaken in the first place. Continuing by describing the research strategy, design and method in order to show how the research has been performed so that the reader of this report can judge the content. The literature review process, sampling method, interview and data analysis process are included in these sections. Finally, the research quality and research ethics are covered.

3.1 Research Purpose

The purpose of this study was to gain new insights regarding how a company retrieves external knowledge from a joint technology cooperation, assimilate that knowledge and in the end exploit it in order to create new products and services that serves its customers. In this respect organisational routines and absorptive capacity within the company was specifically focused. In order to study this topic, a joint technology cooperation, CERC, within the automotive industry in Sweden was chosen. The cooperation was instigated in 1996 and today in 2020 it consists of three companies in the automotive sector Volvo Trucks, Volvo Cars, Scania and Chalmers Institute of Technology (Chalmers, 2019). This study will focus on how Volvo Trucks is using the cooperation in order to explore new possibilities.

3.2 Research Design

In business research there are two main strategies or methods feasible. The quantitative and the qualitative research method. The key distinction is described as being whether the research is based on a collection of numerical data (quantitative research) or based on the collection of data that comprises written or spoken words and images (qualitative research) (Bell, Bryman and Harley, 2019). As this study was focusing on the absorptive capacity and the organisational routines of a specific company in a specific technology cooperation there was not any general data available to be used. The purpose of the study was to gain a better understanding of the processes and routines within the company that help with absorbing external knowledge. Therefore, a qualitative approach was chosen.

Bell, Bryman and Harley (2019) lists five possible research designs. The experimental, the cross sectional, the longitudal, the case study and the comparative research design. The case study methodology was used for this study as it is focusing on a particular cooperation or case and the purpose is to get a better understanding of how the result from the cooperation is used within the company. The typical form of a case study in a qualitative respect is defined as an intensive study by qualitative interviewing, of a single case, which may be an organisation or a group of employees within an organisation (Belle, Bryman and Harley, 2019). This report is based on a group of employees within Volvo Trucks that has been working with the CERC cooperation.

To summarize the research design is a qualitative case study of a single case.

3.3 Research Strategy

There are many possible strategies when taking on a case study research. Bell, Bryman and Harley (2019) have outlined the main steps of qualitative research in their book Business Research Methods. However, this was quite general and another strategy or methodology that was more detailed and specifically directed to case studies was chosen for this study. That is Kathleen Eisenhardt's model in her paper "Building Theories from Case study research" (Eisenhardt, 1989), which is used in this study. She is proposing a strategy with several steps:
Getting started, selecting cases, crafting instruments and protocols, entering the field, analysing in-case data, searching for cross-case patterns, enfolding literature and finally reaching closure.

Eisenhardt's first step in the model is getting started. In this phase she suggests a definition of the research question and possibly a priori construct. As the author of this paper wanted to study how an organisation exploits external knowledge and what mechanisms and structures that affect the absorption of knowledge, she chooses two concepts she thought could add value to the study. There have been many definitions for both the concepts during the years, but the following are the most widely used. The first concept Absorptive Capacity was defined by Cohen and Levinthal in 1989 as "*the firm's Absorptive capacity or Learning capacity is "the firm's ability to identify, assimilate and exploit knowledge from the environmen*t"" (Cohen & Levinthal, 1989). The second concept Organisational Routines was defined in 2003 by Feldman and Pentland as "*a repetitive, recognizable pattern of interdependent actions, involving multiple actors.* " (Feldman & Pentland, 2003).

Eisenhardt states that the reason for choosing concepts or constructs early on is that it provides" *better grounding of construct measures*" (Eisenhardt, 1989). In order to come up with interesting Research Questions that could add something to the already researched area a first literature review was performed. A main research question was chosen: *How does an individual who absorbs external knowledge affect the organizational learning in an inter-organizational cooperation?*

As this was considered to be a very broad question that might be difficult to answer in a complete way a further literature review was performed and finally two research questions that was in line with the main question but more specific was chosen from suggestions from the literature review. Those were:

How does the organizational position of an individual who absorbs external knowledge affect internal learning in their organization?

How are organizational routines an engine of change of higher-level organizational entities?

Eisenhardt reason for taking out the research questions early in the process is that it is focusing the efforts (Eisenhardt, 1989)

Step two in Eisenhardt's process is "*Selecting Cases*". In order to look into how a company is retrieving external knowledge in order to exploit the knowledge into new products and services the CERC cooperation was chosen as case study. It is a partly state-financed joint technology cooperation in the automotive industry between three large automotive companies with a strong Swedish heritage and Chalmers University of Technology. In order to fit a master thesis time frame the study was limited to look into one of the automotive companies namely, Volvo Trucks.

The third step in Eisenhardt's model is "*Crafting Instruments and Protocols*". She states that "*theory-building researchers typically combine multiple data collection methods [..] interviews, observations, and archival sources are particularly common [..]"* and she also states that it is "*the triangulation made possible by multiple data collection methods provides stronger substantiation of constructs and hypothesis"*. (Eisenhardt, 1998). The base for this study is the literature reviews performed on the absorptive capacity and organisational routines constructs as well as the interviews performed at Volvo Trucks. The interview guide was crafted to fit the research questions and the constructs.

Next step in the model is "*Entering the field*". According to Eisenhardt one should overlap data collection and analysis in this phase. The interviews were performed with the interview guideline as a base and after every interview the interview was summarised. The literature was also revisited several times during the process and comments regarding new findings were noted, something Eisenhardt call field notes. All interviews were recorded and then transcribed, and the material was organised in themes in order for it to be easier to search and retrieve the information at a later stage.

In the Fifth step "*Analysing Data*", the data was analysed more in detail. It was scrutinized first in order to see patterns and then to connect it to the research questions. The purpose for this phase is according to Eisenhardt to "*gain familiarity with data and preliminary theory generation*" (Eisenhardt, 1989). The sixth step "*Shaping Hypothesis*" is used to "*confirm, extend and sharpen the theory*" (Eisenhardt, 1989). In this phase the data has been analysed further and connected to the literature even firmer. According to Eisenhardt the "*central idea is that the researchers constantly compare theory and data- iterating toward a theory which closely fits the data". "Enfolding Literature"* is the seventh step and it entails comparing the "*emergent concepts, theories, or hypotheses with the extant literature*". Then finally the *"Reaching Closure"* phase that "*ends the process when improvements are marginal*". All these phases were passed through the work in order to get the end result which is this report.

3.4 Research Method

3.4.1 Data Collection

The data collection in this study consist of a literature review and primary data collected from nine interviews.

The literature review has been done in order not to duplicate research that has already been performed. Bell, Bryman and Harley (2019) say that the most obvious reason that you need to do a literature review "*is that you want to know what is already known so that you do not simply "reinvent" the wheel*". The literature review has been performed continuously and the material has been revisited several times during the study work.

The primary data used in the study is the collected data from the nine interviews performed with Volvo Truck's personnel.

3.4.1.1 Literature review

The literature review was conducted in order for the author of the study to make sure that this study was not a duplication of any other study. Bell, Bryman and Hartley (2019) state that the following questions should be addressed in a literature review "*what is already known about this area*" and *what concepts and theories are relevant*". (Bell, Bryman & Harley, 2019). They also say that the literature review "*provides the basis for the justification of research questions and explanation of the research design*".

The databases Super Search, Google Scholar, and bibliometric analyses were used in the literature review, which consisted of both books and peer reviewed articles. Peer reviewed articles were used in order to secure the legitimacy of the content in the article.

The data system Publish and Perish was used to compare the listings in the bibliometric literature and get a better view of the field.

The key words that were used from the start was absorptive capacity and organizational routines as those were the concepts that were circumstanced early in the study work.

Theoretical Framework	
Inclusion Criteria	Peer reviewed journal articles. Articles and books concerning absorptive capacity and organisational routines. Articles and books in English
Exclusion Criteria	Articles not published in an academic journal

Table 3: Literature review inclusion/exclusion

3.4.1.2 Interviews

The primary data collection was done by interviewing 9 employees (see table 4) at Volvo Trucks that have participated in the CERC cooperation in a longer period during the years that the cooperation has been running. The interviews were performed in a semi-structured way. This is explained as the researcher has a list of questions on fairly specific topics to be covered during the interview, also called an interview guide. The questions do not need to be in the right order, and it is allowed to put in extra questions, but all questions should be asked, and the wording should be similar from interviewee to interviewee. The interviewee has much freedom regarding how to answer (Bell, Bryman & Harley, 2019).

All interviews were made in Swedish as that was the interviewees mother language. Therefor all quotes have been interpreted by the researcher. When possible the interviews where performed face-to-face but as not all participants were in Sweden, skype and mobile phone was also used as a medium. The positions of the interviewees also varied which was a good thing as it rendered the possibility to investigate if there were any differences when answering dependent of position. In a hierarchical perspective Manager 1 in this nomenclature has the highest position, followed by manager 2, 3 and then the specialist is in level 4.

Total interviews: 9

No	Position	Interview	Method	CERC	Highest Education In Engineering	Department
1	Manager3	2 Mars 2020, 13:00	FtF	1996-	PhD	1
2	Manager2	3 Mars 2020, 14:00	Skype	1996-2012, 2015-	MSc	1
3	Specialist	6 Mars 2020, 10:00	FtF	2004-	Industry PhD	1
4	Specialist	11 Mars 2020, 09:00	FtF	2005-2012	PhD	1
5	Specialist	11 Mars 2020, 14:00	FtF		Industry PhD	2
6	Manager3	11 Mars 2020, 15:00	FtF		PhD	2
7	Manager1	16 Mars 2020, 1400	Phone	1996-1997	High school	1
8	Manager3	17 Mars 2020, 12:00	Skype	1994-2010	PhD	1
9	Specialist	17 Mars 2020, 13:00	Skype	2004-2011	Industry PhD	1

Table 4: Interviewees/Respondants from Volvo Truck

3.4.1.3 Sampling

The sampling was made with a purposive sampling method. It is a sampling method were the goal is to sample participants in a strategic way so that it is relevant to the research questions (Bell, Bryman & Harley, 2019).

A method called snowball sampling was chosen as sampling criteria. With this approach the researcher makes initial contact with a small group of people that are relevant to the study and from there he or she uses these contacts to get in touch with other people to interview (Bryman, Bell & Harley, 2019). This method was used as it was not possible to retrieve a list of all people that had participated in the CERC cooperation from Volvo Trucks. Instead the CERC report (Chalmers, 2019) was used as a starting point. Interviewee 1 and Interviewee 2 were listed there as Volvo Trucks employees and they directed the interviewer to other people that they thought had been important for the cooperation.

The sampling criteria was that the interviewee should be working or have worked at Volvo Truck at the time he or she was involved in the CERC cooperation.

3.4.1.4 Interview Guide

Bryman, Bell and Harley state that the interview guide is an important aspect of a semi-structured case study. They also state that it is important to keep the research question in mind when preparing the interview guide and to make sure that the questions asked contributes in answering the research question (Bryman, Bell& Hartley, 2019). Furthermore, they suggest dividing the questions into certain topics to ensure a satisfactory flow (Bryman, Bell & Hartley, 2019).

The interview guide used started with fifteen questions in section one regarding the interviewees background in order to set the scene. Section two was set up thematically with the three themes of Absorptive Capacity clearly visible. That is the Identify, Assimilate and Exploit phase. Finally, in section three there were some questions regarding the conclusion of the interview and those were not put to the participant but concluded by the researcher after the interview was performed.

3.4.1.5 Interview Process

When starting the interview, the interviewer asked the participants if they wanted to be anonymous. Most of the respondents did not object to be in the report by name but as some respondents wanted to be anonymous, all interviewees are anonymised. Then the researcher asked for permission to record the interviews and all respondents were ok with that, so therefore all nine interviewees are recorded. This made it easier for the interviewer as she could concentrate on the actual interviewee instead of concentrating on taking notes.

The researcher also explained the process of transcribing to the interviewees and no one objected to this. The interviews were then performed in a similar manner and all the interview guide questions were asked to all participants more or less identically.

3.4.1.6 Analysis process

The interviews were coded thematically and summarised once more in order to get a good understanding of what the interviewees says. Empirical data was gathered and sorted in accordance with the two constructs Absorptive Capacity and Organisational Routines.

The data was analysed in order to see patterns that could help in answering the Research Questions. As the interviewees had a many common patterns but they answered in different questions the material was re-coded in colour. This helped in the process of finding the core themes and in the end find answers to the research questions asked.

3.5 Research Quality

When evaluating business research there are three prominent criteria that should be met and those criteria are reliability, replicability and validity (Bell, Bryman & Harley, 2019). To establish the quality of the research all three should be met.

3.5.1 Reliability

According to Bell, Bryman and Harley (2019) reliability is concerned with whether the results of a study are repeatable. There are two sets of reliability measures, the external and internal reliability.

The external reliability is the degree to which a study can be replicated (Bell, Bryman and Harley, 2019). Since this is a difficult criterion to meet for a study in a social setting with specific stakeholder, measures have been taken to thoroughly describe the research method. Furthermore, the research has followed the existing standards of qualitative research. The interview guide is put in the appendix so that it can be used again with different stakeholders.

Internal reliability is the question whether different members in a research team agree on what they see and hear (Bell, Bryman and Harley, 2019). As this thesis is performed by one researcher there is only one member in the team and therefore the internal reliability can be questioned but as this master thesis has been supervised and gone through an opponent review this risk has been mitigated.

3.5.2 Replicability

Replicability is referring to when a study can be replicated by others (Bell, Bryman & Harley, 2019). This can be hard to do for a qualitative study as there are specific people involved and in for example an interview situation the interviewees might not answer the same the second time as they might come to think of other things to add. However, in order for others to replicate the study as much as possible the method is described in detail and the interview guide is added to appendix. Yet another problem is that the interviewees in this study are anonymous, which makes it hard to replicate. However, as the answers were consistent it might be possible to do a similar study with other participants from the cooperation.

3.5.3 Validity

According to Bell, Bryman and Hartley (2019) there are two concepts of validity namely the internal and external validity.

The internal validity is concerned with if there is a good match between the researcher's observations and the theoretical ideas that is a result from the study (Bell, Bryman and Hartley, 2019). To mitigate this the questions in the interview guide was carefully selected and it is mirroring the theoretical concept that was chosen as a theoretical base. The research questions were carefully selected to match the theoretical background and the theory has been present all the time through the study and the researcher has iterated between empirical data and theory constantly. So therefor internal validity has been secured as much as possible.

External validity is according to Bell, Bryman and Hartley (2019) the degree to which the findings can be generalized between social settings. In a qualitative study this can be hard to meet as the samples are small and the use of case studies are common (Bell, Bryman & Hartley, 2019). This is a case study focused on CERC and even more specifically on Volvo Trucks which makes it hard to generalize but as the same time the set-up for many similar cooperation's subsidized by governments and EU funds are most probably not so different, which makes it somewhat generalizable.

3.6 Research Ethics

In all research ethical considerations such as confidentiality, informed consent deception prevention, harm avoidance, and visual methods are important (Bell, Bryman & Hartley, 2019). In this study all interviewed persons are confidentially referred to as numbered respondents and the purpose was clearly described before the interview was undertaken. The interviewees also gave their consent of using the material and of the researcher recording and transcribing the interview. The method and the use were clearly described which hinders deception. As the interview was structured and the purpose and method were described in a clear way it may serve as harm avoidance. The questions were in no way unethical and it was secured by the supervisor.

4. Empirical Findings

In the following chapter the main empirical findings will be presented. They will be divided in two parts, the absorptive capacity and the organisational routines framework. The reason for separating them is that they are two different constructs and it will be easier for the reader of the study to separate them. Nevertheless, the constructs are interlinked as the company and the cooperation is built up of organisational routines, but all routines are not aimed at retrieving external knowledge, which is the basis of the absorptive capacity framework. Organisational routines are of course also used in company internal knowledge retrieval.

The overall structure of the cooperation can be seen in picture 1 below. It shows Chalmers University of Technology and CERC to the left with its current stakeholders and Volvo Trucks with its different hierarchical levels to the right. The interviewees are also pictured with numbers in circles. On the top of the figure the three phases of AC, namely the identify, assimilate and exploit phase are shown. Furthermore, the overall CERC cooperation is present. Starting with input from all stakeholders, input that mainly ends up in various licentiate projects.

Highlighted in red is the cooperation between the licentiate and a specific Volvo Truck employee that is appointed Industry Representative for the project. Those persons are crucial to the cooperation. The licentiate is responsible for the actual project and the industry representative is responsible for securing that the project is interesting from a Volvo Trucks perspective. The industry representative is also responsible for giving feedback to the licentiate and taking home the knowledge from the project to Volvo Truck. It is expected that he or she spreads the knowledge within the organisation and also uses it for innovation of new products or services. This picture will be used in modified versions throughout the presentation of the study and the details will be scrutinized further down.

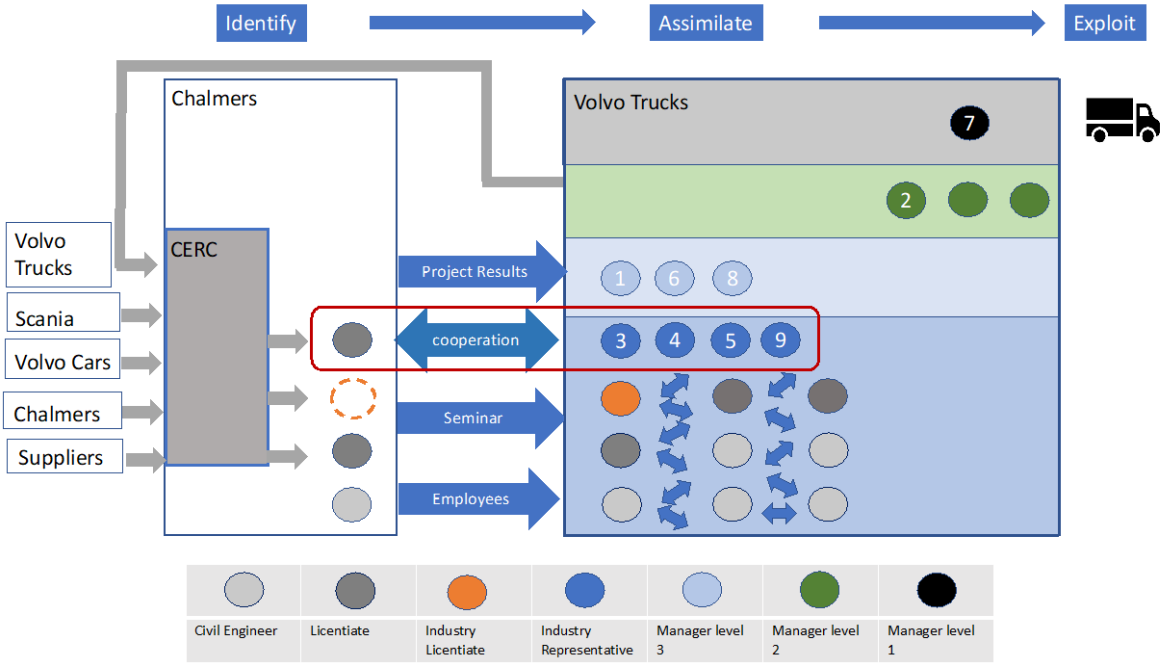

Figure 1: Overall structure of CERC cooperation

4.1 Absorptive Capacity

The definition of Absorptive (or Learning) Capacity is "*a firm's ability to identify assimilate, and exploit knowledge from the environment*" (Cohen & Levinthal, 1990).

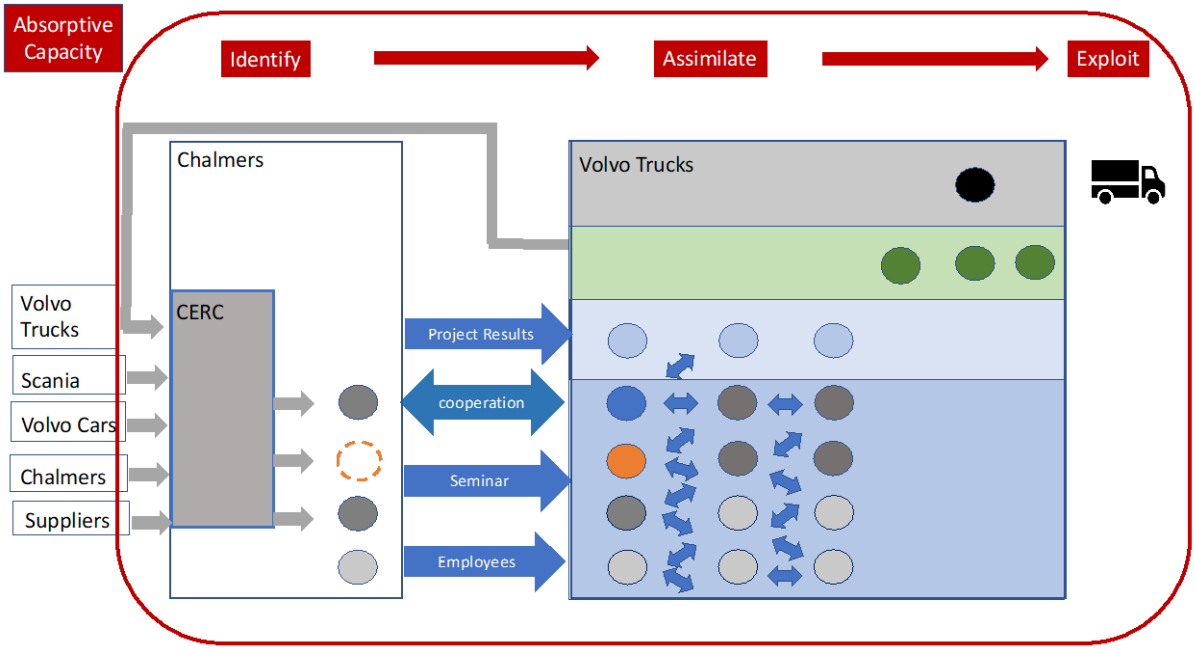

Figure 2: AC capacity

Figure 2 above shows AC in the specific CERC cooperation. In the construct Cohen and Levinthal (1989, 1990) divides a firm´s process of incorporating external knowledge and information into three sequential phases. First it is the *Identify phase* in which the firm identifies vital knowledge from an external source and in this case, Volvo identifies knowledge from the university via the CERC cooperation. Thereafter, comes the *Assimilation phase* where the company should assimilate this new knowledge or information. In the specific CERC case it can be translated to Volvos ability to integrate the knowledge from the cooperation within Volvo. Finally, the third phase *Exploitation* is when the assimilated knowledge is transferred into products or services. In the CERC cooperation it is when the retrieved knowledge is used in a new engine technology at Volvo Trucks. There is a possibility that a firm can excel in one or two of the phases but to really make use of the opportunity of external knowledge it is vital for the firm to master all three phases in an efficient way.

The empirical data regarding AC from the nine interviews performed with employees from Volvo Trucks is gathered in table 5 and in the following chapters different phases will be described more in detail.

R	Identify	Assimilate	Exploit
R1	It is not the specific idea from the university that becomes a product at Volvo.	Resources and engagement are important. It is important to be a part of the analyses of the data and that one is interested in the results. I think that one of the most important outcomes is the licentiates that we have been able to employ and to have a common engagement in those projects makes us get to know the licentiates and that the licentiates understands better what is happening in the industry.	Results of tested hypothesis. And then I know we've benefited from it when we've developed some new things. If you take the Wave piston for example if you know it. It is a Volvo-unique combustion concept that significantly improved our engines. We have not researched on this technology at the universities at all, but we have been able to test hypotheses in the research that have helped us move forward
R2	One is looking into research that one doesn't want to do on one's own because it is a bit like chance taking. It lies a bit forward in time. It isn't something you bring into ongoing projects.	The build-up of competence has been ongoing for many years. The companies must be active in order to benefit from the opportunities that the cooperation can bring. You cannot only passively read reports, but you need to actively take part in reference groups and program councils etc. Industry licentiates is absolutely the best for the companies to bring home knowledge. Licentiates that works in the projects at product development on Volvo Truck and that contributes to better and competitive products. The cooperation has contributed with, partly it has lifted the competence within the Masters education so that civil engineers that Volvo employ, who has read the continuation of the combustion course and maybe even made an Exam thesis, they have a better standard than they have had otherwise	If the result is not what we expected, then we learn from that. If you understand why the results did not end up as expected it may bring a jigsaw piece, which had been missing.
R3	The projects are more specified on examine something than to reach a definite end result.	Some people have been more pushing than other people to get the results home. It is dependent on each person. Then it is also a way to get in contact with licentiates in order to and employ them, which I see ad very important. Recruitment of people that can analyse in a good way, understand context and draw conclusions	Customized results in a product with Volvo's geometry. And then there are of course pure project results that Volvo has taken advantage of.
R4	Few times that the university has brought technical solutions that we can use in product development	Knowledge Build-up. Some here, some there. Small seeds of knowledge. The methodology is more important than the actual result. I think that the biggest benefit of CERC is that they are training a generation of researchers that then come into Volvo. I think that the biggest benefit has been to get people with good education so to say. CERC is a research school.	Also "bad" results are important. They give insight in what to avoid. Wave piston.
R5	The things that are publicised from us and particularly from the university is far from guidelines for product development. It is basic understanding. Have contributed with results and findings that we ourselves would not have been able to produce if we had not had research projects	If you have been part of designing simulation models and you have been performing very many projects that are similar to research on the university, then it is easy to cooperate around these things. If we at Volvo shall benefit from the cooperation, we will have much more benefit if we engage in it. If you do not only attend a sporadic meeting and listen a bit. It is up to us that has the contacts, that in various ways get the knowledge in to the projects as proposals, concrete proposals or we can also propose to test something at CERC. Many of the co-workers has been licentiates and then started at Volvo. It is a research school.	It has been product development in all possible projects here and there. Not all projects but many projects. So, it is spread out. Some parts in the Wave piston development.

R6	Design tools or design parameters for specific hardware that already is in production is utterly unusual.	Over the years we were definitely questioned and on daily basis when one work as an engineer sitting in a reference group so, I do not have time to attend today and that can be right in the moment as it might be a project running in production that need help instead. But is it always like that on a yearly basis then it is not good. Sometimes you need to let go of the production to do something else. To hire licentiates	Everything we did in the nineties became fantastic simulation tools that was the basis for coming up with the Wave product that interviewee 5 came up with. If we had not gotten the internal simulation ability with that data power that coincided with a couple of licentiates that had graduated a couple of years earlier and interviewee 5's creativity. It was fortunate. Some years nothing comes out from the cooperation and some years a lot, but you need to "believe in it
R7	It was seldom that the university approached us with ideas and proposals. It never happened in my time. The important has been that the people working with these things practically or with applied technologies within the university has been working with real things instead of made up.	The industry representative from Volvo handled the cooperation him/herself and it was very often the same person that had been formulating the demands that received the outcome so he or she knew how it should be used. Build very much on engagement from the people involved. Co-workers to employ is most important.	It is like reading a book. These different technologies that we handle within the group that we are part of, parts of it you can use but you cannot take the whole book. But, you can take fragment here and there.
R8	We prepare internally before a CERC meeting. We come up with what we want to do, what ideas we have and then we listen on what the other firms in CERC has and what the university has and then finally it becomes a program that we follow up with industry representatives.	The AE process-what happens in these cooperation's is directed into concept evaluation. And after the evaluation process it comes into our projects and then it turns up in our products. It can take rather long time. The reasons to be in these cooperation's, yes, number one is that it is a route for recruitment in to the University. To get in people that already in their licentiate or "after-university" and also during the university as exam-thesis is working with areas that we can benefit from.	Without being able to point at something specific, there are always unexpected contributions in such research activities. You discover things that you did not expect. Volvo does not dare to put new things into production.
R9	The point with research is that one shall do something that one hasn't done before Steer so that the things one work with at CERC is applicable at Volvo. So, you could say that these cooperation's that we have had is a way to soak up and understand what is new, new findings that has been found. At the same time, you can from the Industry's side give insight regarding what areas that is of interest.	The AE group is a tight team that talks and share a lot of information. Understand underlying causes so that one can develop new concepts. The industry representatives bring this home to the functions and then it is Advance Engineering that has the greatest use of it. And the way we have worked. At that time, we were located in one group together. So, we became a tight team that communicated and talked a lot with each other and shared with each other. The persons that benefit from the information directly is located in that group. It then comes in directly where one benefits from it.	Good and bad results can be of equal value.

Table 5: Empirical data of Absorptive Capacity

4.1.1 The Identify phase

The first phase in the Absorptive Capacity construct is the firm's ability to identify knowledge from the environment. In this specific case it is Volvo's ability to identify useful knowledge from the CERC cooperation see figure 3.

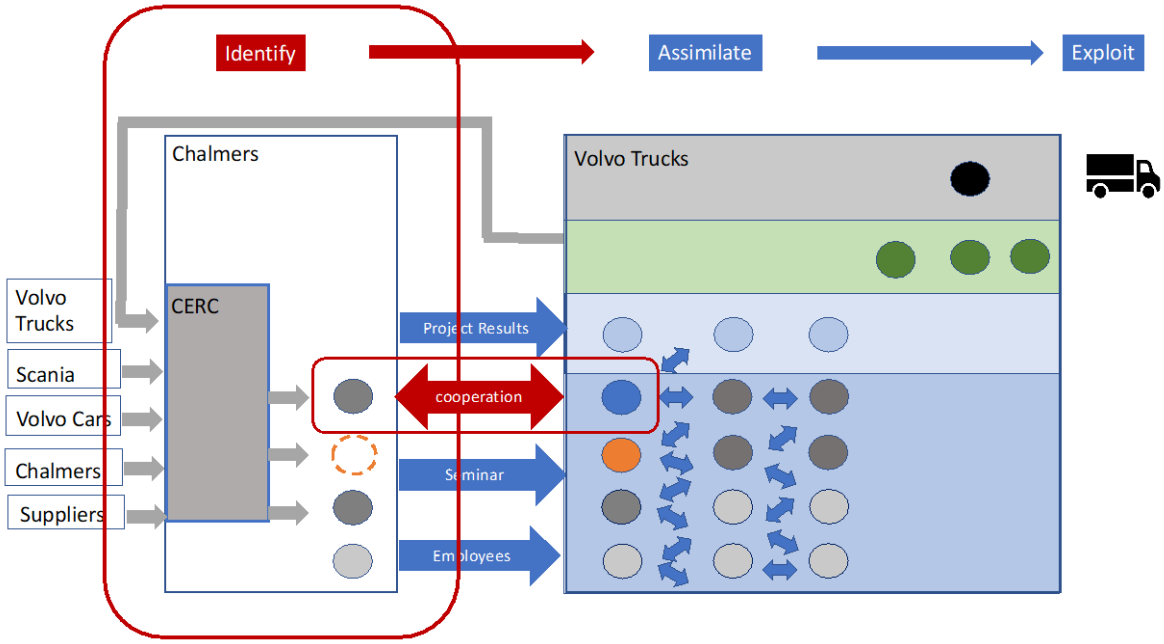

Figure 3: Identify phase

However according to the interviewees at Volvo there is not any specific knowledge that can be retrieved or identified directly from the CERC cooperation and used for product development purposes. R1 says "*specific ideas from the research is seldom becoming products but it is complementary knowledge so to say*", R6 says "*design tools or design parameters for a specific hardware that goes into the product are unusual*" and R7 says *"it was seldom that the university approached us with ideas and proposals. It never happened in my time "*. To sum up the general belief is that it is very seldom that the cooperation outcome is specific knowledge that can be used directly in Volvo Trucks products.

Instead the interviewees talk about an iterative two-way process where knowledge is built up through the actual cooperation per se instead of identified knowledge. The main parties for knowledge build up is the CERC licentiates at the university and the industry representatives at Volvo Truck (together with the participants from the other automotive companies). This is seen as an active process where the industry representative is securing that the research performed at the university will be of value to Volvo Truck. R1 says "*we have also been able to steer the research or testing or what it can be in a way that makes us able to benefit from it in order to get broader knowledge or deeper knowledge*" At the same time, he/she secures that the research is up to date and based on real case scenarios in order for it to be valuable to Volvo Trucks. R9 state that you as an industry representative must secure that the university "*is working with relevant things and then of course to understand what they have discovered in order to retrieve that knowledge into Volvo Truck*" and R7 says "*the most important has been that the people working with practical stuff or directed techniques within the university has worked with real things instead of made up stuff*".

The CERC cooperation runs in a four-year cycle and the program is set by a mutual agreement between the university and the participating automotive companies. This will be described more in detail later, but the initiation is described by R8 as a process where Volvo is active in identifying what to research on. He says "*we prepare internally before a CERC meeting. We come up with what we want to do, what ideas we have and then we listen to what the other firms in CERC has and what the university has and then finally it becomes a program that we follow up with industry representatives"*.

As there are also competitors within the CERC cooperation it is not possible for Volvo Trucks to be entirely open with specific details regarding what they want knowledge on and therefore, it is difficult to perform tailored research specifically for Volvo Trucks. Instead the research performed is more basic research, that can be used to build up knowledge generally. Due to this the identified knowledge usually cannot be used directly in Volvo Trucks products. Instead R1 suggest that "*the cooperation is used to verify various hypothesis*".

In order to retrieve valuable knowledge most interviewees state that it is important to understand what type of projects the university are good at and should take on. They say that it is important to understand how the university operates, what knowledge and tools they excel in and have access to. R2 says "*that it is important to understand the strengths and weaknesses of the centre and what areas they excel in, in order to be able to identify what type of projects that are suitable for the university"*. And in the same spirit many of the interviewed persons state that it is very important for an industry representative at Volvo Truck to have a licentiate background in order to work efficiently with the university. R3 thinks "*that you get an understanding of what the project should consist of and what is reasonable to do if you have gone through it yourself*". R2 and R7 also states that it is important for the industry representatives at Volvo to understand the future roadmaps in order to identify what could be suitable to research on at the CERC. Finally, R7 adds that "*understanding of how the products really are used*" also is important when deciding project boundaries.

To sum up the identify phase the importance of the cooperation does not seem to be direct identification of knowledge but instead the whole process of building knowledge. This is seen as an incremental process. R4 talks about "*small seeds of knowledge*" that is generated and identified. And it is also seen as a somewhat uncertain identification of knowledge as you never know what the result will be. In this respect R2 talks about "*chance taking*" and that the results will not be immediate but "*that the time horizon for the usage of the result will be longer down the road*".

4.1.2 The Assimilate phase

The next phase in the Absorptive Capacity construct is the assimilation phase where the company shall assimilate the retrieved knowledge see figure 4.

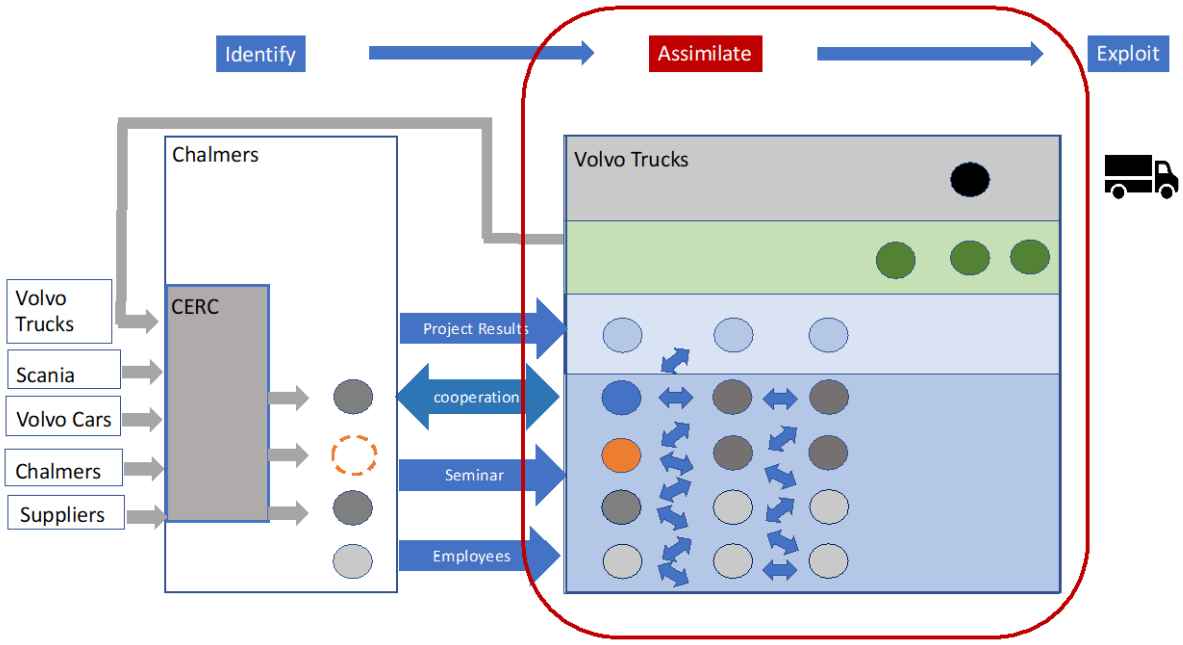

Figure 4: The Assimilate phase.

A firm's ability to assimilate knowledge is crucial in order for it to be able to further exploit the knowledge into something of value to the firm.
The interviewed employees at Volvo Truck suggest various things that affect the assimilation of knowledge within the company. They talk about the human capital aspect in form of engaged industry representatives, skilled master student and professional licentiates graduating from the university, that later can be employed by the company. They also suggest that the ability to spread the retrieved knowledge within the company is crucial and that this ability is affected by the organisational set-up and the "way of working" inside the company. Furthermore, they state that knowledge is assimilated in the simulation models that is an outcome from the cooperation. All this will be elaborated further below.

First the role of the industry representative as knowledge bearer will be discussed further. The industry representative is the person that really absorbs the new external knowledge from the cooperation and as such he/she is supposed to be actively engaged by showing interest, discuss possible solutions to problems and try to direct the project so that Volvo Truck gains valuable insight from it. Many of the interviewees state that it is important that the Industry Representant is active and engaged in the cooperation. R2 says, "*it is of no use to be passive and only read the reports as it is the actual cooperation that fosters and builds up new knowledge*". R1 states that "*it is important to be part of the analyses of the data and that one is interested in the results*" and R5 thinks that "*if we at Volvo Truck shall have any use of the exchange it is much more inspiring if one engages oneself. If you do not only participate in a meeting now and then and listen-in but that one is active*".

Furthermore, the industry representative is seen as the gatekeeper of information. That is, as he/she is the primary person that absorbs the knowledge he/she is also responsible to spread it within the organisation in order for more people to retrieve knowledge, which increases assimilation. In this respect the industry representative controls which information and knowledge that is retrieved by the CERC cooperation and that will be spread within Volvo Trucks. However, the fact that it is often only one person involved is a matter of resources. R1 says "*the limitation lies as you do not have capacity to participate on everything. You need to choose which areas at the university to participate in*". The industry representative spreads the information mainly within his/her internal network. R9 says "*we became a tight team that communicated and talked a lot with each other and shared with each other (..) It then comes in directly where one benefits from it*.". R9 elaborates on the same theme by referring to *"a community of people that are interested in these things*".

The industry representative also spread the knowledge to the management through reporting the project in the Advance Engineering council. It was also mentioned that the organisational position of the industry representative indirectly affected the absorption of knowledge and also the spread of information. This was described as a "*classical organisational problem*" by R2 and will be elaborated further in the analysis section. Furthermore, the information is spread to a broader audience in a yearly seminar where the licentiate presents the project at Volvo Truck. On these occasions a wider audience has the opportunity to absorb the knowledge.

All interviewees state that one of the biggest benefits from the cooperation is that Volvo Truck can employ skilled people with specific technological knowledge and assimilate their knowledge and skills directly. The benefit is that these employees already have built up excellent knowledge regarding the specific technologies and they know the methods and tools that are used in the field. R4 says "*I think that the biggest benefit of CERC is that they are training a generation of researchers that then come into Volvo*". Therefore, they are productive already from the start and it is an indirect form of assimilating external knowledge into the company. Furthermore, by taking on a licentiate assignment they have learnt a structured way of working, which

makes it easier to assimilate new knowledge and they can also influence the organisation to work more structural. R3 says "*Recruitment of people that can analyse in a good way, understand context and draw conclusions*". R4 and R5 states that the cooperation is actually a form of "*Research School*" where the licentiates "*learn a research method or process which is structured and thorough*" an R1 says "*then when you have a research education you are schooled in a research-ish way to look at things*". Finally, R7 call the licentiates "*the most important carriers of knowledge*".

Furthermore, some of the interviewees suggest that the knowledge build-up at the university, which is a product from the CERC cooperation gives better master students that can be employed by Volvo Trucks after graduation. R2 says "*the cooperation has contributed with, partly it has lifted the competence within the masters education so that civil engineers that Volvo Truck can employ, who has read the continuation of the combustion course and maybe even made an exam thesis, they have a better standard than they have had otherwise".* This is also an indirect assimilation of knowledge.

Finally, the knowledge retrieved from the cooperation is built into the simulation and computational models that have been fine-tuned throughout the years. This is absorbed knowledge that is assimilated when used within Volvo Trucks. Also R4 says that "*The most interesting results are stored in an Engineering reporting system in order for others to use as input"*

4.1.3 The Exploit phase

The Exploitation phase of the Absorptive Capacity construct is when the assimilated knowledge is further exploited to become actual products or services see fig 5.

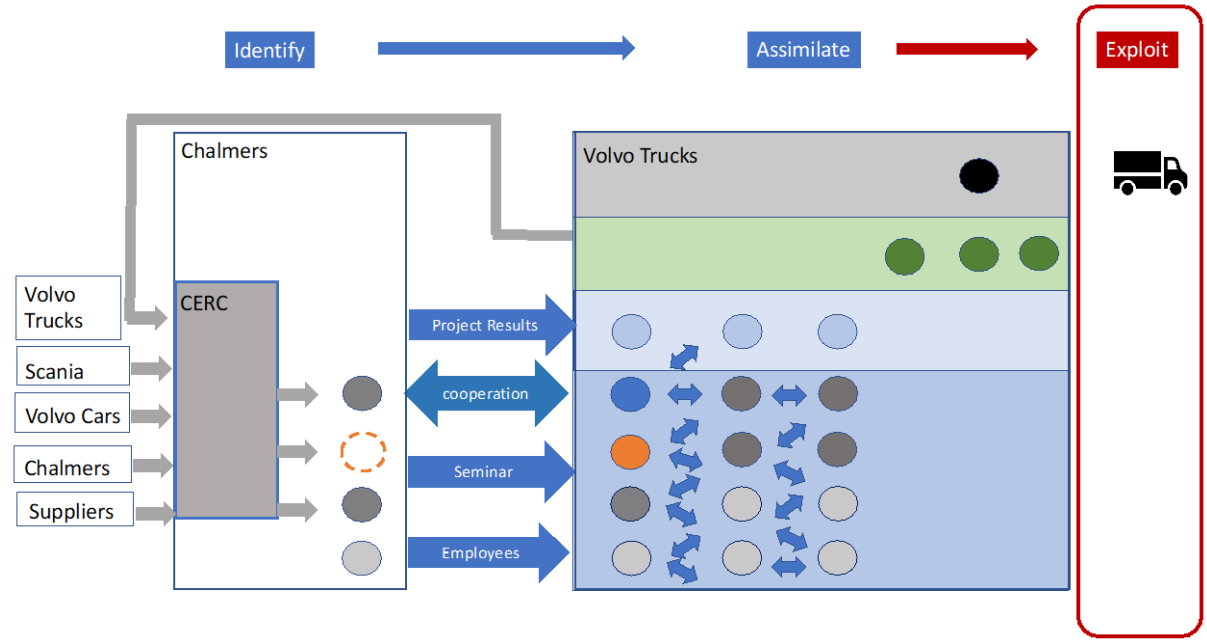

Figure 5: The Exploit phase

Many of the interviewed employees at Volvo Truck think that it is difficult to specify certain specific products that is the actual outcome of the CERC cooperation. R8 states that "*without being able to point at something specific, there are always unexpected contributions in such research activities. You discover things that you did not expec*t.". However, most of the interviewees point at one specific invention, the wave-piston, when they get the specific question regarding a product that can be traced to the cooperation. However, this product is not only a direct CERC product even though some parts of the development came out from the CERC cooperation. R1 says "*and then I know we've benefited from it when we've developed some new things. If you take the Wave piston for example if you know it. It is a Volvo-unique combustion concept that has significantly improved our engines. We have not researched on this technology at the university at all, but we have been able to test hypotheses in the research that have helped us move forward".* The piston was developed during several years and in different settings. R6 describes it as "*the right simulation tools, processor power, skilled knowledgeable licentiates and R5 who had many creative ideas was needed to get this hardware into production.* And the inventor himself said "*that it was very difficult to get attention for the product from the beginning as no one believed in it*".

The interviewees argue that the CERC cooperation is very much about basic research compared to the more applied research and product development directed to a specific product. This basic knowledge might end up in new products, but it is hard to directly specify when this happens. It is more of an incremental development where small steps are taken on a regular basis. R3 says that the CERC projects are more "*specified to examine something than to reach a certain end result*.". R4 states that "*it is some knowledge here and some knowledge there.".* R5 says "but *it has become product development in various projects, here and there, not all projects but many projects so it is spread*" and R7 argues that "*it is like reading a book you could say. These different techniques that is handled in the group. You can take part of them but you cannot take the whole book. You can take fragment here and there.".*

Another aspect mentioned by many of the interviewees is that this kind of research takes time and that it can´t be hurried. That it is like a process of building knowledge layer upon layer. As R6 puts it "*some years nothing comes out from the cooperation and some years a lot, but you need to "believe in it"*". He likens it with a "*ketchup effect*" and he says that one need to believe that it will eventually bear fruit. He also stresses that it is important, especially for the managers, to let people work on and not press them for results. Two of the interviewees states that it is almost impossible to present a Business Case as you do not know in what direction the research will go. R8 says "*It is not possible to do Business Case on this, but we have seen benefits of the collaboration and this has been enough motivation to continue." and* R6 elaborates on this theme by stating that"*the benefits that we got we could see and there was enough motivation to go into it, but it wasn't like we could show it with a Business Case.".* Furthermore, many of the interviewee high

lights that it is not only actual product innovations that can be exploited in a cooperation like this. They add that both good and bad results can be of great use as bad results tells you that this is not a way to go. R2 argues that "*If the result is not what we expected, then we learn from that. If you understand why the results did not end up as expected it may bring a jigsaw piece, which had been missing" and R4 says "also bad results are important. They give insight in what to avoid.".*

To sum up the Exploitation phase it seems that the interviewees find it difficult to specify when the assimilated knowledge is actually implemented in real products. That might be due to that the knowledge retrieved from the CERC cooperation is of a more basic nature and that that kind of knowledge takes a long time to mature. As there also are competitors in the cooperation it is not possible to test things aimed directly at production. Those things are often subjected to patents. But most interviewees state that there are small pieces of knowledge that can be used to further exploit.

4.2 Organisational routines

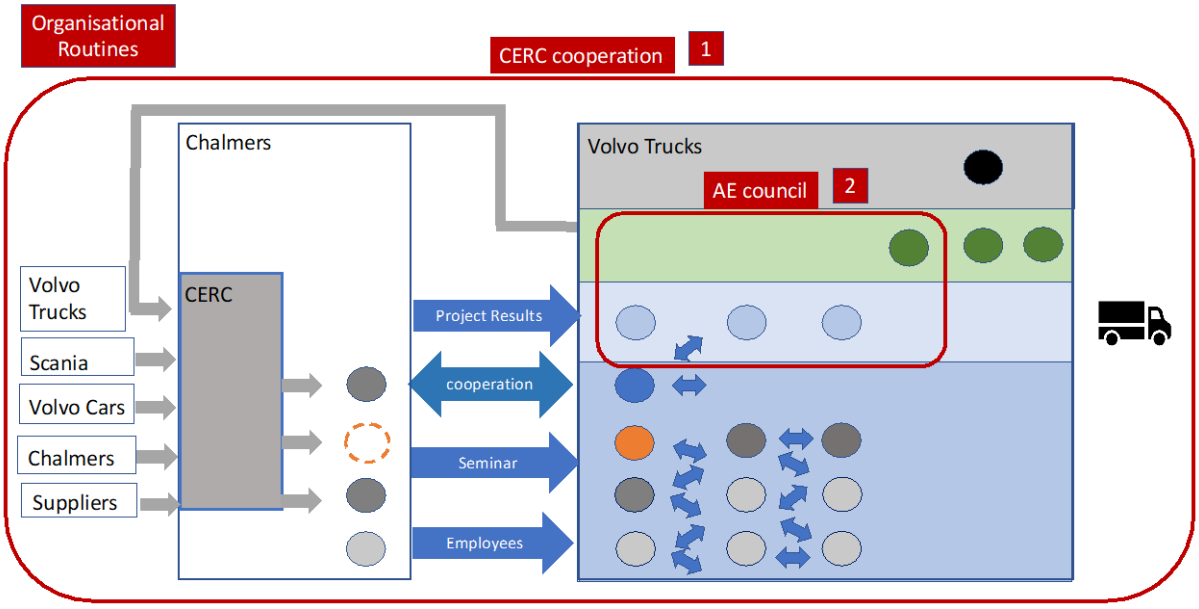

Figure 6: Organisational Routines overview.

Most people have a notion of what a routine is but even so they might have a hard time defining it. In 2003 Feldman and Pentland come up with a definition of routines that are undertaken by an organisation. They state that an organisational routine is*" a repetitive, recognizable pattern of interdependent actions, involving multiple actors*. "(Feldman & Pentland, 2003).

From the empirical data two clear organisational routine patterns emerged see figure 6 above. The first pattern consists of the overarching organisational routines that govern the CERC cooperation as such**.** And the second consist of Volvo Truck's routines regarding how they operate the CERC cooperation internally.

4.2.1 CERC overarching organisational routines

The overarching organisational routines that are governing the CERC cooperation will be described below. Each program or cycle of the cooperation is spanning over four years. In the end of each four-year cycle there is an evaluation of the cooperation and the parties decide whether to start a new program or end the cooperation. Each new cycle starts by defining the overall program. The program consists of several projects that may vary a lot in respect to content. R1 says "*but then if you go into what is actually to be done, it is very different depending on what kind of activity it is. If it's testing, it's calculation or anything else.*". Some of the projects will for example not be of interest to Volvo Trucks as they are using technologies that is merely directed to the car industry. R6 explains that "*sometimes it is an active act not participating. That is when we are not interested in the area by various reasons.*".

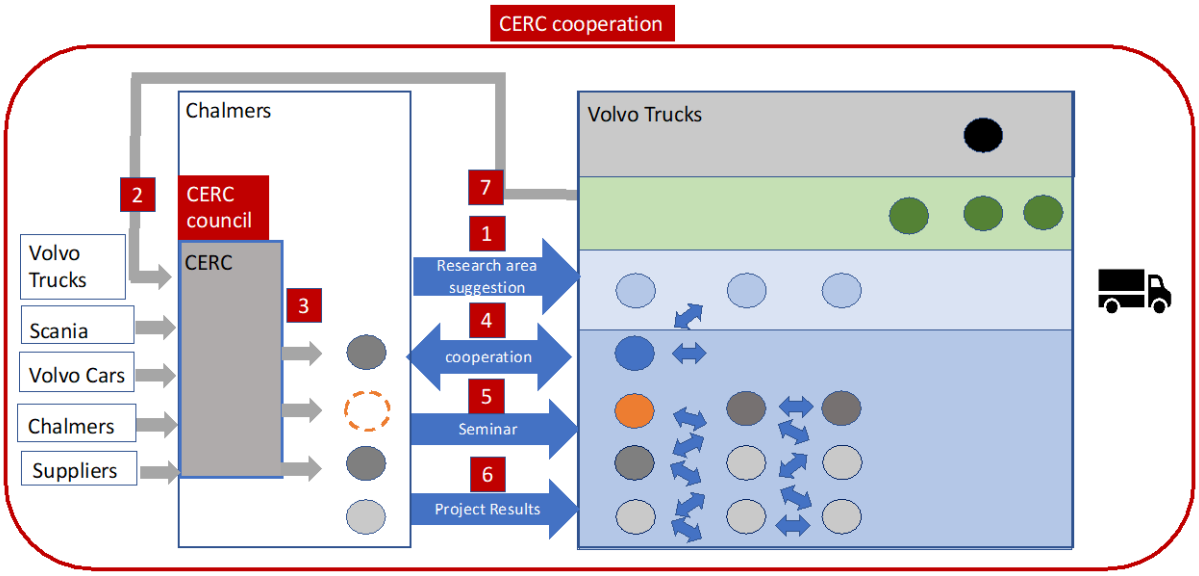

Figure 7: CERC overarching cooperation.

The program formation is an iterative process between the university (CERC) and the member companies. The university starts the cycle by proposing interesting areas of research in line with their mission (see 1 in figure 7). R9 describes this by saying that "*it is actually the university that applies regarding which research they want to pursue and quantifies interesting areas and then verifies with us so that those areas are of interest. So already then, a narrow area that we are interested in is defined.*". Volvo Truck then discuss the scope internally and they are using their knowledge based on current and future technologies, customer demands and government requirements to form an interesting research proposal (see 2 in figure 7). R8 describes the process as "*we prepare internally before a CERC meeting. We come up with what we want to do, what ideas we have and then we listen on what the other firms in CERC has*

and what the university has and then finally it becomes a program that we follow up with industry representatives", R2 describes that "*Volvo Truck is participating when those research projects and their content are planned, and it is mostly done in the reference groups."* and R7 says "*it was the reference person from our side that handled the cooperation as he/she thought best. It was often the same person that had formulated the needs and then received it so he or she knew where it should be used.".* Another aspect that affects the project proposals from Volvo Truck is that there are also competitors within the CERC cooperation and therefore it is not possible for Volvo Truck to be entirely open with what they specifically want to know. Due to this it is difficult to perform tailored research specifically for Volvo Trucks. Instead the research performed is more basic research, that can be used by all companies. R1 explains that "*the cooperation is used to verify various hypothesis*".

A complete four-year program consists of several projects with one or two licentiates per projects (see 3 in figure 7). Volvo Truck appoints an industry representative for all projects that are of interest to them. R6 states that "*we have contact persons in every reference group*" and R1 explains that "*the structure is similar for all projects in fac, you come up with a project proposal, which is brief first and if there is an interest and support for it, it becomes a more elaborate project description and then you decide if the cold run and then you follow that plan. And it's often a PhD project. Most of the projects are PhD projects. So, it follows that structure somehow*.". The CERC program is decided in the CERC committee and the project specifications for those projects sets the direction for the following four years period.

When the program is set the roles in each project should be filled. Two of the most important roles are the licentiate at Chalmers University of Technology and the industry representative on Volvo Truck (see 4 in figure 7). The intention is that the licentiate shall perform the majority of the work but that the industry representative shall help in building-up knowledge by participating in the reference groups and be a speaking partner regarding the relevance of what is done. Each year there is also a seminar held at Volvo Truck where the licentiate presents the progress and more people at Volvo Trucks get the opportunity to discuss the findings and come with suggestions (see 5 in figure 7). And in the end of the four year cycle the project result is presented (see 6 in figure 7). Then the cycle starts again if Volvo Trucks decides to continue the cooperation (see 7 in figure 7). This cycle can be seen as an Organisational Routine as it is "*a repetitive, recognizable pattern of interdependent actions, involving multiple actors"* as defined by Feldman and Pentland (2003).

4.2.2 Volvo Truck internal organisational routines.

The second pattern is Volvo Trucks internal organisational routines that controls the reporting structure of the CERC cooperation (see figure 8 below).

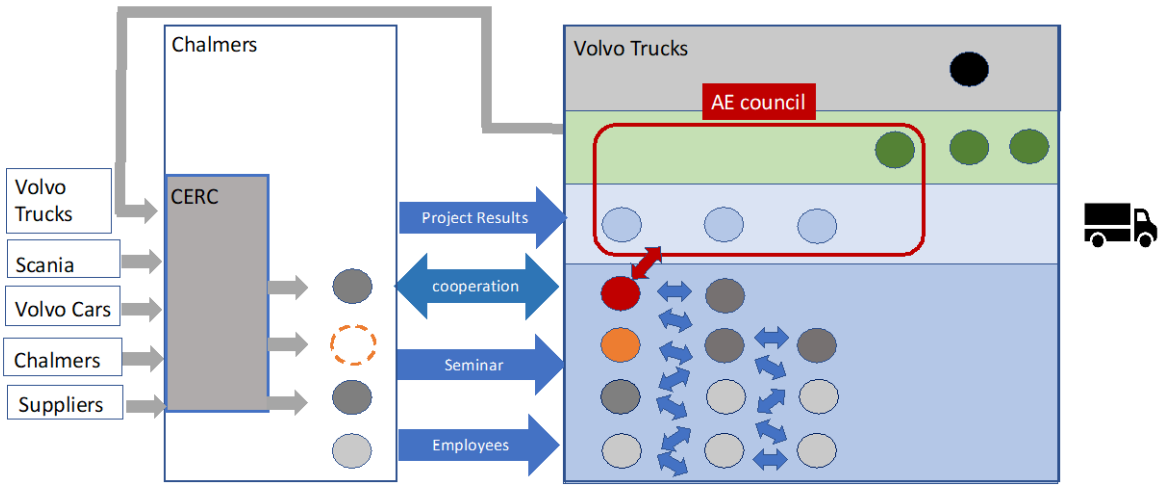

Figure 8 Volvo Trucks internal organisational routines.

This internal routine starts with the definition of the project and the appointment of the Industry representative R6 reflects that the industry representative *"is the person at Volvo Trucks that feel responsible for giving and receiving information from the reference groups. But then you really do not know how the information is spread internally within Volvo, but it is at least the first gate."* and R9 says "*the industry representatives bring this home to the functions and then it is Advance Engineering that has the greatest use of it".* After the projects were initiated at CERC an internal project at Volvo Truck was started up. R4 describes it as "*each CERC project had its own small Volvo project, where, we also internally had to account for milestones [..] mini-projects*. He also describes that you had a project plan with "*both internal and external purposes*" as there could be an internal purpose that was not known in the cooperation depending on that the competitors also were present in CERC.

The industry representative follows and steers the licentiate work via the reference group. The results were presented by the industry representative in the AE council every second month in order to inform the managers regarding the findings and discuss how to proceed. R2 says *"these results they are reported in forums within the company. When I was responsible for advanced engineering, these results were reported in the AE Council where those who worked with AE within the company and also those who were linked to the business at the universities reported. Everything that was in the AE budget was reported and these competence centers were in the AE budget. Each AE project had a responsible person and he/she was then allocated to present the results."*. R2 continue to state that it is a challenge to make use of the knowledge "*the challenge is the internal process within the company to capture and report these project results."* As the organisation has changed recently the AE council routine might not look exactly like this at Volvo Trucks now but it was valid from start to when R2 who was chairing the AE-council left the company.

5. Data analysis

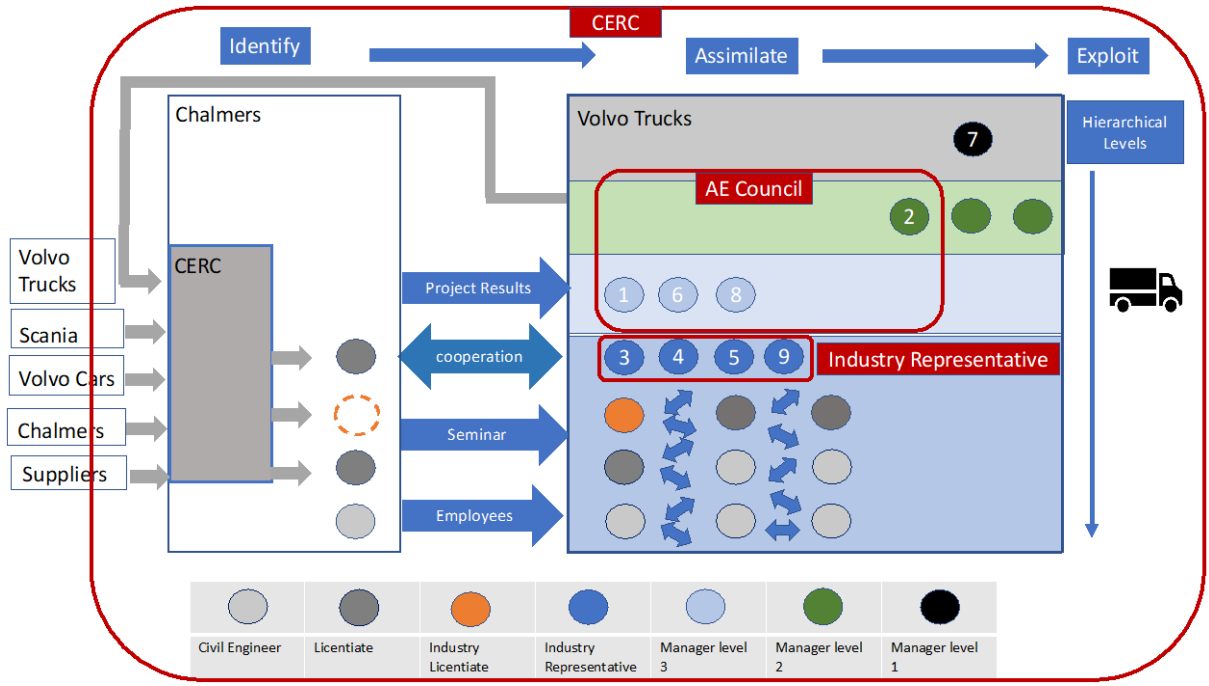

Figure 9 Data analysis

The analysis of the data is concentrated on how an individual who absorbs external knowledge affect the organizational learning in an inter-organizational cooperation, which is the main research question (see figure 9). In this case the inter-organisational cooperation is CERC and the main individual that absorbs the external knowledge is the industry representative. Specifically, two constructs have been used in order to mirror the organizational learning perspective. Those are the absorptive capacity and the organisational routine construct.

As the main research question is too broad to be able to answer in the time frame of a master thesis two more specific research questions were chosen (see table 6). Those will be analysed in the following chapters.

RQ	Construct
How does the organizational position of an individual who absorbs external knowledge affect internal learning in their organization?	*the firm's ability to identify, assimilate and exploit knowledge from the environment*" (Cohen & Levinthal, 1990).
How are organizational routines an engine of change of higher-level organizational entities?	"*an organizational routine is defined as a repetitive, recognizable pattern of interdependent actions, involving multiple actors. (Feldman & Pentland, 2003)*

Table 6: RQ and Construct

5.1 How does the organizational position of an individual who absorbs external knowledge affect internal learning in their organization?

A position of an individual can mean many different things depending on the situation but through the analysis of the data three circumstances where the position of the individual could affect the internal learning emerged. First the hierarchical position, then the organisational position and last but not least the physical position (see figure 10). All those three positions were considered of importance and will be described further.

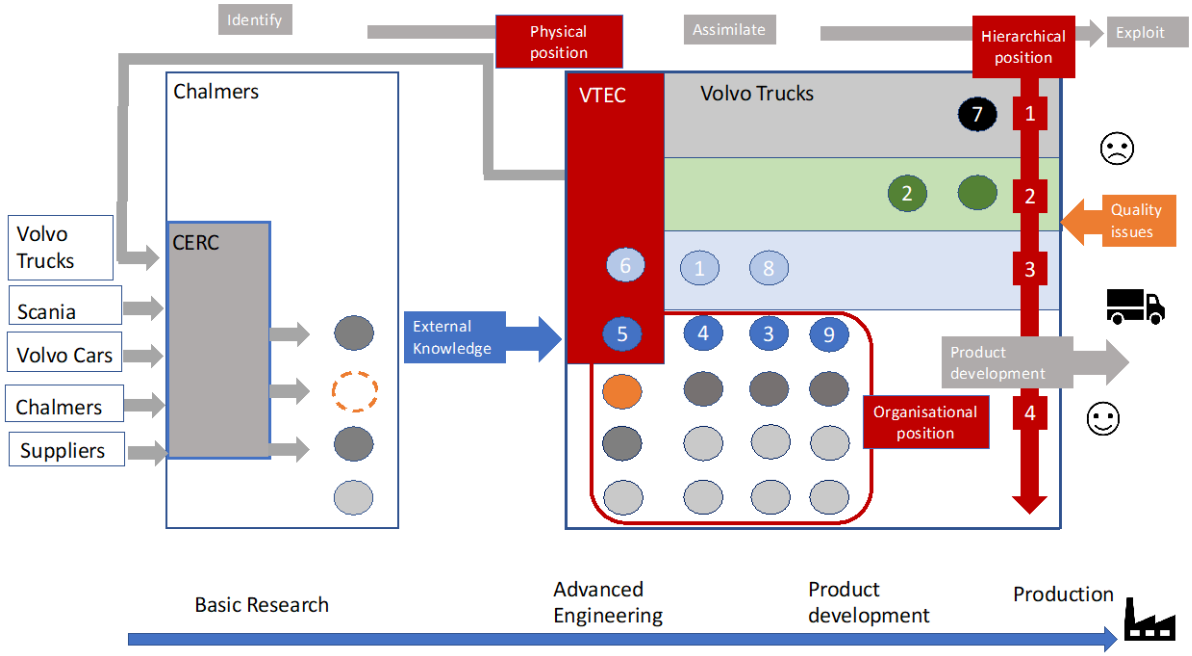

Figure 10: Internal learning in their organization

5.1.1 Hierarchical Position

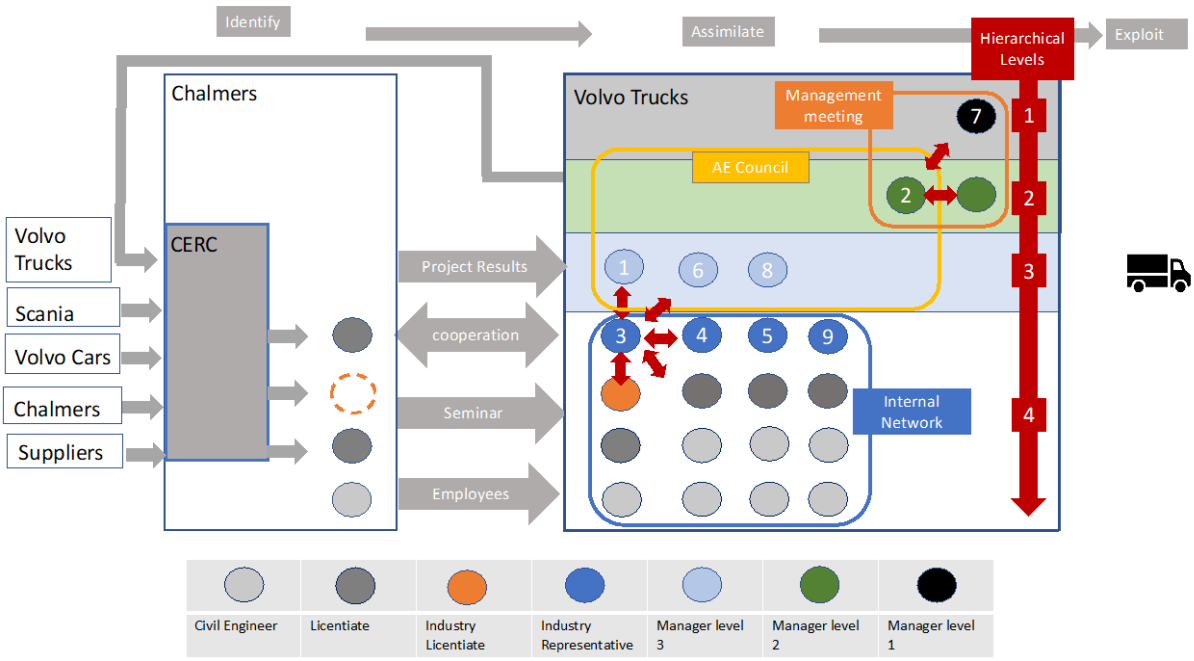

Figure 11 Hierarchical position

All nine interviewees absorb external knowledge from CERC in some way, but the type of knowledge varies, and this affects the internal learning in different ways. Employees from four different hierarchical levels were found in the material. Figure 11 above shows the hierarchical levels labelling the highest hierarchical level as level 1. The employees are presented as circles and the interviewees are numbered in interview sequence. The bar in the bottom shows the roles. The colour coding of those will be explained when discussed later when applicable. Table 7 below shows the related tasks and responsibilities in the CERC cooperation for all interviewed employees at Volvo Truck.

CERC related tasks and responsibilities by Hierarchy position at Volvo Truck.				
Position	Hierarchy level	CERC related responsibility and tasks	Respon dent	Absorbs (mainly)
Manager	1	CERC Go/No Go Structure of Organization	7	internal
Manager	2	CERC Go/No Go Internally responsible for the CERC cooperation FU budget Head of AE-council Strategy: Combustion Concept Own the Product Portfolio Own Organisation Structure In CERC board/council- bring in Volvo opinion Economical financing of CERC	2	internal
Manager	3	Assign Industrial Representative Allocate Work to level 4 Participate in forming strategy: Combustion concept	1,6,8	internal
Technical Specialist	4	Absorb external knowledge from Seminars once a year Absorb external knowledge as network member to the industry representative	3	internal
Industrial representative	4	Absorb external knowledge from CERC project Present project in AE council Spread knowledge to internal network Get project result into AR-projects or production projects	4,5,9	External
New employees: PhD	4	Use their acquired" up to date" skills in combustion technology for innovation Use and spread the structural way of working that a licentiate has learnt at CERC		External
New employees: Civil Engineers		Use their acquired" up to date" skills in combustion technology for innovation		External

Table 7 CERC related tasks and responsibilities by Hierarchy position at Volvo Truck.

It is mainly the industry representative (dark blue) that deeply absorbs the external knowledge from CERC as he/she is taking a regular and active part in the CERC cooperation all through the four years period. The industry representative as a role is positioned in hierarchy level 4, which is the "lowest" hierarchical level. However, in respect of the CERC cooperation he/she has the greatest influence on the internal learning within the organisation. R2 refer to it as a "Bottom-up" approach. The industry representative is responsible to make sure that the result of the cooperation is used in a for Volvo Truck beneficial way and he/she is also responsible to spread the information and knowledge within the organisation. This is mainly done in his/her internal network of specialists that are positioned in level 4, but also through discussions with his/her immediate manager (level 3) and through reporting to the AE council (level 2) (see figure 11).

The internal network (level 4) consist of specialists and other people that can use the external knowledge directly in their work. The knowledge retrieved from the CERC cooperation is very specific and often tailored to the needs and interests of the industry representative. He/she is most often the person that defined the research question in the first place but the specialists in his/her internal network also have the deep technological knowledge to be able to interpret the information and continue to build on it in their own work. It is in this way a constant learning loop that is going on at many levels within the company. Different assumption is tested and verified. Some is accepted, some is refuted, and knowledge is built up incrementally within the level 4 network. The main absorber of the external knowledge, the industry representative can be seen as the "conductor in the orchestra" as he/she is responsible for spreading the information to the people in the organisation that can benefit from the information and in this respect he/she can be seen as a "gate-keeper" as it is up to him/her to decide who to share the information with.

The industry representative presents the progress to the AE council every second month and thereby he/she is informing the employees on level 2 and 3 of the status of the project. However, this information is of another kind and packaged as a status report. The employees on hierarchical level 2 and 3 do not work directly with the specific knowledge in their daily work and have no use of the specific details. Instead they are interested in the overall result so that they can take decisions regarding allocation of resources, adjustment of the internal product portfolio and the further CERC cooperation (for more details se figure 11). There are also regular management meetings where the level 2 employee transfers the status to level 1 when needed. The information handed over to hierarchical level 1 is on an even higher level and mostly it is information regarding the usefulness and progress of the cooperation in order for level 1 to take decisions whether to continue to allocate finances and resources to the cooperation.

However, all hierarchical positions can retrieve some degree of external information if they participate in the CERC councils and reference groups, but this external knowledge consist of higher-level information than the knowledge retrieved by the industry representative. Thereby, the hierarchical position of the person who absorbs external knowledge does affect the internal learning in the organisation. On hierarchy level 4 the knowledge is specific and used directly in the knowledge build-up process and spread within the industry representatives' internal network. The industry representative and the internal network on level 4 are the actual people that acquire deep learning from the information. Level 1-3 retrieves tailor-made higher-level information to serve their operating purposes.

5.1.2 Organisational position

Does the organisational position of the person that absorbs external knowledge also affect the internal learning? The industry representative who is the one that mainly absorbs the external information can be positioned in at least three different organisational set-ups.

Each technological area in the company has three areas it must work with simultaneously. Those are advanced engineering, product development and quality related issues (see figure 12). There is a need to pursue AE in order to come up with new innovative products but there is also a need to work with industrialisation of the on-going project and at the same time there are urgent quality issues that affect the customers coming from the field. The quality issues are very often the most urgent of the three as there is an actual customer that is affected. Thereafter it is the project work as this will create new products in a near future. AE on the other hand is more long-term development, which is easier to down-prioritize. This is considered as a constant battlefield of resources.

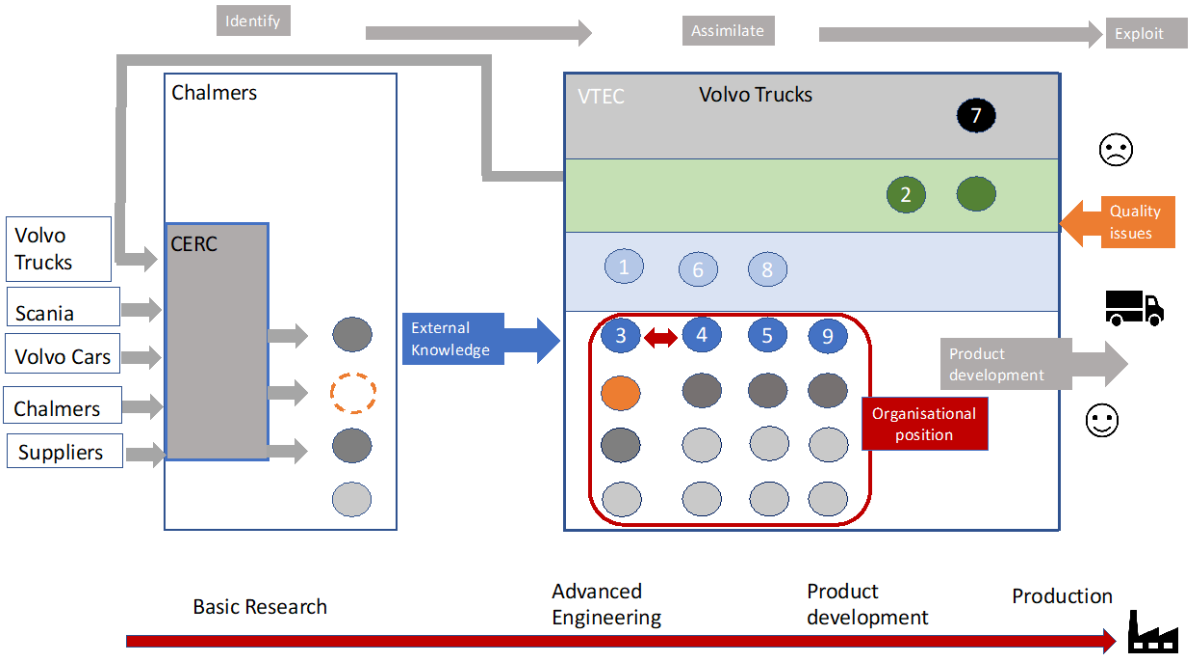

Figure 12: Organisational position.

There are different ways to organize the immediate surroundings of the industry representative. The organisation is decided by level 1 and 2 management and they can decide to organise the group level in different ways. Figure 13 shows a schematic view of three different organisational options. First option is to have all the people working with one technology in one group with dedicated resources for AE. The industry representative who absorbs the external knowledge will then be "guarded" from other disturbing work tasks and can focus on advance engineering including retrieving information from cooperation's like CERC and use the findings to build on his/her existing knowledge. The internal learning will be rather good if the industry representative is sharing the information in an efficient way as there are limited barriers to spread the information.

Another way to organise is to have everyone in one group but without dedicated resources for AE. With this organisation there is a risk that the time spent on AE is eaten up by the quality issues and product development which are more pressing in the short run. The industry representative will in this organisational setting retrieve less external knowledge which affect the absorptive capacity and therefore the internal learning.

Finally, the people working with the same technological area can be divided into two groups. One group with all AE employees and one with the employees working with product development and quality issues. In this case the AE resource is secured but the internal learning might be hindered as it builds up an information barrier between the groups.

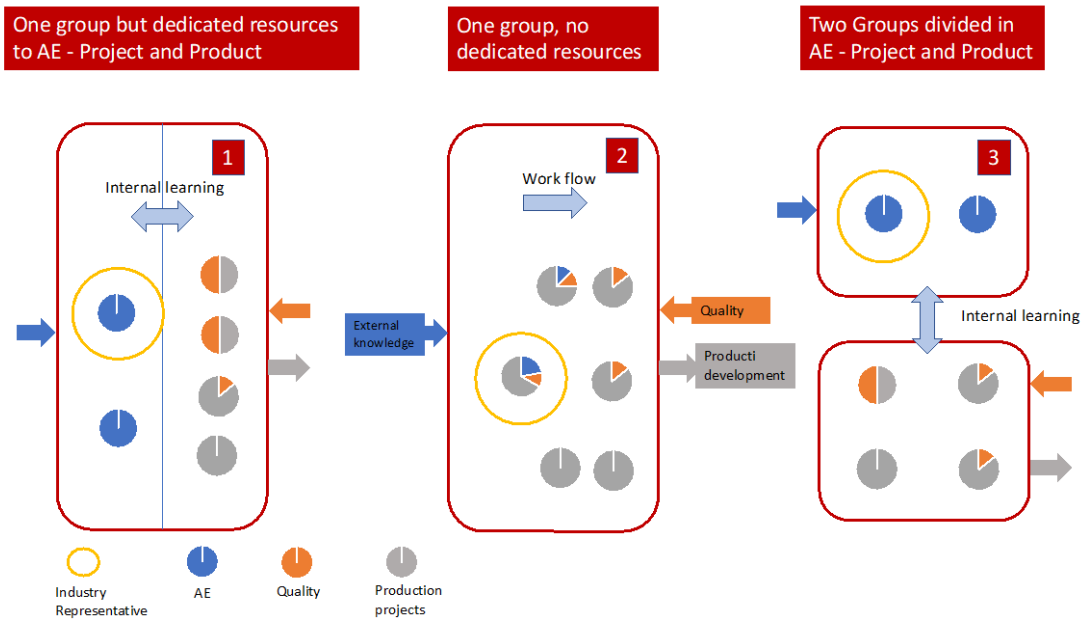

Figure 13 Organisational position of the industry representative.

As all the three organisations have different pros and cons (see table 8), measures must be taken in order to try to mitigate the risks and enhance the organisational learning.

Org	Description	Pros	Cons
1	All employees in one group but employees absorbing external knowledge only works with AE	Secures AE resources. Information sharing quite easy.	Knowledge divided and there might be a barrier between AE and projects that hinder that the projects receive the external AE knowledge.
2	All employees in one group and employees absorbing external knowledge are assign on a project basis	Everyone has the same knowledge.	Risk that the external absorption of knowledge is down prioritized and thereby internal learning decreases. Does not secure AE resources
3	Employees absorbing external knowledge and other employees divided. Physical separation.	Secures AE resources.	Information sharing more difficult and thereby internal learning hindered. The retrieved external information stays in the AE setting.

Table 8: Organisational position of the individual that absorbs external knowledge

How does the organisational position of the person that absorbs external knowledge affect the internal learning? The organisational set-up influences the internal learning as the industry representative is affected. It affects how easy it is to spread retrieved external information and it also influence who will get the information. And this affects the internal learning. The organisational set-up also affects how much knowledge the person who acquire external knowledge (the industry representative) can actually retrieve. This is due to distractions in form of pressing quality issues and product development projects. This also influence the internal learning as the amount of new knowledge is decreased.

5.1.3 Physical position

How then does the physical position influence the internal learning (see figure 14).

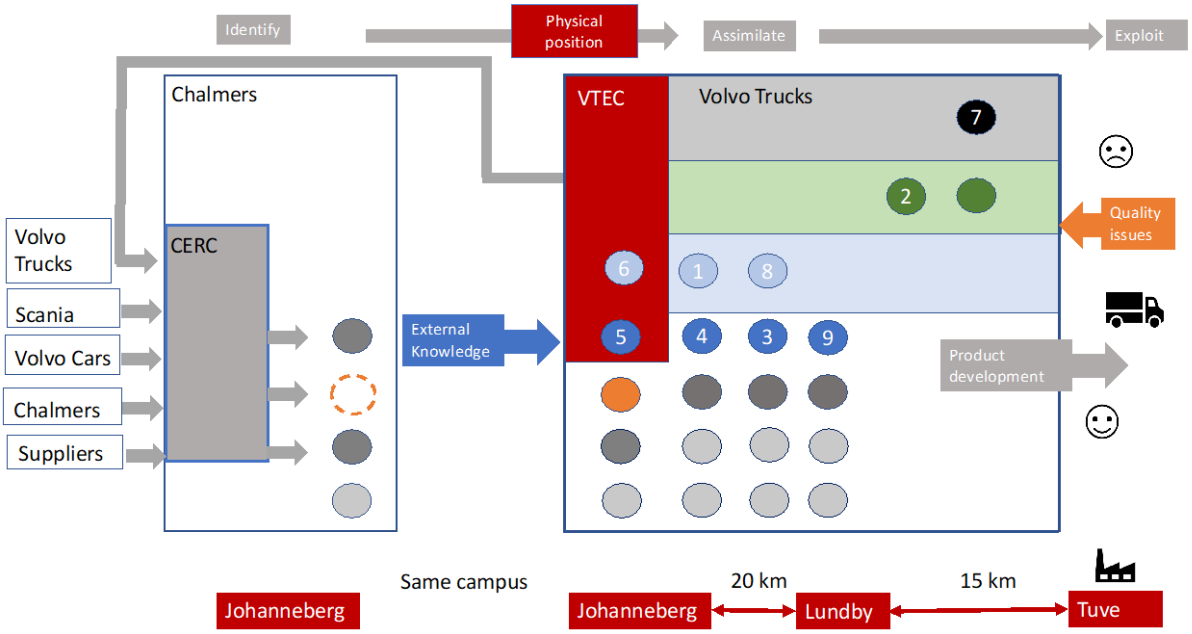

Figure 14: Physical position

Two of the interviewed employees, one manager (R6) and one industry representative (R5) are located in Johanneberg close to Chalmers University of Technology and the licentiates at CERC. They reported to the AE function at Volvo Trucks sitting in Lundby 20 km away, but they belonged to a separate company Volvo Technology (VTEC). Recently there has been a reorganisation and VTEC is not an operating company anymore, but the employees are still located near Chalmers. VTEC originally was moved to the facilities in Johanneberg in order to enhance the cooperation with Chalmers and the university which was in a build-up phase and was judged to need support from the industry. The whole purpose with being located at Lundby is the cooperation with Chalmers. However, this created a distance to the remaining AE-employees and the product development in Lundby and generated a greater distance to the knowledge of what customers need.

The influence on the internal learning is more or less the same as for the organisational position. That said, the physical distance is considered to make the information and knowledge transformation more difficult and might distance the industry representative and create a lock-in situation where the information gets stuck at VTEC and not transferred in a good way to product development. However, in this case Volvo Truck tried to mitigate this risk as R5 was also reporting to the AE council.

5.2 How are organizational routines an engine of change of higher-level organizational entities?

In 2011 Salvato & Rerup created a model of Organisational Capabilities. They defined lower level organisational entities as individual competencies and routines and higher-level organisational entities as capabilities, dynamic capabilities and firm strategy. (Salvato & Rerup, 2011).

Two organisational routine patterns were found in the CERC cooperation that affected the higher-level organizational entities. In this case the firm strategy. The overarching CERC cooperation and the advanced engineering routine within Volvo Truck.

5.2.1 The overarching CERC cooperation knowledge strategy build-up

The first organisational routines that affected the firm strategy was the overall CERC organisation. The cooperation set-up can be considered to be an organisational routine as it is repetitive in a four-year cycle, it has clearly recognizable pattern in forms of meetings, governance structure, roles and responsibilities etc and it is involving multiple actors. An organizational routine is defined as:

"a repetitive, recognizable pattern of interdependent actions, involving multiple actors. "(Feldman & Pentland, 2003).

The overarching higher-level entity that the CERC organisational routine is set up for is the strategy to build up new knowledge in the combustion field.

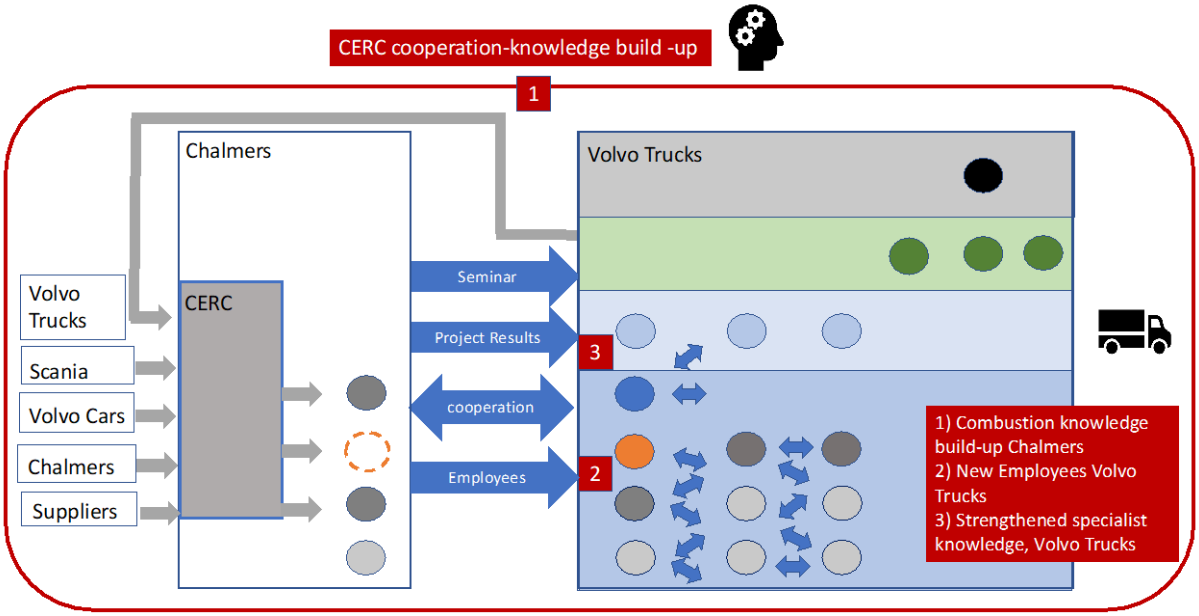

Figure 15: Overarching CERC cooperation.

The overarching organisational routine for the CERC cooperation is already described in chapter 4.2.1. This chapter will instead discuss the knowledge build up process strategy that is the major purpose of the cooperation.

First, there is the general combustion knowledge build-up at Chalmers University of technology. The combustion field is technically complex and in 1996 when the CERC cooperation started it was under immense development due to severe governmental emission legislation. There was a general understanding that new innovative technology was needed in a fast pace in order to meet the stringent requirements and there was a lack of knowledge in the field. One of the measures that was taken in order to increase the knowledge base of the institute of combustions technology at Chalmers was to instigate the CERC cooperation. As this is a mutual cooperation between Chalmers and the automotive companies, both parties build up knowledge. Chalmers gets knowledge about the latest technology used and the projects that fit into this so that they work with things that are tightly tied to reality and not with projects in a “dry-swim” manner. Chalmers have the know-how and structure regarding how to set-up base technology research and they have specialized measuring equipment for this purpose. Together they build up knowledge to strengthen the university and the automotive industry knowledge in combustion technology.

Secondly a very important part of this process is the skilled people that Volvo Truck can employ when they have graduated. It is both licentiates and civil engineers with strengthened knowledge in the specific field. The overall thinking is that when the institute at the university retrieves a higher knowledge level in the specific field the civil engineers graduating from the university subsequently will have better knowledge in that field when they graduate. Also, the licentiates will be "worth" more to Volvo Truck as their research has been performed with real cases in mind and in Volvo Trucks case there was also an engine with Volvo geometry to use for the research, which generated results that was directly applicable to their products. They are also better skilled, retrieves a structured way to work and their knowledge can be assimilated into Volvo Trucks already from day one when they are employed. The cooperation between the industry representative and the licentiate also streamline the tools and methods that are used which makes cooperation smooth and facilitates the cooperation between experts in the field as they all speak the same language.

Thirdly the knowledge is directly built up at Volvo Trucks. Mainly it is the industry representative that absorbs the new knowledge. This is done by the cooperation in the reference groups and through the actual project results. Furthermore, the industry representative spreads the information to his/her internal network and in this process more knowledge is generated through discussions and testing in-house. The licentiates also spread knowledge through seminars at Volvo Trucks.

R5 describes the cooperation like a "*self-playing piano*" that is as long as there has been improvement it has fostered interest in in the next project and the cooperation has continued. He says that they do not need to be missionaries for it. The table below shows the empirical data for the benefits that the interviewed at Volvo Trucks attached to the CERC cooperation and the knowledge build up.

Respondent	Benefit with CERC (knowledge build-up)
1	Employees/PhD students. Testing of hypotheses in the research.
2	Volvo can recruit fully trained doctors. Project results arising from the cooperation. Network of contacts between companies,
3	PhD students to hire. Staff recruitment of people who can analyze, understand relationships and draw conclusions. Providing an opportunity for those involved to come out of the Volvo bubble for a while and get to think new, think differently and it has to contribute in here as well. Even though it may not be exactly the right things, it gives you energy. Strong research provides better civil engineers. Applied research that suits Volvo.
4	Research school which trains a generation of researchers. Methodology building more important than the actual technical result.
5	People that has worked with the same type of tools. Simulated combustion (computer model). Understanding what's going on inside the cylinder. Spray chamber. Optical methods, Single-cylinder engine. Build up of combustion knowledge. Employees who has been licentiates. It's a postgraduate education. One becomes more systematic, more accurate, more source critical and less opinionated. More facts and you get pickier with definitions. Advanced methods and calculation.
6	Employed PhD students. Subject knowledge in the subject. Generic knowledge. Understanding how emissions are formed and how to reduce them.
7	Recruitment of new talent. Actual results (flow in the cylinder head, temperature control). Knowledge. Personal contacts.
8	Contact route into the university for recruitment of people with the right interest and know-how. Knowledge building of specific areas of technology. Although it is often the case that Volvo has subcontractors, it is important to build up deep knowledge so that you understand what you are buying from subcontractors. Personal development. Strong network with Swedish companies and colleges. Also, international network.
9	Employees that Volvo can hire and who do a good job, which goes into the products. PhD student who is trained in research and structured thinking. Relevant research and learning.

Table 9: Benefit with CERC (knowledge build-up)

5.2.2 Advanced engineering routine within Volvo Truck.

The second organisational routine is the internal routine to handle CERC within advance engineering at Volvo Trucks.

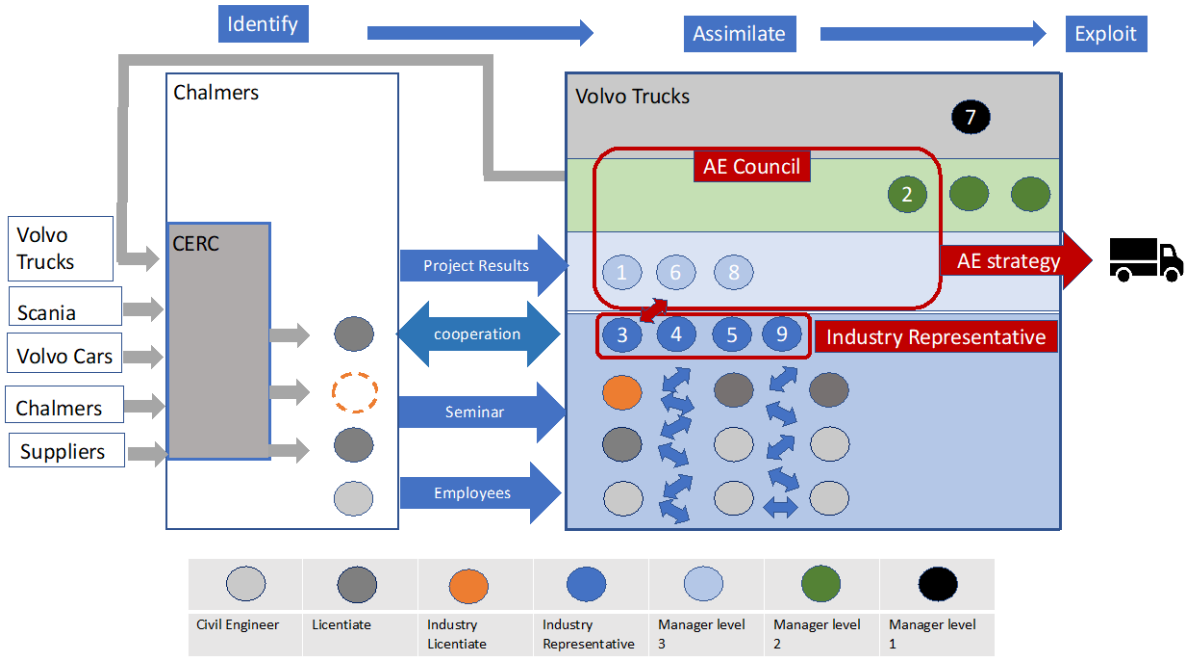

Figure 16: Advance Engineering routine.

The internal organisational routine at Volvo Trucks regarding how to work with advance engineering from the CERC cooperation forms a repetitive, recognizable pattern of interdependent actions and it is involving multiple actors, so it follows Feldman's and Pentlands definition from 2003. Recent re-organisation might have changed this routine somewhat, but this routine is supported by the data from the interviews.

The organisational routine starts when a CERC project is initiated. Volvo Trucks appoint an industry representative. He or she comes up with an internal Volvo project specification. This project specification is written down in a project initiation format. This format consists of an actual project plan, a budget and the deliverables. The industry representative attends the reference groups and hopefully he/she is also actively engaged. Every second month he/she presents the progress in the AE council. If the results are of specific interest a technical engineering report is written and stored.

The AE-council has the total budget responsibility for the advance engineering, and they can therefore decide how to distribute the resources and what combustion strategies to continue work to with and which to close down. That is this organisational routine steer the innovation within the area and it can

therefore be recognized as an engine of change of a higher-level organisational entity namely the AE strategy. R1, R2, R3, R5 and R6 suggest that the wave piston innovation is one of the most important outcomes from the CERC cooperation. It is an innovation that was awarded the Volvo technology award 2017 (Volvo, 2017). Most of the testing and verification for this project was performed internally at Volvo Truck but some basic hypotheses were tested within the CERC cooperation. It was developed and reported through the AE-council and it was in this council that it was decided to patent the innovation.

6. Conclusions

6.1 Answering the Research Questions

Some patterns that can answer the two research questions were found when analysing the data from the interviews. Those will be summed up briefly in this chapter. Starting with research question one: "*How does the organizational position of an individual who absorbs external knowledge affect internal learning in their organization?"*

The empirical findings and data analyses found three different ways that the position of an individual who absorbs external knowledge is affecting the internal learning of an organisation. Those three were: *hierarchical position, organisational position and physical position*. The hierarchical position affects the information that is absorbed and thereby the internal learning, the organisational position affects how the knowledge is spread within the organisation and how much external knowledge that is actually absorbed and finally the physical position affects the knowledge acquisition and the spread of the knowledge.

Continuing with research question two: *How are organizational routines an engine of change of higher-level organizational entities*?

The analyses found two organisational routines patterns in which the individual that absorbed external knowledge affects higher level entities. Those two were the overarching organisational routines that affect the knowledge build-up strategy and the internal Volvo Truck advance engineering routine which affect the technological concept strategy.

6.2 Recommendations

As inter-organisational cooperation like the CERC cooperation is built on basic research that is not always directly applicable to the new products designed it is not the actual results that are of most interest. This is important to notice as it would be easy for the management to say no to further funding when they feel that there are no actual results coming out from the cooperation. But this kind of technology development takes time and one cannot expect quick results. Some years the result will be disappointing and other years the result will be fantastic. Respondent 6 says that it is like a "*ketchup effect*" some years nothing comes out from the cooperation and other years a lot comes out. He also states that "*You have to believe in it*.". Furthermore, maybe the most important part of the cooperation is the actual knowledge build up and that is extremely hard to measure. Several of the respondents notice that you cannot write a business case on the projects as this is basic research and you cannot know where it will end up. Even bad results can be good as then you know what areas not to continue with. To sum-up this the recommendation is to be patient with the results and to believe in it. Then eventually a break-through technology like the Wave piston can come out from the cooperation.

Another recommendation is to be careful when organising the company and setting up organisational routines as the organisation is important for the amount of external knowledge retrieved. It is very important for the managers to "safe-guard" the time of the people that is appointed to retrieve and assimilate the external knowledge. In this specific cooperation it is the industry representative that is the major bearer of knowledge. When the resources are strained due to pressing projects and quality issues it might be easy for the managers to redirect the resources working with the more long-term advance engineering to instead working on the more pressing issues. But if this happens regularly the knowledge build-up will be hindered which will affect the result in the long run and this is devastating for the company as it might be looked in stagnation.

Finally, respondent 3 says that the cooperation gives *"the employees at Volvo Trucks an opportunity to come out of the Volvo bubble for a while and think in new ways*". This is also a vital part of the cooperation even though it is extremely difficult or even impossible to measure. Innovation is very much about thinking in new ways and it is vital for the management to support this effort and believe in it in order for the employees to come up with new ground breaking product like the Wave piston with a totally different design from previous pistons.

6.3 Future Research

There are many interesting possible future research areas that could be undertaken within the frame of a technology cooperation like the CERC cooperation.

One interesting topic for future research could be to dig deeper into the wave piston development and look into what ingredients that made it successful. It would also be interesting to scrutinize if the process could have been speeded up. Some of the interviewees perceived the process as slow. So what obstacles is really hindering the process, and can these be eliminated in some way?

Yet another future research area that would be of interest is to research more on diversity in the workforce and its impact on innovation. One of the respondents discussed that all the employees working in the field has gone in the same schools, taken the same courses and worked in the same setting. That might foster psychological lock-in effects regarding what you can and cannot do in respect to innovation. Would a more diverse workforce from different fields be able to come up with more innovative products as they might be more open to new designs? The inventor of the wave-piston noted that he had a hard time to convince the rest of the company about the brilliant idea. Could it have been different if the workforce was more diverse and collaborated more over the departments. In this respect it is also vital that the organisation really pays attention to the different suggestions. There were respondents in the material that thought that it was hard to get your voice heard without a PhD in the subject. Is this also hindering the innovation process within the firm? How would a more open climate affect the innovation outcome and how can a company set up an organisation with a more cross-collaborative mindset and at the same time keep its hierarchical levels?

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8. Appendix

Appendix A: Interview Guide

Section 1 – Background Questions

Could you tell me about your background?

What is your position at the company today?

Describe why the company began cooperating with the university in the specific case?

How long and to what extent have you worked with or worked closely with The University?

- When in your career did you start interacting with the university?
- What is your experience of collaborating with the university?
- How/by whom were you asked if you wanted to participate in the collaboration?
- Why did you want to be part of the collaboration?

What was your role in the collaboration?
- During what time period where you active?
- Who had your role before you?
- Who had your role after you?
- What were your assignments in cooperation with the university?

Which people have been involved in the cooperation?
- What background has been important to have with you as a participant from the company?

Section 2 – Themes

Apply

How has the cooperation been beneficial/contributed to the company?
- If so, how has it been valuable to the company?
- Where at the company can we see today the results of the collaboration?

Process, production, organization, product, employee.

Identify

How did you come to the conclusion that these contributions were valuable to the company?

- Was it clear from the outset that they were valuable?
- Who did the evaluation of the contribution of the cooperation and where was it made?
- Was it clear from the outset in which areas they were valuable?

Can you describe activities that have been more valuable than others in identifying important contributions?

- Are the activities structured in any way?
- What is the expected outcome on the activity?
- What happens if the result is not reached?

Have there been decisive actors?

- If so, give examples of actors and why they are important.
- Please describe when these actors became important.

Have there been unexpected contributions that have been important?

Have there been unexpected areas at the company where the contributions have come in handy?

Assimilate

How has the company worked to make the contributions come into use?

- Actors - who works
- Activities - how to work
- Time - when does this happen
- Challenges

How has the company worked to spread the grants within the department?
Is it structures in some way?

How has the company worked to spread the contributions within the organization?
Is this structured in some way

Section 3 - Summary - AFTER AN INTERVIEW

- How did the collaboration begin?
- Why did they start working together?
- How has knowledge been applied /where can it be found in products today?
- How was important knowledge identified?
- How was important knowledge assimilated?