Collaboration between university research and industry: innovation process

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LIST OF ABBREVIATIONS

All abbreviations that are used in the thesis are listed below.

U.R. – university research
SMEs – small and medium enterprises
GDP – Gross Domestic Product
UK – United Kingdom
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This dissertation study focuses on reasons and means of industry and university collaboration which lead to innovation. Collaboration in this study is viewed as one: communication, exchange of knowledge and learning form the innovation process. This research has followed a qualitative approach for methodology and the data was collected through two interviews. The results of this study show how university research collaborates with industry from the university research point of view. The findings also reveal that university research can not produce innovation without practical knowledge which is provided by company during collaboration. In the same way the company can not produce scientifically based innovation without the interactive learning.

Key Words: collaboration, university research, innovation process, learning, knowledge, qualitative approach
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1 INTRODUCTION

This chapter is aimed at introducing the information about the innovation process and collaboration between university research and industry. Following this information i will present the research background, problem, objective and delimitations.

There is an obvious decrease of academic research in chemistry and electrical engineering as a source of important new knowledge for industry. In the beginning of technological developments in the semiconductor industry academic researchers were engaged, however later R&D in industry has been distinguished from the activity of academical researchers. In the end of 1980s such studies like biology, metallurgy and computer science became essential sources of new ideas and techniques for industry. Teece D. J. (1989) emphasises the importance of the collaboration between the industries in which mentioned sciences are essential with universities in order to get new knowledge and techniques. Lately it became obvious that close links to the university for certain industries are crucial on the way to success (Teece D. J., 1989).

1.1 Research Background

The importance of the concept of innovation has grown considerably, which resulted from the fast progresses being made in science and technology. Every forward manager is concerned about the implementation of incremental innovations to the production processes. In order to find out if the improvements can be applied in a practice managers develop new products and production processes. Usual people are also interested in changes that could make their life easier and better disposed. Anyway, though changes are all around us the concept of innovation remains to be a mystery. (Knight K.E., 2001).

According to Sundbo J. (1998:8) “The long term competitiveness of firms, and of national economies, reflect their innovative capability and, moreover, firms must engage in activities which aim at innovation just in order to hold their ground.”

Stenberg L.(1995: 27) mentions several ways in which the firms can engage in innovation activities. These are:

- Involvement of suppliers in manufacturing process.
- Close and intense relations with users.
- Collaboration with university research.
- Collaboration with R&D institutions.
- Technical analysis of the products of competitors.

The collaboration with university research is to my mind the best way to engage in innovation activities, as university researchers base their studies on scientific methods and knowledge, which has been continuously improved by learning.
According to Strambach S. (2002) up to now researchers were focusing mainly on technological product and process innovations (TTP). Therefore researchers were orientated mostly on the scientific-technological generation of knowledge which was transferred from science to the economy. Theoretical and empirical studies of innovation system concentrated on research and development of intensive industries, universities, public and semi-public research, technology transfer institutions and political actors, who were from the field of technology policy. “However lately it was becoming obvious that national innovation systems – which have a different way of organizing the institutional production and diffusion of knowledge – have technological, scientific, and industrial specializations which, despite increasing global integration, are changing only slowly” (Strambach S., 2002: 216). A major reason for this is that the technological innovation is associated with institutional development which in turn is connected with different innovation profiles. (Strambach S., 2002)

The relationship between industry and university has been enhanced lately. The importance of university research partnership for the innovative competence of a well developed country is emphasised by many observers. According to the new surveys carried out by U.S. science faculty there is a growing need for partnership with industry among many universities. However very often industry is not aware of the roles that universities play in such partnerships. Another problem is the lack of information available about the economic consequences associated with the impacts of universities (Link A. N. and Scott J. T., 2006)

Link A. N. and Scott J. T. (2006) single out two major motivations for industry-university collaboration:

• Possibility to access to complementary research activity and research results;
• Access to key university personnel.

What concerns the motivation of U.R. Link A. N. and Scott J. T. (2006) argue that university motivations are in most cases financially based.

1.2 Research Problem

The literature review I have done presents a wide scope of books and articles about the importance of innovations and about the suggestions how to develop innovation process. However, the most frequent object of argument is how to improve internal innovation process in the R&D field. But still there is little discussion concerning external innovation processes. External innovation process is the collaboration of cooperative research institutes, public research institutes or universities who use research, knowledge, experiences and science to invent new ideas of how to produce goods.

Sundbo J. (1998) writes also about the lack of information of external innovation process. The author argues that there are several apparent traditions in literature, each dealing with innovation, but with no “dialogue” among them; the authors did not quote one another,
had different views of where the innovations come from, and of who or what produces them.

One of the external sources of knowledge for innovative activities of the company is university research. However, there are still countries, which have not properly developed the collaboration between the university research and industry yet. Not all the big companies use the possibility to collaborate with university research. Why? Probably some companies still don’t know the influence of university research on the innovation process. Some companies don’t even know what exactly happens when university research collaborates with industry.

Stenberg L. (1995) writes that usually the surveys or interviews according the innovation process and collaboration with university research are done from the companies’ perspective. And what about opinion of university research managers? What would they suggest in order to improve such collaboration?

While analysing this collaboration I will also try to answer the following questions:
- Why does industry collaborate with university research?
- How do both sides collaborate?

1.3 Research Objective

According to Lundvall B. A. (1992: 37) “if innovation reflects learning, and if learning is interactive, it follows that innovation is rooted in the institutional set-up of the economy”. In the learning process the exchange of knowledge is the most important factor. Innovation may accordingly be viewed as basically a collective activity; an outcome of communication and interaction between people.

According to the statement above, the formulation of my research objective is as follows: **To analyze university research and industry collaboration, in which communication, exchange of knowledge and learning form the innovation process.**

1.4 Delimitations

In order to achieve the purpose and to answer the questions mentioned above I will study the collaboration between the company Volvo and the university research from Halmstad University. The study of mentioned collaboration is delimitated by two interviews: with the leader of Halmstad research group – professor Bengt-Göran and with researcher Frédéric Cabanettes. Such delimitation was made in order to get to know how and why industry collaborates with U.R. from the perspective of university research group.

Sundbo J. (1998) mentions the distinction between *radical* innovations, which are defined as qualitatively very new and different elements which change a whole field, and *incremental* innovations, which are defined as small improvements which occur
continually through the introduction of smaller new elements. Thus the results of projects managed by university research are more incremental than radical. Therefore incremental innovations will be the core of the analysis in my study.

1.5 Research Outline

The research consist of six main chapters which are illustrated below:

First chapter presents: background to the research, research problem, objective, research questions, and delimitations.

Second chapter presents: literature review, definitions and parent model.

Third chapter presents: methodology which was used to achieve the objective and to get answers for the questions of the research.

Fourth chapter presents: the results of primary research

Fifth chapter presents: the analysis of empirical data in connection to the set objectives and questions asked.

Sixth chapter presents: conclusions of the research, recommendations for U.R and industry in collaboration and suggestions for the future study.

Figure No.1 Research outline
2 THEORETICAL FRAMEWORKS

2.1 Industry - University Research Relationship

Tucker R.C. (2007) points some more reasons for collaboration with U.R. He mentions four types of them:

- Individual consulting by faculty members on a wide variety of subjects ranging from in-house corporate R&D, to production problems, to other business issues.
- Industrial R&D in order to solve problems with existing products or processes requires work at the university.
- Incremental development to improve existing products or processes.
- Basic research that will hopefully lead to significant new discoveries and inventions.

According to Tucker R.C. (2007) the assets of the collaboration between university and company include intellectual skills of the research personnel and supporting staff such as business development, operations engineers and marketers. Usually, equipment of the company complements the research tools available at the university. For example, often happens that during the development of a certain product researchers of university can have a unique understanding of the theory necessary to develop a new material composition to solve the problem. Researchers from university can also have the capability to do materials characterization and laboratory-scale studies, but not the capability to produce the new product. However, industry has mentioned capabilities and a practical knowledge. Respective capabilities of both sides therefore are highly complementary.

The research project must be cost effective and timely for the company to be interested. Industry expects reasonable accountability from a university and expects to pay for work done, not for students to study or faculty to do unrelated work. Sometimes, university overhead rates are too high compared with industry norms and may cause a company to look elsewhere. From the perspective of industry, time limitations depend both on the needs of company and research group. Before starting the project both sides should agree with the conditions of each other. Companies expect accurateness and diligence, however understand also the unpredictable events of project implementation. Just constant communication between both sides ensures satisfaction of analyzing collaboration. Collaboration between U.R. and industry provide significant opportunities for students to interact with the “real” world of industry with the satisfaction of having contributed to useful new products or processes (Tucker R.C., 2007)

According to Link A. N. and Scott J. T. (2006) there are a lot of possibilities how U.R. can attract industry for collaboration. The channels connecting U.R. and industry are: students, publications, research contracts, technical conferences, consultants, personnel exchanges (for example, adjunct professors). Link A. N. and Scott J. T. (2006) mention the reasons why both sides collaborate and present some interesting facts about this
collaboration. One of such facts is that industry does not consider universities to be able to invent totally new products. This argument was proved by a survey, in which 464 examples of collaboration between U.R. and industry were examined. The results of that survey showed that there had been just some cases when new commercially marketable product was the result of collaboration between U.R. and industry. However, companies wish to collaborate with U.R. and try their best to improve good relationships with universities. This willingness exists because of some obvious reasons. Companies want to get access to the educated students, to involve university’s faculties in new business ventures and to stimulate university to familiarize with their equipment. Cooperation with universities enables companies to be aware of science and new technology (Link A. N. and Scott J. T., 2006)

2.2 The Concept of Innovation

Before starting my own analysis I would like to present and to acknowledge the work of experts of the field. In this chapter I will point out the major definitions and perspectives concerning the concept of innovation as reflected in the recent literature.

According to Knight K. E. (2001) it is not easy to define the concept of innovation within a company because there are some value judgments attached to the term of innovation. Innovation in its broader sense can be described as a state when a company produces new products or uses new techniques of production. However, the usual expectation of the people that innovation should be something “positive” brings up a certain misunderstanding. The meaning of “positive” can be linked to the profits, cost savings, etc. whereas people are also inclined to use the term of “innovation” when they are speaking of changes that are socially acceptable. However in a practice innovation not always appears to be positive. That is when we face the phenomenon of the so called “negative innovation”, i.e. innovation that is not economically useful. Having analysed the concept of innovation in detail Knight K. E. (2001: 478) comes up with the following definition: “an innovation is the adoption of a change which is new to an organization and to the relevant environment”.

Grupp H. (1998) defines “innovation” and “to innovate”. According to the author, innovation, as a noun, can be related to the concept of idea. In other words innovation is regarded as a bright event. Whereas, “to innovate” means to develop something significant. Therefore the innovative process is defined in terms of the developing process. The innovation in this sense involves economic, technological, political, cultural and social innovations. In the field of the economic sciences, result-oriented concept shapes scales according to which any process of development is innovative if it brings profits. Grupp H. (1998) relates the term of innovation with the term of novelty. The author points out five forms of innovations:

- new consumer goods
- new production
- new transport methods
- new markets
new organizations

Therefore, according to Grupp H. (1998), the concept of innovation is the complex of the result of an innovation process and the forms of innovations mentioned above.

According to Sundbo J. (1998) the concept of innovation means a re-creation of the elements of the production of a certain product. He sees innovation as a process which begins with the devise of a new element. The devise must be later implemented to the practical production, because the main goal of inventing is commercial use. However, the realization of theoretical inventions is complicated as innovation should be recognized by the people round about and should be developed for commercial use. It means innovation must be useful economically and practically as well.

According to the definitions of Sundbo J. (1998) there are four types of innovations:

1. *A new product or service* – the role of this innovation is to present new products or services which are produced or provided by the company;
2. *A new production process* – the role of this innovation is to present new elements in decisions, organization’s tasks, information system, service operations, technology of the company;
3. *A new organizational or management structure* – the role of this innovation is to present changed work projects, authority relations, and the system of communication. This group of innovations is related to the previous group, because both include formal interactions which influence the production process.
4. *A new type of marketing or overall behaviour on the market* – the role of this innovation is to present new relationships with the state and other official regulation systems.

Knight K.E. (2001) in his article also mentions four types of innovations, however one of them differs from Sundbo’s J. (1998) innovations mentioned above. Knight K.E. (2001) named the fourth type of Sundbo’s J. (1998) innovation (“*new type of marketing or overall behavior on the market*”) “people innovation”. People innovation can occur for two reasons:

1. Changing the personnel by increasing or reducing the number of employees working in a company;
2. Changing the rules, techniques, education system of the organization, what leads to the modification of the behavior of employees.

In my work I am analyzing only one type of innovations: a new production process. Researchers by the scientific methods try to find incremental innovations considered as improvements which occur continually through the introduction of smaller new elements of production.

### 2.3. The System of Innovation

Lundvall B. A. (1992) writes that innovation can also be viewed as a system, in which actors compose the innovation process by collaborating with each other. In my study I
describe the concept of innovation system in order to make the reader aware where the collaboration between U.R and industry comes from. To my mind it is necessary to explain for the reader that besides two actors: U.R. and industry, some other actors are linked to make the process of innovation possible.

Firstly, it is helpful to define the concept of a system. Lundvall B. A. (1992) gives the broadest possible definition of a system. He writes that anything that is not chaos can be called a system. The main feature of a system is that it consists of elements which are related with each other. Consequently, a system of innovation consists of elements which interact in the production, diffusion and consumption processes. According to Lundvall B. A. (1992) the basic activity in the system of innovation is learning. Since learning is a social activity it involves interactions between people. The innovation system is also dynamic because it is distinguished by reproduction and positive feedback. The relationship between these elements can be both useful and disadvantageous. In useful relationship elements reinforce each other in promoting processes of learning. However, in disadvantageous relationship elements join in constellations blocking the process of learning. Despite the corollary of the interaction of elements, their dependence on each other is characteristic in any system. (Lundvall B. A., 1992).

According to Lundvall B. A. (1992) there are four main elements of the innovation:

1. **Organization**
2. **Government** (it should promote innovation by investing money in science and development of new technology).
3. **Financial sector** (the connection between the financial system and the process of innovation is a growing public interest, because it enables the role of the financial system in regard to innovation).
4. **Formal institutions** (R&D departments which organize research activities).

The capacity of R&D departments depends on informational interactions inside the company and relations with other companies. For instance the number of extramural R&D organizations is widely increasing, what means that inter-organizational communication and cooperation is essential. The organizations of basic research such as universities, engineering schools and others are fundamental segments of the formal institutional infrastructure which influences searches in a contemporary economy. In a knowledge-based society mechanisms which join science with technology are very important. Such mechanisms can be referred to governmental and public laboratories what leads to acquisition of the awareness of mentioned phenomenon. (Lundvall B. A., 1992)

According to West A. (1992) government invests money to the processes of innovation in order to help the commercial organizations improve their competitive position in the international environment. Government is interested to increase profits of national companies, because the development of industry produces bigger GDP.

“The first factor in assessing direct investment by governments available to national companies is to consider overall expenditure by national governments as a proportion of
GDP. The role of government in managing change has grown with the greater and greater share of total Gross Domestic Product (GDP) raised by taxes: governments in the majority of industrialized countries take over 40 per cent of GDP. " (West A., 1992: 99-110)

2.4 The Concepts of Knowledge, Learning and Communication in the Innovation Process

Nowadays innovation is omnipresent phenomenon. People look forward processes of learning, searching and exploring the results of which are new products, techniques, new forms of organization and new markets. These activities sometimes can be slow and not so distinct; they can go step by step, but they will be still visible. It is always possible in certain parts of economy to find an ongoing process of innovation. Therefore, Lundvall B. A. (1992) tends to assume that innovations appear presently, at this moment, first of all not as single events, but rather as processes.

As it was mentioned in previous chapter the system of innovation consists of the actors, who are involved in the innovation process. In my thesis I will concentrate on the collaboration between the two actors: the university research and industry. I will analyze university research and industry collaboration, in which communication, exchange of knowledge and learning form the innovation process.

First of all it is useful to know how authors define the concept of process. Fagerstrom B. (2004) writes that all companies have different processes, but they become concentrating only when they have been identified and valued. Fagerstrom B. (2004) distinguishes four types of processes: organised, unorganised, planned and unplanned. However, in practice the arrangements of planned and unplanned processes are most current. The processes do not function separately. They are dependent on each other and operate together as a system. The processes viewed in a system perspective are considered as tasks and relationships between them.

Fagerstrom B. (2004) also writes about two main reasons for using processes:
1. Using of processes attracts attention on the activities;
2. Contrary to the hierarchical organisational structures, using of processes helps to determine lead-times, costs, quality, flexibility and clients’ contentment.

According to Fagerstrom B. (2004) there are two ways of defining the concept of process. First definition states that a process can be viewed as a unit of resources and activities which are related to each other and convert expenditure into production. The second definition argues that a process can be viewed as an organised set of interrelated tasks which act together.

In the management literature the concepts of knowledge management and organizational learning are current. For the last hundred years these terms have been used independently of organizational creativity and innovation. However, today in a modern management
According to Basadur M. and Garry A. Gelade (2006) the terms of knowledge management and organizational learning can be successfully connected to organizational creativity and innovation. Authors distinguish between the cognition of knowledge and the use of knowledge and join these two concepts into one general framework. This framework allows companies:

- To detect errors and implement changes to restore or improve routines;
- Make sense of sudden unexpected events and crises and convert them into opportunities for innovation.
- Anticipate and seek out new information, and emerging opportunities to develop new products, services, and routines (Basadur M. and Garry A. Gelade, 2006:46)

Morgan G. (1994) in his new famous book about organizations also mentions the importance of learning and even compares organizations to the brains. “It is possible to design learning organizations that have the capacity to be as flexible, resilient, and inventive as the functioning of the brain. Organizations are information, communication and decision-making systems. We can thus go a long way toward understanding them as information processing brains.” (Morgan G., 1994: 78).

Morgan G. (1994) proves that organizations can learn to learn. He writes that organizations are able to learn in an ongoing way. He illustrates and explains single-loop and double-loop learning. (Figures 1 and 2)

![Diagram of single-loop learning](image)

*Figure No.1 Single-loop learning rests in an ability to detect and correct error in relation to a given set of operating norms*

Adapted from: Morgan G. (1994: 79)
Figure No.2 Double-loop learning depends on being able to take a “double look” at the situation by questioning the relevance of operating norms

Adapted from: Morgan G. (1994: 79)

Step 1 = the process of sensing, scanning, and monitoring the environment;
Step 2 = the comparison of this information against operating norms;
Step 2a = the process of questioning whether operating norms are appropriate;
Step 3 = the process of initiating appropriate action

Basadur M. and Garry A. Gelade (2006) also write about single and double loop learning. According to them there are two levels of organizational learning, both of which involve detecting and correcting errors in routine. The situation is called “single-loop learning” if occurred error is detected and corrected without changing the company’s existing rules, standards, behavior and purposes. The situation in which detected error is corrected by changing company’s existing rules, standards, behavior and purposes is called “double-loop learning”. Therefore, mentioned above single- and double-loop organizational learning are interrelated with the efficiency and development of the company. Single-loop learning renews routine (efficiency) and double loop learning develops or modifies it (Basadur M. and Garry A. Gelade, 2006).

Therefore, Basadur M., Garry A. and Morgan G. write about single- and double loop learning, but don’t mention who detects and corrects the errors in single-loop learning and who takes “double look” at the situation by questioning the relevance of operating norm in double-loop learning.

If we take single- and double-look learning as objects, we encounter the question: who are the subjects in these processes? The authors analyze these processes having in mind that the subject is the organization itself. However, my assumption is that subject in double-loop learning in Step 2a can be extramural R&D organization, like for example U.R. Than the steps “2” and “2a” show the interactive learning between industry and extramural R&D organization.
Communication

According to Lundvall B. A. (1992) the process of innovation is impossible without communication. In the innovation process people constantly communicate and cooperate to each other. The result of such communication is a collective activity. Therefore, innovation can be viewed as a corporate activity.

Lundvall B. A. (1992) distinguishes 2 types of communication:
1. communication and interaction inside organizations
2. communication and interaction between organizations

In the first type of communication, departments of production, marketing, IT, R&D and other communicate to each other. If working conditions, rules and standards of the company are not formulated in respect of employees the process of innovation including interactive learning can be interrupted, because in such case employees are not motivated to communicate to other levels of the organization. Employees are forced to communicate and they do it automatically without any interest. According to Lundvall B. A. (1992) there are two main reasons explaining why communication in the organization can be hampered:
• Strict rules and strained work supervision can reduce employee’s strength to interact positively in the innovation process.
• Conflicts between different levels of hierarchical organizational structure are common and unavoidable. Managers from higher levels of hierarchical organizational structure have always more authority and are better paid comparing with employees from lower levels. Such kind of conflicts are common both in individual and big companies.

In the second type of communication, where companies communicate and interact to each other, the process of learning is obvious. Lundvall B. A. (1992) writes that a feedback from clients is essential in an innovation process. In order to have better idea of the materials delivered by suppliers it is useful to involve them in producing management processes. Therefore, both customers and suppliers are relevant to product-innovation ideas. Hence independent of the company’s size, organizations with R&D departments are more or less engaged in out-of-firm R&D cooperation. Universities and other organisations for basic research, engineering schools and so on are the important parts of the formal institutional infrastructure, which affect searches in a modern economy and have obvious impact on learning processes (Lundvall B. A., 1992).

2.5 Previous Research

Several studies have been done before concerning the collaboration between university research (U.R.) and a company. I will start with the comparison of ideas presented in the previous studies of university research and industry collaboration. I have found three articles which focus mainly on collaboration:
“Optimizing university research collaborations” by Elizabeth Starbuck;
“Developing industry – university research links – a successful model” by Fisher and Norman
“A case study of SME-university research collaboration in the context of a small peripheral country (Cyprus)” by Athanasios Hadjimanolis

The main goal of the article of Starbuck E. (2001) is to improve the collaboration between university research and a company. The author focuses mainly on the activities of the company in this collaboration and suggests the rules of managing them. Starbuck E. (2001) writes that companies must learn gradually how to collaborate with university. In the beginning companies should recognize the need of such collaboration, then it is important to choose the right partner and start cooperation. Managers of the companies must also be learned how to start, realize and manage the projects (Starbuck E., 2001)

According to Starbuck E. (2001: 40) all cost-effective university collaborations meet three criteria: “they align with the technology strategy of the company; they are managed on time and on budget; and the results are harvested efficiently to impact products or processes.” These criteria assume some conditions of the company. The article emphasizes how to achieve such conditions looking at the process of collaboration.

Starbuck E. (2001) writes a lot about how managers of a company should manage university collaborations. According to her a company should provide a training program for internal managers of university projects. This training should cover:

- Rules of engagement with university administrators and faculty members;
- Role of meetings in the two organizations;
- Decision-making differences between company and university;
- Integration of university schedules into company stage-gate process.

Starbuck E. (2001:42)

In the summary Starbuck E. (2001) sees the collaboration between university research and the company as cooperation between two subjects. And the author concentrates on the activities of one of the subjects – the company. Starbuck E. does not analyze the objects of such collaboration. The concept of innovation or innovation process was not even mentioned in the article. Therefore, the way of analysing the collaboration between university research and the company in my thesis is quite different. I will focus more on the objects (knowledge, learning, innovation) of such collaboration. To achieve the objective I will use the model (Figure 4) which illustrates the relations between learning, growth of knowledge and innovation.

Fisher and Norman (1994) in their article describe a successful example of a large programme of industry-university research collaboration in the field of construction engineering and management. The article describes how BAA plc, one of the UK’s largest construction clients, works closely with a leading university department undertaking construction engineering and management research. The initial objectives and the anticipated benefits of the collaboration for both parties are discussed in the article. The article outlines, in the form of a case study, how the initial research
collaboration links were formed and how they have developed into a major research, technological transfer, education and training programme.

So, Fisher and Norman (1994) describe a particular case. Authors write a lot about company’s benefits of collaboration with university research. In conclusion authors emphasise that commercial organization tends to have a shorter timescale for a research project and usually looks for “quick wins”. In contrast, university researches are naturally suspicious of “quick” studies and see any result from such a study as lacking precision. “Collaboration develops both organizations skills because with the help of university, company manager can keep up to date, broaden his vision and seek an assessment of issues from a “friendly” outsider. It allows the academic to keep in touch with commercial reality, and be exposed to the commercial pressures of a business in the private sector.”( Fisher and Norman, 1994:10)

The aim of my thesis differs from the aim of Fisher’s and Norman’s (1994) article. There the authors analyse the collaboration between university research and the company in a similar way like Starbuck E. (2001) does. The authors concentrate on the subjects of such collaboration and analyze particular cases. Differently from Starbuck E. they write about benefits of such collaboration for both sides. The authors in this article don’t mention the concept of innovation. Instead they write about the results and benefits of the projects. Therefore, the main difference is that in my thesis I will focus on collaboration between university research and industry from the university research manager point of view. Besides, such collaboration is analysed in my thesis as innovation process. So, differently from Fisher and Norman (1994) I will use the concept of innovation in analyzing the collaboration.

Hadjimanolis A. (2006) in his article focuses on the collaboration of small and medium size enterprises (SMEs) with universities and the main factors, which affect such collaboration in the context of a small less industrialized country. The author discusses the culture and institutions which, according to him are important factors, while government policies play a critical role in relation to barriers and facilitators of such relationships. The article gives a brief overview of the profile of public research organisations, mainly the University of Cyprus. Hadjimanolis A. (2006) also mentions the role of innovation policy of the government of Cyprus and the industrial problems which can occur while cooperating with U.R.

According to Hadjimanolis A. (2006:68) “the main issue in collaboration is the degree of knowledge tacit ness”. The concept of knowledge tacit ness means the volume of the knowledge which can not be encoded in a text or pictures and can be only transferred by personal contact.

The author analyzes not only barriers, but also facilitators of collaboration between university research and small and medium size enterprises (SME). During the analysis Hadjimanolis A. (2006) mentions the negative and positive factors which influence the interaction between U.R. and industry. The author applies two theoretical patterns to the facts of the case study. The two facts are considered as follows:
Knowledge is transferred from the U.R. to the company. U.R. is considered as a producer of knowledge and a private company as a user of knowledge. There are three stages of transferring the knowledge from producer to the user: generation, transmission and distribution. Some barriers and facilitators are associated with each of these stages.

It is difficult to predict the barriers and facilitators of the interacting in the beginning of the project, because the process is unstable and knowledge-transfer stages are overlapped. However, such difficulties are characteristic for a company from less industrialised country.

To sum up, the main difference between the problem of my analysis and the problem in this article is that Hadjimanolis A. (2006) concentrates on small and medium size enterprises (SMEs). But the main similarity is, that the author analyses the object of knowledge of such collaboration. In my thesis I am going to analyze the relations between the objects: knowledge, learning and innovation of collaboration between the university research and a company. Hadjimanolis A. starts with describing the theoretical patterns and goes on to the methodological part where he applies these patterns to the facts of the case study. In the same methodological way I am going to apply the theory to the practice with the help of a model of the relationships between the knowledge, learning and innovation. In my research I am going to answer the questions mentioned in the beginning: why does industry collaborate with university research? How do both sides collaborate?

### 2.6 The Model of Innovation process

To make easier to reach the research objective, the model (Figure 4) of Lundvall B. A. (1992) has been chosen. This model illustrates relations between learning, growth of knowledge and innovation in innovation process. According to this model I will analyze the relations between industry and university research in the innovation process. This model is used also as “a tool” in my study to collect empirical data.
2.6.1 Institutional Impact

If we take a look at the model we can see that institutional set-up influences every step of innovation process. Institutional set-up and its impacts on the model are illustrated by dashed arrows. As it was discussed above institutional infrastructure involves all extramural R&D organizations.

According to Kitanovic J. (2005) the term *institution* involves two descriptions. “On the one hand, institutions are concrete units that deal with the organization and utilization of R&D, like universities, research institutes or R&D departments in large firms. These are labelled as organization. On the other hand, institutions are defined as factors that shape behaviour, like rules, norms or expectations. In everyday language both types are
summarized as institutions by including organizations in the concept of institutions.” Kitanovic J. (2005:22)

In my research the analysis of the model (Figure 4) the institutions are interpreted as the university research (U.R.)

2.6.2 Interactive Learning

The innovation process starts from the interactive learning. The author Lundvall B.A. (1992) characterizes the modern industrialized society with its universities, different types of research institutes and R&D departments. The modern society involves multiplex and concentrated forms of interaction inside the research community. The interaction also exists between communities and individuals. Since almost all learning is done by some form of interaction it is shaped by institutions. Learning is a social process which is hardly done individually. Learning needs support and relations in order to exchange the knowledge. Modern economy develops its capability to learn step by step. Researches are institutionalised and linked to science through the universities, research institutes, R&D departments of big companies and so on. People of the organization have different knowledge which is exchanged during the permanent communication. Many companies are interested in increased knowledge in order to stimulate innovation. This is a special kind of learning – a subset of the total set of learning processes. It is searching. Lundvall B.A. (1992)

Universities are non-profit organizations; therefore they can ignore the potential economic usefulness of new knowledge. Nevertheless the university research is an important part of the total knowledge creating system. There are two kinds of professional and organised searching for new knowledge:

1. the search activities organised in close connection with production;
2. the less profit-oriented basic research activities of universities and similar organisations. Such research is called learning by exploring.

Institutional impact on interactive learning: These two kinds of searching are, however, strongly interdependent, and the borderlines between them seem to be increasingly blurred.

2.6.3 Stock of Knowledge and its Remembering

Interactive learning in the forms of learning-by-producing, learning-by-searching and learning-by-exploring tends to increase the stock of knowledge. The stock of knowledge is increasing over time because learning is cumulative. The arrow going from interactive learning to stock of knowledge means that knowledge appears after learning.

Institutional impact on the stock of knowledge and its remembering: According to Hodgson, G. M. (1988) institutions influence the growth of knowledge in many ways and
on many levels. In fact, it is impossible for an individual to think and act in any specific field of the application of knowledge without being influenced by the institutional set-up. Information is culturally processed: it is never transmitted raw but selected, arranged and perceived through institutions. In society knowledge is stored in many ways, and institutions are important for determining how this is done.

2.6.4 Innovative Ideas and Projects
Managers from a company accumulate the knowledge through learning after what innovative ideas start to appear. In order to implement ideas managers organize the projects. This is shown by arrow which goes from knowledge to innovative ideas and projects.

2.6.5 Innovation
If the project is going well the real innovations are found. This is shown by arrow which goes from innovative ideas and projects to the innovation.

Institutional impact is illustrated in the model like selection mechanism. It means that Institutional set-up influence the selection of innovation from the project.

2.6.6 Forgetting and Creative Forgetting
In the innovation process the concept of forgetting is also important, however it is not leading. Lundvall B.A. (1992) at his model illustrates not only forgetting but also creative forgetting.

Forgetting on the model (Figure 4) comes from knowledge. It means that knowledge can be diminished by forgetting. According to Lundvall B.A. (1992) any scientific or technological modification requires forgetting of old knowledge and skills. The implementation of innovations requires old rules of behaviour, routines and models of collaboration within as well as between companies to be changed or forgotten. However, in practice the process of forgetting is handled painfully. It may be not easy to change activities and forget knowledge into which time, effort and prestige have been invested. As a consequence of forgetting process the reaction of some employees surely can be negative. Employees are influenced by forgetting socially, economically or psychologically. Discontent of employees leads to the conflicts.

Creative forgetting can come from two sides: knowledge and forgetting. The arrow going from forgetting to creative forgetting means that the stock of knowledge tends to be diminished by different kinds of forgetting, but creative forgetting may actually establish a feed-back mechanism to learning and indirectly lead to increased knowledge. Parts of the new knowledge may under certain circumstances find their way into production in the form of innovations. The luck and coincidental combinations of creativity may be necessary in order to take all the steps from learning to innovation. The arrow going from knowledge to creative forgetting means the shorter way of feed-back mechanism to learning. According to Kitanovic J. (2005 :22) creative forgetting is an important element
of the learning process. There impact of institutional set-up is huge because without it companies would resist changes. For implementing of innovative activities it is necessary to forget old habits of thoughts, routines or structures.

According to Lundvall B.A. (1992) forgetting is, thus, an essential and integrated part of learning, even if it is not always easy to separate ex ante between creative forgetting and just forgetting. Institutional impact on creative forgetting and just forgetting also take place in the model. Bengt-Ake Lundval (1992) means that institutional infrastructure like educational one influence the process of forgetting by providing new knowledge – the old knowledge should be forgotten. Kitanovic J. (2005 :22) writes that in order to advance a process of catching up, requirements for creative forgetting have to be fulfilled by adapting institutions and organizations.

Finally, the innovation process continually changes the conditions for interactive learning which is illustrated by the long feedback arrow on Figure 4.

3 RESEARCH METHODOLOGY

3.1 Research Approach

According to Fagerstrom B. (2004) data can be qualitative or quantitative. These data can be collected by different ways: interviews, participant observations, diary keeping, informal discussions or videos. Diary keeping is specific way to collect data, because during it active intervention can occur and the studying process than will be influenced. Sometimes researchers are not sure about the kind of methodology and must make some effort to recognize if method is qualitative or quantitative. However, Fagerstrom B. (2004) argues that it is the collected data that is qualitative or quantitative, not the method itself.

According to Sullivan T.A. (2005) it is possible to hypothesize only if theoretical frameworks are done deeply enough. Theoretical hypothesis is tested using empirical data. Primary is versus secondary data.

Advantages and disadvantages of quantitative and qualitative approaches

According to Johansson B. (1995) one of advantages of the quantitative approach is that it is possible to receive the responses of a great amount of people by using limited quantity of questions. However, received answers can be not relevant to the real thoughts of respondents. The researcher can ask questions and will receive the answers, but he will never know how important and actual these questions are for respondents. Therefore, quantitative approach can quickly provide broad and general conclusions. Contrary to the quantitative approach, qualitative research methods provide a lot of particular and detailed data about a much smaller number of people and cases. The main difference is that the researcher using qualitative research methods is interested in the point of view of a responding person and tries to understand his situation. The case of the researcher is understood than better, but level of generalization is low. (Johansson B., 1995)
For this study I chose the qualitative research method for the one important reason. In comparison with quantitative methods, qualitative research provides the analysis of a selected case in more detail. Using quantitative methods the researcher should refer only on determined rules and shifts what leads to the limited understanding of respondents’ perspectives and experiences.

In my thesis I used the case study as one of the main types of qualitative research because a detailed description uncovering how events were linked was necessary. Moreover case study method enables investigator to appreciate and analyze real problems and events faced by people in business. The case study method allows also applying the theory.

Neill J. (2006) defines the case study as attempts “to shed light on a phenomena” by studying a single case example. According to Neill J. the case can be an individual person, an event, a group, or an institution. Wanstrom C. (2006) emphasizes another important reason for using case study. He argues that if the researcher has no control over the events, but he wants to analyse actual events, case study can be the most suitable. According to Zach L. (2006:5) a case study is an exploration of a bounded system. Bounded system can be considered as a program, an event, an activity or individuals. In my study I am analyzing an activity – collaboration between U.R. and industry.

Case studies can be multiple or single, and for this thesis single case study was chosen because of its unique characteristics. The research group from Halmstad University as well as the company Volvo have been chosen on purpose. I came to Halmstad in September 2006 in order to study at Halmstad University. Since for me it was a foreign institution of higher education I wanted to get to know as much as possible about it. While collecting the information about the university’s activities I found that the University of Halmstad is not just an institution of higher education but also the institution of research. Furthermore the research activity of the university revealed to be well developed as it had good relations with the famous international company Volvo. Since I was interested in the process of innovation for a long time, the collaboration between the Halmstad University Research Group and the company Volvo seemed to be a perfect case to study.

3.2 Data Collection

3.2.1 Primary Research

Sullivan T. A. (2005) argues that the greatest advantage of primary data is the ability of researcher to apply the data collection exactly to the planned question. However the disadvantage is that primary data collection is high-priced and requires a lot of time. If total study was done just by collecting primary data, the research would be small and subject charged of being non-representative. The variations and any biases are typical to the process of primary data collection. Therefore exceptional attention should be paid to the quality of data. In order to prevent the mistakes and misunderstandings during the primary data collection, the competent researcher or research group should be chosen.
The role of researchers involved in the process of primary data collection is very crucial, because it is them who identify, sort out, keep and structure the data. Investigators are very responsible for the primary data collection, because missed, incorrect or incomplete information determines disadvantages and limitations in a study. Also results of such study can be unreliable. Hence the conclusion is made that for the process of primary data collection not only invested time and money is important, but also consideration and concentration of researchers (Sullivan T. A., 2005)

Patton M. Q. (1990) has analyzed the qualitative approach and pointed out that qualitative methods consist of three kinds of data-collection:

1. In depth, open-ended interviews
2. Direct observation
3. Written documents

In comparison with qualitative methods, mentioned above, the main quantitative research methods use structured interviews, measurements, standardized tests, statistics, questionnaires and experiments. Methodological sciences nowadays are so well developed, that there is a large choice of different methods which can be used in research. The most important is to make right decision about which method is the most relevant in order to solve chosen problem (Johansson J., 1995)

In my study I used the face-to-face interviews to collect empirical data. While studying the web site of Halmstad University I found the link to the web site of the research group of this university, which provides all relevant information about the activity of the research group. The leader of research group is professor Bengt-Göran Rosén. Since the most relevant methodology for the purpose of this study to my mind was an interview I decided to interview the manager of the research group – professor Bengt-Göran Rosén. By e-mail he agreed to meet with me and answer my questions in one week. I prepared two copies of written questions: one copy was for me in order to help me ask the questions; another one for the manager in order to make the interview go smoother.

There were two groups of questions regarding the collaboration between the U.R and industry. Questions of the first group were asked in regard to collaboration between the U.R. and industry at all points. Questions of the second group were asked in regard to the relations between learning, growth of knowledge and innovation (Figure 4). The questions are attached in the appendix No 1.

While analyzing the relations between learning, growth of knowledge and innovation according the chosen model (Figure 4), the professor suggested speaking directly to the researcher in order to know more about the interactive learning. The researcher knows more about the interactive learning from his experience in working on the project and communicating with the company’s managers during the meetings. Thereby I interviewed the PhD student - researcher from Halmstad University - Frédéric Cabanettes.
As I mentioned before in face-to-face non-structured interviews were used in order to collect primary data. This kind of interviews gave respondents room to speak freely. The interviews took place at the respondent’s offices and averaged about two hours.

According to Fagerstrom B. (2004) the process of interview consists of several steps: purpose, planning, interview, noting, investigation, review and reporting. All mentioned steps should be thoroughly planned before initiation of the interview process.

Before trying to find scientific clarifications, it is essential during interviews to understand correctly the meaning, experiences and comments from the respondent’s point of view.

The interview of the high quality is characterized by following factors:

- Short interview questions and long answers are treated positively; An ideal interview should have a continuous interpretation during the interview;
- The interview is self-communicated, a readable story;
- The number of spontaneous, specific and relevant answers is an important criterion for a good interview.

Interviews are often criticized for one main reason. Critics assume that in order to investigate subject deeply it is not enough to interview just few persons. Critics suggest selecting a few intensive and conventional cases in order to obtain general knowledge. However proponents of interviews ignore this suggestion, because they assume that knowledge is created during the interview, between the interviewer and the respondent. During the interview secondary subjectivity can occur. Secondary subjectivity according Fagerstrom B. (2004: 24) “is the phenomenon in which the respondent gives a subjective statement that is interpreted subjectively by the interviewer.” In order to prevent appearing of secondary subjectivity Fagerstrom B. (2004) recommends interviewing at least two respondents.

3.2.2 Secondary Research

According to Sullivan T. A. (2005) secondary data is the databases and literature that already exists. Investigator analyzes the secondary data in accordance with his specific research problem. Before collecting primary data researcher always reviews the secondary data which is already available. Researchers can use libraries, archives, different governmental information, and other kind of information which was collected by others. Therefore the process of studying secondary data can be defined as reanalysis of primary data collected by others. There is a big advantage regarding to the expense of secondary analysis, because secondary data doesn’t require so much time and efforts like original primary data. Somebody already had collected information and during the secondary analysis investigator should just understand and select information which is
needed. The main disadvantage of secondary data is the problem that data was collected not in order to answer the researcher’s specific question (Sullivan T. A., 2005)

Secondary data for this thesis was collected from the library of Halmstad University. The library of Halmstad University is seen as central pedagogic resource. Library has as an assignment to effectively serve and promote research- and development work, teaching and higher studies; also students, teachers, researchers, other personnel and the public.

I found a lot of useful information for my thesis in the literature from the library of Halmstad University. Useful information was selected from books, journals, articles, published dissertations of PhD students. Of course the IT like internet and famous databases from it was also widely used. Mainly I was using the EBSCO HOST research databases.

### 3.3 Research Validity and Reliability

According to Eisenhardt K. M. (1989) it is important to discuss the reliability and validity of the research. However, it is assumed that reliability and validity are mainly related to quantitative research. Nevertheless, reliability and validity have been discussed in relation to the case study method. Before analyzing the conclusions and quality of a certain study researcher should take into account reliability and validity of that study. The concept of reliability can be viewed as research testing or evaluating. If we understand the term of testing as a way of receiving information, then the most important test of any qualitative study is its quality. Qualitative study with high enough degree of reliability is not confusing or unclear. In order to ensure reliability in qualitative research, the proof of trustworthy is very important. Reliability is a consequence of the validity in a research. Investigator’s comprehension of validity has a big impact on the validity of research. Therefore many investigators have created their own concepts of validity. For instance researchers identify validity with terms, such as quality, rigor and trustworthy (Golafshani N., 2003)

Reliability is like an indicator of whether a renewal of a research will provide the same results. It is also like a measure of the extent to which a study can be attributed to be relevant or not (Remenyi D., 1998). “Reliability is concerned with the question of whether the study is carried out in such a way that the data collection can be replicated”. Wanstrom C. (2006: 43) It means the ability to receive the identical results of the study if this study would be done later, but with the same conditions and using the same methods. In order to decrease the number of mistakes and discrepancies it is useful to increase the number of interviews or questions in regard with an analyzing subject.

The possibility of replicating the case studies and obtaining the same results is an important question. Since the respondents were asked questions of their day-to-day work, it is likely that they would give the same answers in a replicating study. The data collection in this research has been well documented, because reports of interviews were sent to the respondents and the feedback was received. This fact increases the reliability of this case study. However, all case studies are unique and the companies are continuously changing, meaning that the exact same situation will never exist again.
External and internal validity
According to Wanstrom C. (2006) external validity creates the field to which a study’s results can be generalized. The author distinguishes between two types of generalisation:
  • Analytic generalisation
  • Statistical generalisation
Analytical generalisation is typical for case studies and for statistical methods, like a survey for instance. In analytical generalisation previously developed theory is used as a model according to which the empirical results of the case study are compared.

According Calder B. J., Phillips L. W and Tybout A. M. (2001), internal validity addresses whether or not an observed covariation should be considered a causal relationship. External validity examines whether or not an observed causal relationship should be generalized to and cross different measures, persons, settings, and times. According to Wanstrom C. (2006) “the internal validity is only a concern in explanatory case studies, which means that it is only applicable to case study where simulation was used.” It means that results of the study are mostly characteristic only for this one analyzing case. There is no guarantee that the same results would be achieved if another case had been analyzed.

Validity of my research is internal, because the findings are relevant mostly just for analyzing case – collaboration between Halmstad University Research and industry.

Communicative validity
According to (Kvale S., 1996) the interviews conducted in a dialogical form allow avoiding any misunderstanding, moreover they enable establishing a shared understanding of the study. Therefore dialogical interviews perfectly develop communicative validity and differently to structured questions and answers more often notice crucial misconceptions.
In my study the interviews were conducted in a dialogical form.

Pragmatic validity
According to Kvale S. (1996) problem of pragmatic validity means that information which respondents provide during the interview can be not true. As people in reality can behave differently comparing what they say during interview. The best way to improve pragmatic validity is naturalistic observation. However in my study I had no opportunity to observe my problem in practice, instead another method have been used to increase pragmatic validity. The questions of a practical character like concrete examples or situations have been asked.

According to Kvale S. (1996) the investigator in qualitative research is like “a tool” himself, because validity depends just on the communicative skills and competence of the researcher.

According to Wanstrom C. (2006) interviews have big impact on the validity in case study, because they collect relevant and important data. The problem is that sometimes
respondents can answer not correctly or be not enough objective in their answers regarding their work. However this kind of problem will be minimized if researcher asks the same questions more than one respondent.

4 EMPIRICAL DATA

Empirical is a term that includes many methods, including both quantitative and qualitative approaches. Anyone considering an empirical project should consider first whether to use primary or secondary data. Primary data are those collected by an investigator for a specific project (Wanstrom C., 2006).

4.1 Profile of the Company Volvo and Research of Halmstad University

4.1.1 Halmstad University Research Group

The research group of Halmstad University specializes in knowing management and development. The group is doing researches in Information Technology, Environmental Science, Biosciences, Innovation Systems, Microtechnology. The university research group can try to help with any idea from start to finish. The research group at Halmstad University is like the system, where the processes of innovations are going on. Researchers successfully collaborate between the business world and the university. The topics of Halmstad University Research Group concern the quality of different kinds of surfaces. The main aim is to produce surfaces 100% “tailor-made” for specified purposes. Researchers by investigations try to answer to the questions as follows:

- whether a dental implant will last 5 or 50 years;
- if our cars trucks will be able to reduce their petrol consumption;
- if a mobile phone will have a high-quality texture appearance;

The research has a wide range of application. In order to support engineering applications some general methods within research areas can be applied. These methods can be for example: signals analysis, statistics, physical metrology, and quantitative topography characterisation. Mentioned applications vary from the automotive industry with manufacturing of low fuel-consumption engines, silent gear boxes, and complex car body panels, to manufacturing of dental implant surfaces and characterisation of artificial hip joint-implants for improved function and long product life. When controlling the manufacturing of the micrometer-large criss-cross pattern of the cylinder liner walls of an internal combustion engine, the research group and its partners have the tools to significantly change the fuel- and oil consumption, with strong impact on the environment. Researchers from the Research Group of Halmstad University are mostly PhD students. Halmstad Research Group cooperates with Chalmers university, Linkoping University, and Lund University in order to find partners within the mechanical and biotechnical industry. Financially the Halmstad University Research Group is supported by governmental VINNOVA, as well as the national SSF- and KK-foundations.
4.1.2 Volvo

Looking back to the history, in 1927 the first series-manufactured Volvo car, the Volvo OV4, rolled off the production line on the island of Hisingen, Goteborg. Since then, Volvo has developed from a small local industry to one of the world’s largest manufacturers of heavy trucks, buses and construction equipment, with more than 83000 employees, production in 25 countries and operations on more than 185 markets. The Volvo Group is a mixed organization, because there are both separate and common business areas. Such versatility of the company increases its flexibility and allows being closer to the customers. The R&D follows that model as well. Business areas control and perform the product development. Research, main processes, development of technology, tools and infrastructures are coordinated and performed by common boards and units. About 50% of the Volvo Group R&D is performed in Sweden and the rest in different locations in Europe, US, Asia, South America.

Research group of Halmstad University collaborates with two of the several common business units of Volvo Group: **Volvo Powertrain** and **VolvoTechnology**.

**Volvo Powertrain** group has common engine platform that fulfil the latest environmental requirements, a more focused research and development program, more efficient production and a more focused supplier structure. The driveline, which consists of the engine, gearbox and the driveshaft or driveshafts, is often described as the heart of a vehicle. Volvo Powertrain is responsible for the development and production of heavy engines, gearboxes and driveshafts. Powertrain is also a substantial manufacturer of heavy gearboxes in-house, with production Köping, Sweden and Hagerstown, Maryln, in the US.

**Volvo Technology** (VTEC) is an innovation company that develops new technologies and concepts for “hard” as well as “soft” products and processes within the transport and vehicle industry. Volvo technology participates in national and international research programs involving universities, research institutes and other companies (www.volvo.com).

4.2 Empirical Presentation

4.2.1 Collaboration between the U.R. and Industry from the Perspective of University Research Manager

In the beginning of the interview I tried to investigate the collaboration between the U.R and industry. The collaboration here was mentioned as the communication and interaction between firms.
Regarding the difference between U.R. and R&D department, the manager of Halmstad University Research Group told that the company is acting more in the wider field and university research specializes in one area. For example Halmstad University Research is specialized only on surfaces. Company doesn’t have the same competence like U.R. The main difference is that R&D department is interested in doing work quickly and U.R. is working much longer (2-4 years) on the same project. Another crucial difference is that in R&D department engineers are engaged, while in U.R. we deal with researchers. According to the manager of U.R. the usefulness of such collaboration for researchers from university is huge. For PhD students it is much more interesting and useful to do projects the results of which will be used in practice. Also PhD students and U.R. need publicity.

The interesting fact is, that although the collaboration is necessary for both sides, the company is looking for U.R not U.R. for a company. When company has a problem it starts to look for someone who can solve it using scientific methods. At this point the size of the company is of crucial importance. The manager said that only bigger companies really need the collaboration with U.R. Smaller ones, like those with less than 500 employees are not able to handle the collaboration with U.R. Furthermore small companies don’t usually have the problems which should be solved by U.R. using the scientific methods.

For some companies it can be interesting how the projects are financed. The manager said that usually financing of the project is mixed: 50% of project’s price is paid by the company; another 50% comes from the industrial branches and the governmental VINNOVA, as well as the national SSF- and KK-foundations. However there are some projects, which are paid 100% by a company.”

It is possible that some companies are afraid of publicity of the U.R. projects because of competition. It means that a company can hesitate to collaborate with U.R. because it can be afraid that innovative results of the project will be published. The company invests its knowledge, time and money for the project and of course doesn’t want to share the results with competitors. The manager of U.R. told that research member can sign the contract that he/she will not demonstrate the results of successfully done project. However U.R. as it has been already mentioned need publicity anyway. So the project is always published. But the information which will be published depends only on the company. Before publishing the scientific article, the researcher always shows the draft to the managers of the company, for which that project was done in case if company’s managers prefer not to publicize some results of their project.

Not every company is prepared to collaborate with U.R. it can be useful to know which factors are important to take to the company’s account before making decision to cooperate with university research. The manager said that the most important factor is time. Company’s managers must take into account that U.R. requires the close collaboration with the company. Close collaboration in this case means: meetings, seminars, discussions. Researchers from U.R. in order to solve the problem of the project and receive correct answers must learn a lot. It means that the performance of the project takes a long time: 2-4 years. If a company is not prepared for time consumption, it faces a
misunderstanding. In this case U.R. may send a company to a consultancy firm, which gives the answer in a shorter period of time.

Regarding the manager’s opinion on what can be still improved in the collaboration between U.R. and industry the manager said that some companies really don’t know how they can use U.R. in order to improve their profits. Companies need to have more information about U.R. Also if companies don’t have experience with cooperating with U.R. it is complicated for them. Usually university research for company’s managers associates with teaching. However U.R. has nothing in common with teaching. Some companies get to know about U.R. from other companies. By reading scientific articles or by communicating with other companies managers can get to know that something was done for another company by U.R. and it was good.

4.2.2 The Impact of U.R. on Forgetting, Stock of Knowledge and Innovation from the U.R. Manager Perspective

According to the answers of the manager, the impact of U.R. on creative forgetting and just forgetting is the most problematic one. According to him, the biggest problem is to persuade the company that there have been new – and better - ways found by scientific methods. Companies don’t understand the use of scientific methods. Companies try to keep old knowledge, they hardly separate with old knowledge. When something new is found, companies don’t ask “why” (which scientific methods have been used to receive such results), they usually rely on the old knowledge. And this is one of the biggest problems in collaboration.

Concerning the stock of knowledge and remembering of it, the manager explained that in a company new people are employed, so sometimes the memory from the company is lost. However the university research still has all information about the company. Therefore often employees from companies come back to university research in order to re-start projects, or just to renew the memory (remembering).

It was interesting to know when innovation is born. How do researchers recognize it? The manager answered that nobody can prove that the newly found ways of production are correct. It is a natural process that new innovative ideas appear during continuous learning and these ideas are based on knowledge. There is no project without any good results. Every project has useful new results that are always implemented in production. Of course before production the results of the project are modified and tested.

4.2.3 Concrete Example of Interactive Learning

The process of learning in the model of relations between learning, growth of knowledge and innovation (Figure 4) is named “interactive”, which leads to assumption that collaboration between the U.R and industry appears exactly at this point. Bengt-Ake Lundval (1992) writes that two kinds of learning: by searching and by exploring are
strongly interdependent and the borderlines between them seem to be increasingly blurred.

Since the meetings with company’s managers according the researcher decide what researcher would do next, I asked to explain in turn what is going on during every meeting. In order to make serial order of the meeting I decided to number each of them. Periods of the researcher’s activity were also numbered. The numbered meetings and periods will help to make a diagram in the analysis part (chapter 5) of this thesis.

**The order of meetings:**

1st meeting. The university research manager received proposition of collaborating from company Volvo. During the first meeting there was a discussion about financial support. Also discussion about which PhD students will be involved to the project. Two sides decided about the duration of the project and materials needed.

2nd meeting. Everyone is introduced to each other. The person responsible for the project from company is appointed. Company shows the examples of studies which were done before for the company.

3rd meeting. The researcher went to the Volvo production department, where producers showed the facilities of production. The researcher also is learning a lot during this meeting.

4th meeting. The meeting is with Volvo group which is in charge of analyzing problems. Volvo group receive back the components directly from customers who are not satisfied of the quality of components.

5th meeting. The meeting is with Volvo group. During this meeting managers from Volvo were explaining the problem much deeper, because the research is already studied in this field. The researcher already started to know what is going on. The Volvo group explained, that this was in purpose to left the researcher alone to study the literature. From this meeting company started to give much more information for the researcher.

6th meeting. During this meeting it was decided to publish first results. Just part of the project is going to be published. More intensive collaboration starts. Company gave the equipment, camshaft and university provides the laboratories. During this meeting it was decided about exchange of materials, needed for the project performance.

7th meeting. Conference. There is the discussion what have been learned from the first publication. Collectively are selected other ways to collaborate, the subject for next publication is chosen.

7th meeting – Conference.
Order of periods:

A Literature survey. Researcher works by himself. Analyzing the literature of the problem takes long time 3-4 months. In this period researcher learns a lot. There are some meetings to present literature review results. Already in this period the collaborative learning started: the managers from the company were teaching the researcher. The literature review was comparing with practice.

B In this period researcher receives the literature from Volvo group about the problem.

C This period can be called "The state of the art" (the fact when researcher is checking how advanced is field). "The state of the art" is the highest level of development, as of a device, technique, or scientific field, achieved at a particular time. During this period researchers were visiting companies which are related more or less to the problem or can help to give solutions for later. All companies were doing presentation about the problem from their point of view.

D This period - preparing for the next conference.

E This period - preparing for the next conference.

F – PhDs courses, learning from meetings, learning from colleagues, news update

5 ANALYSIS

In this chapter, the analysis of the empirical data will be connected to the model (Figure 4) of relations between learning, growth of knowledge, forgetting and innovation. Also the reasons for collaboration from the research manager point will be discussed. In comparison with the theoretical and empirical findings, the research questions are either favourable or unfavourable.

5.1 Impact of U.R on Interactive Learning

According to Lundval B. A. (1992) the impact of institutional impact on interactive learning means that learning by searching and learning by exploring are strongly interdependent, and the borderlines between them seem to be increasingly blurred.

In order to analyze the interdependence between learning by searching and learning by exploring the diagram (Figure 5) of project from the researcher point of view was created. The diagram shows what researcher is doing during different periods of the project evaluation. The meetings with the managers from company are crucial in changing periods. The periods are marked by letters while the meetings by numbers.
Time represents researcher’s time which was spent on project. The area above the line of time means innovative results and the area below – learning. From the first sight we can see that at the beginning researcher spends time just for learning: periods A and B (Figure 5). Later periods D and E show that researcher is finding innovative results. However we see that during the entire time researcher is learning: periods A, B, C, F are going along with the line of time.

The fact that researcher is learning all the time while working on the project proves the statement of Lundvall B. A. (1992) who argued that innovation process reflects learning. Lundvall B. A. (1992) also says that the exchange of knowledge is the most important factor in the process of learning. Respondent Frédéric Cabanettes proved this argument. Researcher said that during meetings with Volvo managers the exchange of knowledge is going on. Lundvall B. A. (1992) was writing that innovation may accordingly be viewed as basically a collective activity; an outcome of communication and interaction between people. This kind of interaction between people takes place during the meetings where both sides collaborate.

Therefore meetings are very important in collaboration between the U.R. and industry. On the diagram (Figure 5) the numbers represent meetings. What was decided during these meetings was explained in chapter 4.2.2. On diagram it is easy to see that meetings (marked by numbers) are deciding the start of new period (marked by letter). Periods here have two meanings:

- time spent on certain activity of researcher (area of learning)
- time when researcher finds the innovative results (area of innovative results)

The timescale on diagram is approximate, because the goal of this diagram is to show general picture of project evaluation from the researcher’s point. When in the same time on diagram there are two periods like: D and C or D and F; it means that researcher was learning and at the same time already finding innovative results. From period E-F the activity of researcher is not changing a lot. Researcher continuous to learn (period F) and in the same time he has periodically meetings (7-8). Now during meetings both sides decide what will be published. Dashed lines in the end of diagram mean that project is evaluated enough and the activity of researcher becomes routine: conferences – preparing for the conference, after again new conference and so on until the project is finished.

Therefore the theoretical interactive learning was proved. Bengt-Ake Lundvall (1992) wrote that searching and exploring are strongly interdependent, and the borderlines between them seem to be increasingly blurred. Learning by searching is inside company and learning by exploring inside university research. Study shows that in a practice researcher and managers form Volvo company collaborate, have meetings, during which exchange the knowledge all the time: researcher gives the theory – the company compares it to the practice. So the innovative ideas are born just because of collaborating of two sides. The company would not find anything new without scientific methods and researcher will not find anything without the practice.
5.2 Impact of U.R. on Creative Forgetting and Forgetting

Institutional impact on creative forgetting and forgetting also take place in the model. Lundvall B. A. (1992) means that institutional infrastructure like educational one influence the concept of forgetting by providing new knowledge – the old knowledge should be forgotten. The creative forgetting is necessary in the process of innovation and establishes huge feedback mechanism to learning and indirectly leads to increased knowledge.

However in reference to the answers of managers according the analyzing model (Figure 4) the manager doesn’t separate the concepts of creative forgetting and just forgetting. According him forgetting means one: to forget old knowledge and use new one, found by scientific methods.

According Lundvall B. A. (1992) forgetting is, thus, an essential and integrated part of learning, even if it is not always easy to separate ex ante between creative forgetting and just forgetting.
5.3 U.R. Impact on the Stock of Knowledge and its Remembering

Institutional impact on the stock of knowledge and its remembering according to Hodgson, G. M. (1988) means that institutions influence the growth of knowledge in many ways and on many levels. In fact, it is impossible for an individual to think and act in any specific field of the application of knowledge without being influenced by the institutional set-up. In society knowledge is stored in many ways, and institutions are important for determining how this is done.

From the first sight the impact of U.R. on the stock of knowledge and its remembering looks strange. However the manager without doubt confirmed that this impact is big. The manager explained that in a company new people are employing, so sometimes happens that memory from the company is lost. However the university research still has all information about the company. Therefore often employees from companies come back to university research in order to re-start projects, or just to renew the memory (remembering).

5.4 U.R. Impact - the Selection Mechanism

The impact of institutional infrastructure on innovative ideas and innovations is illustrated in the model like selection mechanism. The concept of selection mechanism according to Lundvall B. A. (1992) means the automatic process, working on the set of innovative ideas and projects, which are generated by new knowledge.

The manager of Halmstad U.R. didn’t weight down the impact to the selection of innovative ideas and projects. The impact on innovative ideas according the manager is not big, because innovation process is first of all natural process, where new innovative ideas appear naturally during continuous learning.

5.5 Reasons for collaboration between the U.R. and industry

According Lundvall B. A. (1992) modern firms often search for a new knowledge to be used in production, as new processes or new products. Because of competition, searching will always be conducted under some degree of hiding, so that the results from learning in one firm are not immediately accessible in other firms. The interview results show that statement of Lundvall B. A. (1992) mentioned above is proved in the practice. Therefore company shouldn’t be afraid, that if it invests money and time for the collaboration, the results can be published and other companies can use them. Not everything is published. Furthermore before publishing the researcher sends a draft for confirmation for the manager of company. A published article is full of information and results. The way to get results is explained with certain methods. Nevertheless explanations are not sufficient to reproduce directly the same results. There is still a great amount of information hidden in the text, so a reader of the article encounters lack of explanations. Therefore appears
the concept of “black box”. Those “black boxes” which often correspond to a computer program are giving results without showing enough the steps to get them.

According to West A. (1992) government invests money to the processes of innovation in order to help the firms improve their competitive position in the international environment. Companies should know that government is interested to help in the producing innovations because innovations influence the rise of GDP (Gross Domestic Product). The results of this study show that governmental institutions like VINNOVA support innovative projects until even 50%. Rationally is to use such possibilities of financing.

According to Tucker R.C. (2007) researchers of university can have a unique understanding of the theory necessary to develop a new product. Students are able to characterize materials and do laboratory-scale studies. Similar reasons mentioned Link A. N. and Scott J. T. (2006). They argue that companies want to get access to the educated students, to involve university’s faculties in new business ventures and to stimulate university to familiarize with their equipment. Cooperation with universities enables companies to be aware of science and new technology. The results of the study have proved the fact that industry collaborates with university research in order to produce innovation because of university research’s competence to find new scientifically based ideas.

According to Tucker R.C. (2007) collaboration between U.R. and industry provide significant opportunities for students to interact with the “real” world of industry with the satisfaction of having contributed to useful new products or processes. Results of the interview show that the core is that PhD students are the most interested to find the innovative results in this collaboration. Students are interested to write their dissertations as best as it is possible with any new innovative, practical based ideas since the received diploma is direct road towards their professional success. The researchers of university are mostly students full of energy and willingness to work on the project. While for company’s personnel the project can be just the next task to perform. The researcher has his full time spared for the project, while the company’s managers have a lot of other tasks to perform. It means that for company’s employee as for individual the innovative project is just the matter of his big company and results of the project will influence the company’s image, not his. While for the student from U.R. any innovative result find by himself is crucial for his dissertation and articles, periodically written for publication.

6 CONCLUSIONS AND RECOMMENDATION

6.1 Conclusions

The objective of this study: to analyze university research and industry collaboration, in which communication, exchange of knowledge and learning creates the innovation process was achieved.
The results of this study showed that relations between knowledge, learning and innovation determine the innovation process. University research can not produce innovation without practical knowledge which is provided by company during collaboration. As the present study has shown, similarly the company can not produce scientifically based innovation without the interactive learning with university research during the collaboration.

The results of this study show very clearly all collaboration process. It was found out that the first step to start collaboration is always made by industry, not by university. Since researchers from university use scientific methods and study theory of the problem, the implementation of the project is long: from 2 until 4 years. In this case meetings and communication during collaboration are crucial. Meetings with the managers from company decide what researcher will do next.

In analyzing case researcher is learning during the all project implementation. In the beginning he is learning the most. Results of the study show that both sides need each other, because of many reasons. For example university researchers need publications and industry needs access to the university databases and competence of students.

6.2 Recommendations

After analysing the collaboration between the U.R. and industry from the U.R. manager’s point of view, follows that recommendations can be given for industry. Therefore there are two kinds of recommendations according this study:

• What companies should take into account before collaboration with U.R.;
• How to improve the collaboration.

6.2.1 Factors to Know before Collaboration with U.R.

Managers must be prepared to explain problem scientifically for the researcher and every time give suggestions comparing theory to the practice. Company should choose strategy to collaborate with researcher. Results of this research show that company Volvo in the beginning of collaboration left researcher to study alone, in order to avoid him to be formatted by their approach of the problem. Companies should not be afraid that project can be failed. According the interview, “every project is with good results” which are later implemented to the production.

6.2.2 Suggestions of collaboration improvement

For the better collaboration I would suggest writing a code in which should be included all rules according the collaboration with U.R. Rules must be regarding the time spared for the meetings, particular terms of the project, persons included in the project. Like
manager of U.R. mentioned that collaboration requires the participation not only the employees from R&D department, but also from production department, design engineering, sometimes even suppliers. In the code should be written the schedule and responsibilities of every employee involved to the project.

And finally I recommend having a lively interest in university researcher. It means to be more interested in articles written by university research, in discussions about U.R. because it is always possible to find useful information about the collaboration. I would also recommend for managers be more flexible, more open to the new ideas of researchers, because to my mind the support and encouragement are relative to the quality of work of researchers.

6.3 Future Study

Future studies in this field must be conducted because the usefulness of the collaboration between U.R. and industry is obvious, it is innovation process. However this collaboration in my study was analyzed from the U.R. manager point. It was mentioned in this paper that a lot of studies have been done according this collaboration from side of industry, but those studies did not include so much the meaning of concepts of interactive learning and knowledge. Therefore I would suggest that future studies in this field can be done from point of other actors of innovation systems mentioned in the literature review of this study. I mean from point of:

• government
• financial institution,
• other formal R&D institutions.
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Interview with the leader of Halmstad University Research Group - professor Bengt-Göran Rosén

Interview with Fred the PhD student - researcher from Halmstad University - Frédéric Cabanettes.


http://www.vinnova.se/In-English/About-VINNOVA/


http://www.hh.se
Appendix 1

Interview Questions

The following are the questions for interview.

1. Why do you think company should cooperate with you if they have their own R&D department? What is the difference between U.R. and this department?

2. Why is it useful for U.R. to cooperate with company?

3. How do you find the company which would be interested to cooperate with you?

4. Which factors are important to take to the account before making decision to cooperate with university research? (if company never had relations with U.R. before)

5. Does company finance the projects you are doing for them?

6. How is the connection with company? Is it easy to get information you need?

7. How do you exchange the knowledge with R&D departments from Volvo?

8. With whom are you meeting to exchange knowledge?

9. When innovation is born? How do you know it? Who proves it?

10. How company can protect the innovation, the new improvements you found in production? Can research member sign contract that he/she will not demonstrate the results of successfully done project?

11. What is really going on in innovation process, when both sides cooperate? Exchange of knowledge? Learning?

12. According you, as U.R. manager, what can be still improved in the collaboration between U.R. and industry?

13. How does U.R. influence the learning, forgetting, creative forgetting, stock of knowledge, selection mechanism in the company?